



**Ministry of Surface Transport
(Roads Wing)**

**ADDENDUM TO MINISTRY'S
TECHNICAL CIRCULARS AND DIRECTIVES ON
NATIONAL HIGHWAYS AND CENTRALLY
SPONSORED ROAD & BRIDGE PROJECTS**

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(January 1995 to December 1997)

**Published by the
Indian Roads Congress
on behalf of the Govt. of India
Ministry of Surface Transport (Roads Wing)**

**Copies can be had from
the Secretary, Indian Roads Congress,
Jamnagar House, Shahjahan Road,
New Delhi-110011**

FOREWORD

Ministry's Technical Circulars and Directives on National Highways and centrally sponsored Road and Bridge Projects issued upto 1985 were published in two volumes. In addition, three Addendums covering circular issued upto December, 1994 have been published.

Between January 1995 and December 1997 a number of Circulars and guidelines have been issued. These have been compiled (upto December, 1997) and are being published as the 4th Addendum.

Ministry's Circular No. NH-VI/50(21)/79 dated 25th January, 1980 regarding "Investigations and design for high embankments at approaches to bridges and overbridges on NH's and other centrally financed roads" was printed (without enclosures) in Compendium of Circulars Vol. I. Keeping in view the demand for the enclosures from Consultants and P.W.D., the complete circular with enclosures has now been included in the present addendum.

The compendium of technical circulars have served useful purpose for making the Government policies in highway sector widely known to all concerned. It is expected that this addendum will afford an opportunity to the officers of Roads Wing as well as various State PWDs to keep abreast with the policy changes since the issue of the last addendum.

It will be our endeavour to keep updating these volumes as and when new Circulars are issued by the Ministry and bring them out in the form of Addendum for the benefit of the users. Any feedback from the State PWDs as well as technical officers of the Roads Wing to effect improvements in the future editions of the Addendum would be welcome.

New Delhi,
Dated: March, 1999

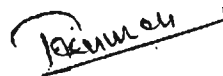

(Prafulla Kumar)
Director General (Road Development),
Government of India,
Ministry of Surface Transport (Roads Wing)

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119.13	RW/NH-11038/3/39-D.O.I dated 8.8.94	Updated norms for maintenance of National Highways	119/1 to 52

NO.RW/NH-11038/3/93-DO.I

Dated the 8th August, 1994

To

The Secretaries (dealing with National Highways), Public Works Departments of all States & Union Territories, Director General, Central Public Works Department, Secretary, Border Roads Development Board

Subject: Updated norms for maintenance of National Highways

I am to refer to this Ministry's letter No.RW/NH-11038/2/92-DO.I dated 13.4.1993 enclosing therewith updated norms for maintenance of State roads finalised by the Committee on norms for maintenance of roads. That Committee had, inter-alia, recommended separate group to consider the norms for maintenance of roads in hilly regions. A copy of the report finalised by the Committee on norms for maintenance of roads in hilly areas was also sent to the State Governments vide Ministry's letter No.RW/NH-11038/1/93-DO.I dated 26th July, 1993 for assessing the requirements of maintenance funds for State roads and projecting the same to the 10th Finance Commission.

2. The norms settled for State Highways in the above reports have now been made applicable to National Highways also. I am, accordingly, enclosing a copy of the above reports for your information and necessary action. It is, therefore, requested that in future the estimates for maintenance of National Highways may be projected on the basis of these norms.

**REPORT OF THE
COMMITTEE ON NORMS FOR
MAINTENANCE OF ROADS
IN HILL AREAS**

**GOVERNMENT OF INDIA
MINISTRY OF SURFACE TRANSPORT
(ROADS WING)
JUNE 1993**

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**MINISTRY OF SURFACE TRANSPORT
(ROADS WING)**

D.K. GUPTA
(CHAIRMAN, COMMITTEE ON NORMS
FOR MAINTENANCE OF ROADS IN HILLY AREAS)
ENGINEER-IN-CHIEF,
U.P. P.W.D.

No.RW/NH-11038/1/93-DOI

Lucknow, Dated the 8th July, 1993

Subject: COMMITTEE ON NORMS FOR MAINTENANCE OF ROADS IN HILL AREAS

Dear Sri Bagla,

Kindly refer to the Ministry of Surface Transport Order No.RW/NH-11038/2/92-DOI dated 16.3.93 on the above mentioned subject vide which a Committee was set up to recommend norms.

2. I have great pleasure in submitting the report of the Committee on Norms for maintenance of roads in hill areas. The report brings out separate norms for roads in hill areas to the price level of 1992-93, recommendations for monitoring of funds for maintenance and suggests methodology and approach for updating and its periodicity for review of maintenance of norms,

3. I hope that the concerned agencies in the centre and state will implement the recommendations of the committee with the commitment necessary so that the hill road infrastructure is preserved and continue to perform its due role.

4. I would like to take the opportunity to express my sincere thanks to the members of the committee for their guidance in completing the work of the committee and the other officers of this Ministry, the Indian Roads Congress and State P.W.D. for the efforts put in by them in the preparation of the report.

With regards,

Shri S.P. Bagla
Secretary,
Ministry of Surface Transport,
New Delhi - 110001

CHAPTER-1

INTRODUCTION

1.1. The Ministry of Surface Transport, Govt. of India had constituted, in January, 1993, a Committee on Norms for Maintenance of Roads. This committee while submitting its recommendations inter-alia observed that there was a need to work-out the maintenance requirement separately for hill roads keeping in view the peculiar problems encountered in hilly region such as landslides, removal of slips, clearance of snow in high altitude areas, maintenance of retaining/breast walls, etc. Though the Committee recommended updated premiums for hill roads on ad hoc basis, it observed that this may not meet the needs of hill roads fully and separate norms for hill areas are needed.

1.2. Accordingly, the Ministry of Surface Transport, Govt. of India constituted a Committee on Norms for Maintenance of Roads in Hill Areas vide their letter No.RW/NH-11033/2/92/DOI dated 16.3.93 (ANNEXURE-I)

1.3. TERMS OF REFERENCES:

The terms of reference of Committee are:

1. To review and update the exiting norms and criteria adopted for assessing the requirements of funds for maintenance of roads in hill areas.
2. To review the existing arrangements for monitoring of funds provided for maintenance and recommend measures for effective monitoring and supervision.
3. To recommend methodology and approach for updating and its periodicity for review of maintenance norms.

1.4. COMPOSITION:

The composition of the Committee is as under:

- | | | |
|----|---|----------|
| 1. | Shri D.K. Gupta
Engineer-in-Chief,
PWD, Uttar Pradesh | Chairman |
| 2. | Shri S.N. Mane,
Additional Director General
Border Roads. | Member |
| 3. | Shri S.K. Agarwal
Chief Engineer,
P.W.D. Himachal Pradesh | Member |
| 4. | Shri C.K. Hazarika
Secretary
P.W.D., Meghalaya | Member |
| 5. | Shri B. Megu
Chief Engineer
PWD Arunachal Pradesh | Member |
| 6. | Shri M. Radhakrishnan
Chief Engineer,
PWD, Kerala | Member |

- | | | |
|----|---|-----------------|
| 7. | Shri S.P. Gupta
Chief Engineer
P.W.D. JAMMU | Member |
| 8. | Shri S. Biswas,
Chief Controller of Accounts
Ministry of Surface Transport | Member |
| 9. | Shri D.P. Gupta
Chief Engineer (Planning)
Ministry of Surface Transport
(Roads Wing) | Member Convenor |

Shri Ravindra Kumar, Chief Engineer, Kumaon Zone, P.W.D., Almora (Uttar Pradesh) was also coopted as member of the Committee.

1.5. The first meeting of the committee was held on 26.4.93 in New Delhi when broad issues pertaining to the maintenance requirements for hill roads were discussed. Subsequently, detailed questionnaire was circulated to all members requesting them to intimate the maintenance practices being followed in their States for hill roads, the funds being allotted under different maintenance sub-heads, current average rates of labour and material, etc.

The second meeting was held at Najnital from 23rd to 25th May, 1993 when a draft report prepared by the Chairman was discussed at length. The draft report was modified and restructured based on the views expressed by the members in the meeting. The report was subsequently approved by the Committee subject to certain modifications to be carried out by the Member Convenor. The report was later on finalised by the Chairman.

S/Shri S.K. Agarwal, B. Megu and M. Radhakrishnan could not attend meetings of the committee.

1.6. These recommendations are supplement to the general recommendations made by the committee on norms of roads which are not being repeated in the report. However, these shall be valid for Hill roads also.

CHAPTER 2

IMPORTANCE OF MAINTENANCE

2.1. ROLE OF TRANSPORTATION

2.1.1. Transport is a very vital infrastructure for rapid economic growth of the country. In a developing country like India, transportation of natural resources which are not equally distributed throughout the length and breadth of the country is a basic input for economic growth. In fact the development of important sectors of economy such as agriculture, industry, mining and forestry, as well as international trade depends upon an efficient and speedy transportation network. Social activities such as education, health, family planning and promotion of tourism also depend to a large extent on transport. Accessibility is thus the first requirement for any development activity.

2.1.2. Out of the various modes of transport, road transport, is the only mode, which is complete in itself. Because of certain advantages such as flexibility, door to door service, reliability, speed, less stringent packing conditions etc., there has been a gradual shift in volume of traffic carried by roads over the past four decades and this trend is expected to continue.

2.1.3. The share of road transport in freight movement has increased from 11 per cent in 1951 to 60 per cent in 1991 to 80 per cent now.

2.2. GROWTH OF ROAD NETWORK IN THE PAST

2.2.1. In the last four decades, our road network has increased from 4 lakh km to 20 lakh km. Annexure-II gives an idea of the steady growth of road network in the country. Simultaneously the population of vehicles has also witnessed an unprecedented growth from 3 lakh vehicles in 1951 to about 213 lakh vehicles in 1991. Annexure-III gives historical growth of vehicle population.

2.2.2. The place of development of highways has thus been overtaken by the growth of traffic due to growing economic activities.

Inadequacies in road width and crust thickness are now threatening the economy causing congestion, delay and higher vehicle operating costs. There has also been steep increase in the number of road accidents and resulting fatalities, Annexure-IV gives the increase in road accidents during the last two decades.

2.3. HIGHWAY MAINTENANCE

2.3.1. An amount of nearly Rs.20,000 crore (Annexure-V) has been spent on roads during the various plan periods so far. The road network built at such a huge cost is now showing signs of disintegration and deterioration allround. For the preservation of huge public investment in highways, their timely upkeep and maintenance is an inescapable necessity. Maintenance of roads serves four main purposes:

- i) Reduces rate of deterioration and prolongs life of road.
- ii) Reduces Vehicle Operating Cost by providing good riding quality.
- iii) Keeps road open more continuously for use of traffic particularly in monsoon season.
- iv) Adds to the safety of the road user.

2.3.2. The problem of maintenance has acquired a new urgency in recent years as the traffic using the roads has shown a steep increase and this has also been accompanied by an all round rise in cost of materials and wages of labour. Highway maintenance budgets have, however, not risen correspondingly over this period. As a consequence, there has been a general fall in the maintenance standards and deterioration of surfaces in many cases.

2.3.3. The Planning Commission in their document on the Eighth Five Year Plan (1992-97) has inter-alia made the following observation in respect of road maintenance (ref. para 9.9.8 Vol.II pp.232).

"Maintenance of roads has not received adequate attention in the past primarily because of lack of funds."

It was estimated that availability of funds for maintenance generally does not exceed 60 per cent of normal requirements and in case of rural roads it is still less.

The overall gap between requirements and actual allocations has been self-accumulating over several years.

2.3.4. The failure to maintain roads is tantamount to an act of disinvestment for it implies the sacrifice of past investments in roads. Continuous neglect of maintenance may even lead to complete loss of infrastructure built at great cost. However, bad roads seldom deter users or curb the volume of traffic. Instead they raise the cost of road transport and thus the road users bear the brunt of these additional costs.

2.4. **COMPONENTS OF MAINTENANCE**

The objective of maintenance is to maintain roads and bridges on a continuing basis to their original level of construction and serviceability.

The maintenance operations are divided into following major activities:

a) **ORDINARY REPAIRS**

This activity involves routine maintenance such as maintenance of culverts, patch repairs, road side drainage, repairing of shoulders, painting of highway signs and arboriculture. This is also referred to as routine maintenance.

In hill areas, ordinary repairs also include some major repairs like repairs to breast walls/retaining wall, removal of slips/snow clearance and repairs to drains and reconstruction of damaged works.

b) **PERIODICAL RENEWAL**

This activity involves provision of renewal coat to the wearing surface at a predetermined frequency.

This is done to safeguard the road crust and at the same time giving pavement a better riding surface.

c) **SPECIAL REPAIRS**

This activity deals with minor works of original nature such as minor improvement to curves improvements to visibility, repairs to culverts, bridges etc.

d) **RAIN/FLOOD DAMAGE REPAIRS**

This activity involves immediate repairs to roads breached during incessant heavy torrential rains/floods due to landslide and washing away of bridges.

CHAPTER 3

SPECIAL REQUIREMENTS OF MAINTENANCE OF HILL ROADS

3.1. GENERAL

The maintenance operation for in Hill roads (cross slope of terrain greater than 25 per cent) differ greatly from those for plain roads because of the typical characteristics of hill roads. This variation is due to different topographical conditions of roads in hills. The basic difference in the hill roads is its gradient, cross-slopes requisite cross drainage works and problems related to heavy rain fall and snow. The ruling gradient of roads in hills is generally 1:20 and the gradients upto 1 in 12 have also to be adopted whereas the gradients in plains normally do not exceed 1:100. The second major variation is that the roads in hill have a large number of curves for which radius upto 14 M is to be provided whereas the roads in plains do not have curves of lesser than 250 M radius. The problem of excessive wear and tear of road surface at these curves is significant. Quite often the roads in hills have to be provided with hairpin bends which have consequent problems of disposal of surface drainage and slips. The road surface at curves has to be provided with superelevation which, in case of hill road, is normally the limiting Super Elevation of 1:15. Hills normally have much higher rain falls and there are occasional cloud bursts also. The hill roads therefore require much larger cross drainage works than roads in plains. It may be recollected that the hill roads should have a proper and efficient drainage system. The road have to be constructed at high altitudes which are covered by snow for a considerable period. Such roads have to face the problems of frost and snow.

3.2. SPECIAL PROBLEMS IN HILL ROADS

3.2.1. LAND/ROCK SLIDE

Landslides constitute by far the most serious problem in maintenance of roads in hilly terrain subjected to heavy rainfall.

Denudation of hill, deforestation, cuts steeper than angle of repose, rock cutting with faults and joints in adverse dispensation, thawing effect on rock laminates due to seepage of rain water and freezing and melting into rock joints during winter, movement of over-burden over the underneath rock interfaces etc. all cause landslides and rock slides during and after rains and snow fall.

3.2.2. DRAINAGE

3.2.2.1. The single most important factor for Hill roads maintenance management is drainage both in respect of surface/sub-surface and cross drainage, especially in the areas which receive high and intense rain and snow-fall. The drains (Kaccha or Pucca) built to adequate sections need to be cleaned and cleared all the time, so that the catchment water from the hill-side and the road surface water from camber to drain side is efficiently drained out without causing surface over-flow or sub-surface flow. This needs regular cleaning/clearing drains of all debris which get deposited by surface erosion from hill side to ensure the flow of water through the drains rather than over the road surface.

3.2.2.2. The drain water needs to be drained out either through culverts or dips or scuppers and such structures also need to be kept clear all the time to ensure efficient cross drainage of the road surface water as well as natural run off from the hill side.

3.2.2.3. The rainfall in high altitude area is generally scanty and the drainage problems are mostly due to melting of snow/ice and thawing of ice lanes in frost penetration zone. During snow clearance operations, the road formation itself acts as a drain, because the side drains filled with compacted snow can be cleared only at the end of the operation. This causes heavy damages to the pavement and at times, even the base/sub-base also get washed off, particularly when that gets loosened due to movement of tracked snow clearance equipment and frost heave action.

It is advisable to remove the snow with the snow clearance equipment leaving 15-20 cms of snow over the road crust to obviate damage to the pavement due to movement of snow clearance equipment. The temperature rise during the day results in rapid melting of snow in catchment areas of the streams leading to high floods during the evenings. Flash floods also sometimes occur due to bursting of lakes formed due to avalanches, leading to damages to the bridges.

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3.2.2.4. Quick run-off condition from the catchments created due to deforestation, intensive precipitation causing high or flash floods in Nallahs rivulets and streams also cause heavy damages to the previously constructed cross - drainage structures which also need to be inspected, monitored and repaired before and after heavy rains for uninterrupted service effectiveness of "Hill roads system".

3.2.3. **SOIL EROSION**

Erosion of soil from hill slopes both above and below the road formation eventually leads to landslides/choking of drains and natural water courses. In order to prevent soil erosion due to discharge of water through cross drainage structures, on valley side, proper channel training and erosion control works like packing/pitching of the channel and outfall points, drop walls, apron etc. are required to be properly maintained. The activity of establishing vegetation on barren slopes is also a part of regular maintenance activity in hill roads. Frequently, there is a problem of toe erosion of the hill slope which leads to subsidence of the road.

3.2.4. **TOE CUTTING/SCOUR OF HILLS BY STREAMS**

Hill toe cutting by Nallahs and streams also causes sinking and sliding of road stretches. The preventive measures for such phenomena are generally cost prohibitive and maintenance of even temporary road formation at such locations also entails heavy maintenance cost by way of positioning of heavy earth moving equipments, POL and labour etc. for ensuring communication of traffic.

3.2.5. **MAINTENANCE OF RETAINING WALLS**

Because of the financial constraint most of retaining walls constructed on Hill roads are either Kachha dry R.R. Masonary or dry R.R. Masonary with horizontal and vertical bands of R.R. Masonary in cement with lean mortars and only in far and few locations these are Pucca Stone Masonary cement walls. Most of these Retaining walls are constructed on the basis of empirical practice rather than proper structural analysis and design for considerations of short-term economy in initial cost, expediency, and commensurate cost V/s service effectiveness. In high intensity snow/rain fall hilly areas, the damages to the Retaining Walls are often colossal during and after heavy incessant torrential rains due to the following reasons requiring huge maintenance cost for restoration of the same for making the road traffic-worthy.

- i) Erosion of toe of Retaining walls due to surface water over-flow over Retaining walls due to blockage of drains/land slides or some other reasons.
- ii) Ingress of water into the back-fill exerting high pressure.
- iii) Stability failure of high Retaining Walls Constructed as per empirical practice under worst compounded conditions.
- iv) Foundation failure or settlement due to geological changes.
- v) Sliding of foundation of Retaining Walls.
- vi) Loss of passive resistance to the foundation soil of the Retaining Walls.

Constraint of funds either under maintenance or Capital outlays, does not permit the rehabilitation of the Retaining walls with permanent design stability and there is always a tendency to restore the same almost with the original type of design and specifications to ensure mobility of traffic as quickly as possible with the result colossal amounts are required for maintenance of Retaining walls every year on the Hill Roads.

3.2.6. **PROTECTIVE WORKS**

Regular protective works are required to be carried out in changing road system regime in areas of moving slides, scoured/eroded foundation of cross drainage structures, for protecting slide prone areas by way of constructing Breast walls/Check walls etc. and other locations according to necessity from time to time, which also necessitate substantial maintenance cost on Hill Roads.

3.2.7. **SNOW FALL**

Heavy snow fall combined with severe cold climate causes numerous problems for the maintenance of roads at high altitudes. The problems faced are slow seepage, (causing subsidence of subgrade over long lengths destabilisation

of hill slopes resulting in landslides), snow avalanches (causing damage to road formation, pavement and permanent structures), effect of frost and icing problems (causing slipperiness). Snow fall in altitudes upto 3000 metres in generally light/medium with a depth of about one metre. Clearance of such snow can be done continuously as and when it occurs and is fairly easy as compared to the compacted snow. This operation can be done from within the provision made for slide clearance in the maintenance norms. However, in higher reaches, where the intensity and periodicity of snow fall is high and is combined with avalanches and icing problems, it is not possible/economical to undertake snow clearance operations continuously. In such cases, snow is allowed to accumulate during winter months and cleared at the end of the winter. This operation needs special efforts as the depth of compacted snow on the road at places is of the order of 10 m to 20 m, or even upto 30 m at avalanche sites and passes. Special snow clearance grant based on the assessment of resources like dozers, motor graders, snow ploughs, rotary snow blasts, snow sweepers etc. has to be made for such heavy snow clearance.

3.2.8. PAVEMENT

The damages to the pavement occur due to movement of tracked snow clearance equipment, flow of water over the pavement and unevenness/cracking due to frost heave during freezing and subsidence during thawing. Considerable efforts are required to repair such damages. Chemicals/abrasives are used at times to reduce slippery conditions due to icing.

3.2.9. RESTRICTED EFFICIENCY OF MEN AND MACHINES

Efficiency of men and machinery decreases at high altitudes due to lack of oxygen, low atmosphere pressure and severe climatic condition. Working hours are also restricted. Working season for construction works involving cement and bitumen is normally limited between middle of May to middle of November.

3.2.10. LACK OF RESOURCES

The high altitude regions are well known for lack of resources. In certain regions even stone for construction has to be imported from long distance. The shortage of water is almost chronic because of existence of very few water courses. The availability of fuel like timber is almost negligible.

3.3. MAINTENANCE OF SEMI PERMANENT BRIDGES

In hilly areas, the number of streams and nallahs are quite large, for which a number of major and minor bridges are required. These bridges require frequent maintenance of protective works as these are often damaged due to high velocity flow of water along with debris. These timber bridges having limited life cycle need replacement with respect to their deck, flooring, supporting trusses and beams, railings etc. periodically. Till such time, these are replaced by permanent bridges, these have to be maintained.

3.4. AFFORESTATION ALONG ROAD SIDES

Afforestation along road sides on hill slopes is essential for the stability of road structure.

The maintenance of such plantation is a charge on the maintenance norms of the hill roads.

3.5. SALIENT MAINTENANCE ITEMS

The salient maintenance items for hill roads are as under:

- i) Repair of cross drainage works such as scuppers, causeways, dips and culverts.
- ii) Cleaning of side drains, catch pits, scruppers, repair and construction of toe/breast walls, retaining walls, crib walls and boulder crates etc. due to erosion/subsidence, hill side drains and catch water drains, etc.
- iii) Repair of parapets and edge stones
- iv) White washing of parapets and hill side traffic visuals to guide the traffic during night and in fog.
- v) Removal of slips and snow in High Altitude Areas.

CHAPTER 4

CRITERIA ADOPTED AND NORMS PROPOSED

4.1. EXISTING NORMS

The existing norms as recommended by the committee set up in 1988 provide for a premium of 15 per cent over the maintenance norms for roads in plain areas for hills having no snow fall and 30 per cent for roads having snow fall. These norms have been updated in March, 1993 by a Committee constituted by the Govt. of India, which provisionally recommended a premium of 25 per cent over normal maintenance cost (for ordinary repairs only) in plains for roads having no snow fall and a premium of 40 per cent for roads having snow fall and further suggested that in view of specific features of hill roads, separate norms need to be evolved.

4.2. APPROACH FOR FIXING NORMS

4.2.1. ZONING

The cost for maintenance and repairs of roads includes cost of stone chips/metal, sand, cement, bitumen and labour input. The cost of materials goes on increasing with the altitude. Keeping this in view the maintenance requirements have been worked-out by dividing the hill roads in three categories as under:

- i) Category I - Upto 500 M. altitude i.e. foot hill
- ii) Category II- From 500 to 2000 M. altitude Middle hill range
- iii) Category III- 2000 M. altitude - High altitude hills

4.2.2. CATEGORIES OF ROADS

The maintenance norms have been evolved for two categories of road viz. State Highway/Major District Road (MDR) and other District Road (ODR)/Village Road (V.R.). Further with respect to surfacing, maintenance norms have been worked out for black topped, WBM Kaccha and bridle roads.

4.2.3. TRAFFIC CLASSIFICATION

For the purpose of norms, the SH/MDR have been divided into two traffic zones namely less than 450 commercial vehicles per day (CVD) and more than 450 per day (CVD). For the O.D.R./V.R. only traffic upto 450 CVD has been considered.

4.3. ROAD GANGS

4.3.1. The road gangs employed by P.W.Ds attend to routine maintenance to keep the road pavement and shoulders in proper shape and condition and free from undergrowth and other obstruction. These gangs also attend to defects like pot holes, edge breaking, cracking of surface, etc. by carrying out patch repair work.

4.3.2. The existing road gang system prevalent in various State was reviewed. The considered view of the Committee is that this system is outmoded and inefficient. In many States the existing road gang staff is in excess of the norms of 0.3 labour/Km. In some States, the existing staff is almost double compared to the norms. No fresh recruitment, however, is generally being made for road gangs in most States. As almost all the States are paying wages to the road gangs as per the Minimum Wages Act or even higher wages, bulk of the maintenance funds are going towards meeting the wages and very little funds are left for actual maintenance of the road. It is also felt that all the States should bring down the road gang strength to a maximum of 0.3 labour per Km. by 1995-96. The States, should therefore, make concerted efforts in this regard so that more funds become available for preventive maintenance of the road.

4.3.3. The feasibility of introducing mechanisation in the routine maintenance work was also considered. It is felt that only part mechanisation may be possible since some of the items like berm repair, patch repair etc. can be done only manually.

Therefore, some element of minimum labour is a must for road maintenance operations.

4.3.4. It is the general experience that the output of the casual labour is higher compared to permanent road gangs. The Committee, therefore, recommends that efforts should be made to keep the permanent labour to the minimum i.e. only for carrying out patch repairs, clearing of road surface and dressing of berms and other maintenance operations should be got done through casual labour.

4.3.5. The Committee wishes to stress that to overcome the difficulties of maintenance operation, a change in the present methods of road maintenance being done solely through gang labour is called for. It is time a shift was made to the system prevalent in other advanced countries where instead of moving individually on foot, the labours move about collectively in groups of 8 to 10 with patcher mounted on trolley or in a truck equipped with the necessary tools for routine maintenance. Such groups because of their mobility, are capable of looking after sections of road from 30 to 50 Km. with much greater ease and efficiency than dispersed gang labourers as now.

4.3.6. It was brought out that mobile system of road gangs has been tried on National Highways in the States of Rajasthan and U.P. and on State Highways in Haryana etc. Experience has shown that the system is efficient although more costly initially. It is likely that similar system with minor adjustments for the peculiar conditions of hills would prove cost effective in the long run. Broad requirements of labour force, tools and plants and material for a Mobile Maintenance Unit are given in ANNEXURE-IV. It is recommended that the system of mobile road gangs may be introduced in more States on experimental basis and decisions taken for reorganisation of the maintenance operations for improved efficiency on the basis of experience gained out of these experiments.

4.4. PATCH REPAIRS

For the purpose of carrying out patch repairs, on BT roads the patch area has been considered as 5.5 and 6 per cent for the two traffic classification of less than 450 CVD and greater than 450 CVD respectively for State Highways/MDRs. The patch area for WBM roads in these categories has been considered as 5.5 per cent. Average thickness of patch has been taken as 25 mm for B.T. roads and 75 mm for WBM roads.

4.5. FIXED COST ITEMS

There are certain maintenance activities under ordinary repairs for which lump sum provisions based on experience/analysis are proposed. The activities are:

- i) Repair to breast walls/retaining walls, bed bars, etc.
- ii) Removal of slips/snow clearance
- iii) Repair to drains and reconstruction of damaged works.
- iv) Repairs to parapet walls/jungle clearance wherever needed
- v) C.D. works and bridges, clearing of scuppers, reconstruction of toe wall and protection walls.
- vi) Store House and Sheds
- vii) Arboriculture
- viii) Traffic Census

Provisions for above mentioned items are indicated in ANNEXURE-VII A to F with relevant rate analysis in ANNEXURE VIII to XII.

4.6. PREMIUM FOR RAINFALL

The major problems faced in maintaining the hill roads are landslips, drainage and soil erosion as a result of rainfall.

Heavy rainfall results in extensive damages to breast walls/retaining walls, drains and soil/rock slides, which have to be attended to on priority from routine maintenance funds .

The analysis prepared are for hill roads having rainfall between 1500 to 3000 mm per year. Provisions for the items relating to major repairs (repairs to breast walls/retaining walls, removal of slips, snow clearance and repairs to drains and reconstruction of damaged works) under ordinary repairs may be reduced by 15 per cent in case of hill roads having rainfall less than 1500 mm per year and the provision increased by 15 per cent in case of hill roads having rainfall more than 3000 mm per year.

4.7. SPECIAL NEEDS OF HILL ROADS SUBJECTED TO HEAVY SNOWFALL

As earlier mentioned, heavy snowfall combined with cold climate causes numerous problems for the maintenance of roads. The main task in such areas is to clear the snow and restore the road to traffic. It is proposed that snow clearance work for snow fall upto 1 m in a year can be done from out of the provision recommended for removal of slips/snow clearance. For snow fall more than this, the repair needs may be separately assessed on case to case basis and approval of competent authority obtained for special repairs to restore the road to traffic.

4.8. PERIODIC RENEWALS

The life cycle for different renewal treatments depends on several factors climate, soil and traffic conditions. Table gives the recommended renewal cycle in year and treatment for different categories of roads.

LIFE CYCLE IN YEARS FOR DIFFERENT RENEWAL TREATMENT

Type of Treatment	S.H/M.D.R.				O.D.R/V.R.	
	Traffic upto 450 CVD		Traffic more than 450 CVD		Traffic 450 CVD	
	B.T.	WBM	B.T.	WBM	B.T.	WBM
S.D.C.	-	-	6	-	-	-
P.C.	6	-	5	-	6	-
S.D.	5	-	4	-	5	-
MR	-	5	-	4	-	5

SDC	-	25 mm semidense carpet
PC	-	20 mm premix carpet with seal coat
SD	-	One coat surface dressing with precoated chips
MR	-	75 mm (compacted) mental renewal i.e. 100 mm loose

4.9. SPECIAL REPAIRS

There are certain items of work of original nature such as minor improvement to curves, improvement to visibility repair/reconstruction of protective works etc. which may be required to be done. A lump-sum provision of Rs.2000/- per lane per Km is proposed for such works.

4.10. RAIN/FLOOD DAMAGE REPAIRS

Heavy rains/flash floods in hilly areas often result in washing away of bridges, slides/in the hill face resulting breach of road works etc. It may not be possible to restore these damages from out of funds for routine maintenance. A lump-sum provision of 12.5 per cent of O.R. and P.R.costs is proposed for such repairs.

4.11. SEMI-PERMANENT TIMBER BRIDGES

4.11.1. In the North-East region and a few pockets of certain States, there are a number of semi-permanent timber (SPT) bridges which are yet to be replaced by permanent RCC bridges. For instance there are about 1,48,400 running meters of SPT bridges in Assam alone.

Due to socio-economic growth in the region, some industries have already come-up, with the result there will be more generation of vehicular traffic. And hence, these timber bridges will have to be replaced by permanent bridges gradually as per availability of plan funds. In the meantime, the existing SPT bridges need to be maintained properly to keep the roads in traffic worthy condition.

4.11.2. In the maintenance norms now being proposed there is a lump sum provision for the maintenance of bridges which is not considered to be adequate to cover the maintenance of SPT bridges also. Hence rate analysis for Assam has been given to indicate the unit cost of maintenance of SPT bridges/Km length of road. The cost thus worked-out is about Rs.9000/- per Km. (Annexure-XIII). Similarly, the unit cost of maintenance can be worked for other regions where such type of bridges still exist.

4.12. BRIDLE ROADS

Bridle roads are additional category of roads in hill areas. These serve villages and habitations in the remote, under developed and under development areas at varying altitudes. Bridle roads are not motorable roads and have steeper gradients for connecting villages and places and are used for pedestrians and animals transport. During rains these are heavily damaged in the form of slips, erosion, etc. and have to be maintained for use of movement on foot. A provision of Rs.5000/- per Km is proposed for maintenance of such roads (Annexure-VII D to F). The rate for maintenance shall be on the basis of actual requirements in case of roads which require snow clearance of more than 1 m.

4.13. FOOT BRIDGES

In addition to permanent and SPT bridges on hill roads, a number of foot bridges are also constructed across the streams in remote area even without any hill roads. These are also required to be maintained and a separate provision for @ 1000/- per metre shall be needed.

4.14. MAINTENANCE REQUIREMENT FOR TWO LANE/INTERMEDIATE LANE ROADS

The requirement of funds for various items of works has been worked out for single lane of road per Km. Requirement of M&R grants for two lane road would be 60 per cent more than on one lane road. Like-wise for intermediate roads (5.5m) the M&R grants would be 30 per cent more than on one lane road.

4.15. RECOMMENDED NORMS FOR MAINTENANCE AND REPAIRS

4.15.1. The Committee after discussions and careful consideration of

- a) factors relevant to maintenance and repairs requirement
- b) review of M&R practices in the States
- c) the study of the earlier work done by similar Committees, study Groups
- d) the present day needs of rapidly growing traffic
- e) life cycle costs

has worked out norms for different categories of roads carrying different traffic volumes and located in different price zones. These norms are minimum "Must" if the large capital assets are to be saved from deterioration beyond redemption. The details of norms of M&R costs for roads are given in ANNEXURE-VII A to F respectively for State Highways and other roads with the supporting rate analysis in ANNEXURE-VIII to XII.

4.15.2. The gist of M&R costs for lower and higher need roads in the zones is given in table below:

M&R COSTS PER KM IN LAKHS SAVING ANNUAL RAINFALL BETWEEN 1500-3000 MM

Category	Surface	Foot Hill I		Medium Altitude Hill II'		High Altitude Hill III	
		Less than 450 CVD	More than 450 CVD	Less than 450 CVD	More than 450 CVD	Less than 450 CVD	More than 450 CVD
SH/MDR	BT	61000	67000	69000	76500	76500	85500
	WBM	43000	47000	56000	62500	56000	62500
ODR/VR	BT	54000	—	62000	—	69500	—
	WBM	37000	—	49000	—	49000	—
	Kacha	22500	—	27500	—	27500	—
	Bridle road	5000	—	5000	—	5000	—

4.15.3. The State PWDs and other executing agencies for road would need to work out the requirement of funds for maintenance separately under the four sub-heads viz. Ordinary Repairs, Periodic renewals, Special Repairs and restoration of flood/rainfall damages. The figures given in Table above include element of special repair and flood/excessive rain damages repair on pro-rata basis.

4.16. PERIODICITY/PROCEDURES FOR UPDATING THE NORMS

The norms need to be updated periodically to account for the change in traffic pattern technological advancement and experience etc. After deliberation on various aspects in the meetings of the Committee, it is recommended that the norms be reviewed after an interval of 5 years. This may coincide with the formulation of Five Years Plans. The norms should in any case be updated every year to allow for the increase in prices of material and wages of labour etc. This should also be applied to fixed cost items mentioned above when found necessary.

CHAPTER 5

REVIEW OF EXISTING ARRANGEMENTS FOR MONITORING

5.1. EXISTING SCENARIO

5.1.1. The budgets for road maintenance are often much less compared to the requirements as per norms. Because much of the budget goes towards the wages of large labour force, the balance available funds for maintenance of road proper get further reduced when budgets are cut or prices rise. Hence there is a dire need for improving the efficiency of the organisation and it must focus on ways to make the organisation accountable for their performance.

5.1.2. The absence of the internal accountability is a common cause of the institutional failure of the road authority. The allocation of funds is seldom linked to explicit physical plans and post project evaluation is rarely done. In order to ensure the desired progress in terms of physical and financial targets, it is essential to keep a close watch by monitoring of funds provided for maintenance. To achieve the above, the existing arrangements for monitoring of funds need to be reviewed and made more stringent.

5.2. MEASURES FOR MONITORING THE PROGRESS OF MAINTENANCE

5.2.1. The staff involved in the maintenance should be dedicated and fully motivated. Training of all personnel involved in maintenance is an integral part of the maintenance function. To achieve better performance, the training of the operating and maintenance personnel (gang men/mate Engineering subordinates/junior engineers) is necessary.

5.2.2. As per the existing system, the routine maintenance/ordinary repairs is being done departmentally by most of the State PWDs. In the above system, there are some problems, like the management of labour force and material and tools. Experience shows that for one reason or the other it is very difficult to enforce discipline among the labour force by the departmental staff and, therefore, full utilisation of labour is not achieved. Further, at time it also becomes difficult to maintain regular supply of material required for maintenance particularly at critical juncture i.e. during monsoon which hinders the maintenance operation. To obviate above problems, it is suggested that as an experiment the work of routine maintenance/ordinary repairs may also be tried to be got done through contracting agency, on the heavily trafficked sections. This system will have following advantages:

- The problem of managing the labour force and continuous supply of material by the department will be removed.
- It will be the responsibility of the contractors to maintain the road in a traffic worthy condition round the year.
- Close supervision and evaluation of work can be done by a separate agency other than executing agency itself. This will also improve accountability.

5.2.3. A system for collecting the data needed to monitor performance (financial flows and physical performance) is also equally necessary. The data can also be used to make an independent and public assessment of the agency performance. Some kind of audit of expenditure on maintenance is required.

5.2.4. Planning and scheduling operations should be given due importance. Budgeting for maintenance expenditure should also be done in advance to facilitate field officers to plan and implement the programme effectively. It is necessary to carry out pre/post monsoon inspections for condition survey and to assess the quantum of maintenance tasks.

5.2.5. Attention of the State PWDs is also required for monitoring of implementation and intervening to rectify the lapses revealed during monitoring, meaningful supervision, surprise checks, management of tools and equipment used for maintenance, disaster management measures from cyclones, unprecedented floods or other natural calamities, balanced allocation of available funds among the different maintenance activities.

5.2.6. Maintenance culture needs to be improved in respect of roads. Each State should bring out a booklet giving the names of roads or sections of road that are programmed to be treated with surface renewal every year together with a subsequent appraisal of actual achievements and reasons for shortfall, if any. Similarly, bridges programmed to be maintained should be indicated.

5.3. DOCUMENTATION AND RETURNS

5.3.1. Indian Roads Congress has brought out a number of publications on various aspects of maintenance operations, which contain detailed instructions on execution and monitoring of the maintenance operations. These are :

1. Ministry of Shipping and Transport (Roads Wing) Manual for Maintenance of Roads
2. IRC:82-1982 "Code of Practice for Maintenance of Bituminous Surface of Highways"
3. IRC:SP:18-1978 "Manual for Highway Bridge Maintenance Inspection"
4. IRC:SP:35-1990 "Guidelines for Inspection and Maintenance of Bridges"

The State PWDs and other executing agencies should follow the guidelines given in these publications for carrying out and monitoring of the maintenance operations.

5.3.2. Effective monitoring can be done through submission of returns, details for which are given in the IRC Manual for Maintenance of Roads. The important returns for monitoring at different levels in the field are suggested below :

- i) At the lowest of Junior Engineer, a report of work accomplished during the week should be filled in the form of Work Report (Annexure-XIV)
- ii) Assistant Engineer in-charge of Sub-Division should call a meeting of Junior Engineers under his control once a month and review both the physical and financial progress made during the month and a consolidated report sent to the Executive Engineer in-charge of a Division.
- iii) The Divisional Engineer should convene a meeting of Assistant Engineers under his charge once a month and review the progress of work both physical as well as financial. He should submit the report to the Superintending Engineer in the format suggested at Annexure-XV.
- iv) Superintending Engineer/Chief Engineer should review with Executive Engineer atleast once in three months for effective control on maintenance.

However, for effective monitoring, these returns should not be treated as routine formality. These need to be critically examined and analysed in the correct perspective at different levels. For effective supervision actual material consumption, labour output etc. need to be examined thoroughly and remedial measures taken where called for.

5.4. MONITORING

5.4.1. AT CENTRAL LEVEL

The States are by and large not getting the allotments as per the norms and recommendations of the Finance Commission. Many of the States are just getting only about 50 to 70 per cent of the recommended amounts. In this context, the following extracts from the Report of the Ninth Finance Commission are reproduced :

"We find that successive Finance Commissions have made provision for maintenance expenditure based on certain engineering norms, but the expenditure incurred in actual practice by the State has been for too low relative to the norms as well as the requirements for the maintenance of the assets even on a minimum basis. There appears to be a strong preference for the creation of additional assets with little attention being paid to the maintenance of assets already created. In the process, the quality of the assets and their useful life span decline steeply. The neglect of maintenance is an unhealthy practice and must be discouraged. The amount required to the maintenance of the existing assets should be the first charge on the resources of the States. We would even suggest that the Planning Commission should be given a special responsibility for ensuring that the maintenance of the existing assets in the States is in no way compromised. At the time of assessing the resources for the State Plan, the Planning Commission should take special care to ensure that the maintenance expenditures are fully provided for".

Therefore, the Committee cannot but underline the need for having a mechanism for monitoring of release of funds by State for Maintenance and Repairs and also to know broadly how the funds are allocated. The Committee recommends that monitoring and evaluation may be done by a Central Agency which could be the Ministry of Surface Transport (Roads Wing) and the Planning Commission.

5.4.2. AT STATE P.W.D. HEADQUARTER

5.4.2.1. In order to ensure optimum utilisation of maintenance funds, allotment of funds to field officers should be appropriated distinctly under the sub-heads, O.R.P.R., S.R. and F.D.R. as is being done by the Ministry of Surface Transport (Roads Wing), in respect of National Highways. The targets may be set both in physical and financial terms. The expenditure actually incurred on maintenance may be booked distinctly under the above mentioned heads to enable monitoring and control at various levels of the department.

5.5. QUALITY CONTROL AND QUALITY ASSURANCE

5.5.1. QUALITY CONTROL

To ensure proper quality control in the execution of maintenance works, it is felt by the Committee that a quality Monitoring Cell may be constituted under Engineer-in-Chief/Chief Engineer which shall undertake random checking. With the above provision, there should not be the need for any other independent agency to be involved in checking the quality of maintenance works.

5.5.2. QUALITY ASSURANCE

5.5.2.1. It was felt by the Committee that there should be some in built system for quality assurance. It was observed that the officer who is responsible for the progress of work should also be accountable for quality of works instead of entrusting the job to some other officer/agency who are not accountable for the progress of work. In view of above, it is suggested by the Committee that the Executive Engineer concerned with the execution of maintenance works would also be accountable for quality control/assurance and quality check/monitoring should be done at the level of Superintending Engineer/Controlling Officer.

5.5.2.2. It is desirable to complete all bituminous works on hill roads by the end of June every year because the work done later than this gets deteriorated during winters as the bitumen does not get enough time to mature. During rains the road surface and chips do not get dried up with the result that bitumen does not get properly coated on the chips.

5.5.2.3. The periodical renewal programme should be chalked out in advance and completed before the onset of monsoon so that the occurrence of pot holes is minimised during rainy season.

CHAPTER-6

CONCLUSIONS AND RECOMMENDATIONS

6.1 The maintenance and repair costs per km length of road as worked out in Annexure-VII A to F reflect the Minimum needs at a price level of 1992-93. These would need to be updated every year taking into consideration prevalent rates of labour and material. In case allotments are less than this minimum, this may lead to deterioration of assets constructed at huge cost to the country. Continuous neglect of maintenance would result in much higher plan funds for rehabilitation and strengthening of existing roads and/or high operation cost of transport.

6.2 As mentioned earlier in para 1.6, general recommendations made by the Committee on Norms for Maintenance of Roads are equally applicable for hill roads. These are given in Appendix-I and may be deemed to be recommendations of this Committee also.

6.3 The Committee feels that the output of the casual labour is higher compared to permanent road gangs. Efforts should therefore be made to keep the permanent labour to the minimum i.e. only for carrying out patch repairs, clearing of road surface and dressing of berms and other maintenance operations should be got done through casual labour.

6.4 Periodic renewals of BT surfacing should preferably be done with either semi-dense carpet or premix carpet with seal coat for SH/MDFs. Renewal by single coat surface dressing may be considered as an option when adequate funds are not available and large lengths are required to be covered by thin dust-proof course. Periodic renewal of BT surface of ODR/village roads may be done with 20mm premix carpet with seal coat or single coat surface dressing as considered appropriate based on importance of road, traffic volume and availability of funds.

6.5 All repair works including pot hole filling, patching and surfacing in short stretches required on bituminous surfacings during wet season must invariably be carried out using bitumen emulsions. Use of this strategy is also advocated for 20mm premix carpet renewal coat or seal coat work carried out in the immediate premonsoon session.

6.6 In order to ensure optimum utilisation of maintenance funds, allotment of funds to field officers should be appropriated distinctly under the sub-heads, O.R., P.R., S.R. and F.D.R. The targets may be set both in physical and financial terms. The expenditure actually incurred on maintenance may be booked distinctly under the above mentioned heads to enable monitoring and control at various levels of the department.

6.7 To ensure quality control in maintenance works, a Quality Monitoring Cell may be constituted under Engineer-in- Chief/Chief Engineer which shall undertake random checking of the work done specially renewals.

6.8 There should be in built system for quality assurance. Executive Engineer concerned with the execution of maintenance works should also be accountable for quality control/assurance. Quality check/monitoring should be done at the level of Superintending Engineer/Controlling Officer.

6.9 All bituminous work should be completed in fair weather and work during monsoons and extreme cold weather should be avoided.

6.10 The periodical renewal programme should be chalked out in advance and completed before the onset of monsoon, so that occurrence of pot holes is minimised during rainy season.

6.11 In order to ensure quality, the semi-dense carpet/premix carpet should be carried out using hot mix plant etc.

6.12 For roads in high altitude areas with snow fall heavier than 1 meter additional snow clearance grant based on actual assessment should be allotted.

6.13 Although repairs to the damages in existing walls or cross drainage structures due to heavy rainfall/floods shall be carried out within the provisions of major repairs under maintenance, separate provision is necessary and is being made on ad hoc basis under the sub-head of flood damages for reconstruction of washed away bridges or sections of roads entirely damaged. This may have to be provided on basis of detailed estimates in some cases.

CHAPTER-7**ACKNOWLEDEMENT**

The Committee would like to keep on record the valuable assistance given by Shri N.S. Jain, Superintending Engineer (Roads) Planning and Shri Sanjay Mishra, Assistant Executive Engineer (Roads) of Ministry of Surface Transport, Shri Nirmal Jit Singh, Deputy Secretary (R) of Indian Roads Congress, Shri P.K. Sharma, Chief Engineer, Pauri (Garhwal) and Shri P.C. Shrivastava, Executive Engineer, Ranikhet of U.P., P.W.D. Shri T.D. Pant of Nainital Division of U.P. P.W.D. and Shri S.K. Chadha of Indian Roads Congress provided excellent stenographic assistance.

sd/-
(D.K. Gupta)
Chairman

sd/-
S.N. Mane
Member

sd/-
C.K. Hazarika
Member

sd/-
S.P. Gupta
Member

sd/-
S. Biswas
Member

sd/-
Ravindra Kumar
Member (Co-opted)

sd/-
D.P. Gupta
Member-Convenor

**MINISTRY OF SURFACE TRANSPORT
(ROADS WING)
ORDER**

No.RW/NH-11038/2/92-DO I

Dated 16th March, 1993

Subject: Constitution of Committee on Norms for Maintenance of Roads in Hill Areas

The undersigned is directed to say that it has been decided to work out separate norms for maintenance of roads in hill areas. The composition of the Committee will be as follows :

- | | | |
|----|--|-----------------|
| 1. | Shri D.K. Gupta
Engineer-in-Chief,
PWD, Uttar Pradesh | Chairman |
| 2. | Shri S.N. Mane
Additional Director General
Border Roads | Member |
| 3. | Shri S.K. Agarwal
Chief Engineer
PWD, Himachal Pradesh | Member |
| 4. | Shri C.K. Hazarika
Secretary,
PWD, Meghalaya | Member |
| 5. | Shri B. Megu
Chief Engineer,
PWD, Arunachal Pradesh | Member |
| 6. | Shri M. Radhakrishnan
Chief Engineer,
PWD, Kerala | Member |
| 7. | Shri S.P. Gupta
Chief Engineer,
PWD, Jammu | Member |
| 8. | Shri S. Biswas
Chief Controller of Accounts,
Ministry of Surface Transport | Member |
| 9. | Shri D.P. Gupta
Chief Engineer (Planning),
Ministry of Surface Transport
(Roads Wing) | Member-Convenor |

2. The Terms of Reference of the Committee will be as follows :
 - i) To review and update the existing norms and criteria adopted for assessing the requirements of funds for maintenance of roads in hill areas.
 - ii) To review the existing arrangements for monitoring of funds provided for maintenance and recommend measures for effective monitoring and supervision.
 - iii) To recommend methodology and approach for updating and its periodicity for review of maintenance norms.
3. The Chairman of the Committee may invite or co-opt such officials as may be considered necessary.
4. The TA/DA of the Chairman and members will be met by the respective State Governments/Departments.
5. The Committee will submit its report to the Ministry of Surface Transport by 17th May, 1993.

ANNEXURE-II**GROWTH OF ROAD NETWORK**

(Lakh Km)

Year	National Highways	State Highways	Other Roads over 1950-51	Total	Per cent increase
1950-51	0.22	0.43	3.35	4.00	
1960-61	0.24	0.62	4.39	5.25	31
1970-71	0.24	0.80	8.13	9.17	129
1980-81	0.29	0.95	13.80	15.04	276
1990-91	0.34	1.27	19.06	20.37	409

ANNEXURE-II**GROWTH OF ROAD NETWORK**

(Lakh Km)

Year	National Highways	State Highways	Other Roads over 1950-51	Total	Per cent increase
1950-51	0.22	0.43	3.35	4.00	
1960-61	0.24	0.62	4.39	5.25	31
1970-71	0.24	0.80	8.13	9.17	129
1980-81	0.29	0.95	13.80	15.04	276
1990-91	0.34	1.27	19.06	20.37	409

ANNEXURE-III**GROWTH OF MOTOR VEHICLES IN INDIA**

(In Lakh)						
Year	All vehicles	Two-wheelers	Cars, Jeeps & Taxis	Buses	Trucks	Others
1951	3.06	0.27	1.59	0.34	0.82	0.04
1961	6.65	0.88	3.10	0.57	1.68	0.42
1971	18.65	5.76	6.82	0.94	3.43	1.70
1981	51.73	25.28	11.17	1.54	5.27	8.47
1991(P)	213.10	140.47	30.13	3.33	14.11	25.06

Note : P-Provisional

ANNEXURE-IV

ROAD ACCIDENTS IN INDIA

Year	No. of registered Motor Vehicles (in thousands)	No. of Accidents (in thousands)	No. of Accidents per 1000 vehicles	No. of persons killed	No. of persons injured (in thousands)	Total (5+6)
1	2	3	4	5	6	7
1970	1401	114.1	81.37	14.5	70.1	84.6
1971	1865	120.2	64.34	15.0	70.7	85.7
1972	2045	122.3	59.66	16.1	76.4	92.5
1973	2109	121.6	57.85	17.6	79.3	96.9
1974	2327	114.3	48.99	17.3	76.7	94.0
1975	2472	116.8	47.33	16.9	77.0	93.9
1976	2700	124.7	46.30	17.8	82.5	100.3
1977	3260	135.4	41.41	20.1	95.6	115.7
1978	3614	146.3	40.40	21.8	99.5	121.3
1979	4059	144.4	35.48	22.6	102.9	125.5
1980	4514	153.2	33.89	24.6	109.1	133.7
1981	5173	161.2	31.12	28.4	114.0	142.4
1982	5844	166.2	28.40	30.7	126.0	156.7
1983	6905	177.0	25.63	32.8	134.1	166.9
1984	7783	195.0	25.05	35.1	156.2	191.3
1985	9097	207.0	22.75	39.2	163.4	202.6
1986	10490	215.5	20.54	40.0	176.4	216.5
1987	12539	234.0	18.66	44.4	189.0	234.2
1988	14733	246.7	16.74	46.6	214.8	262.0
1989	15920	270.0	15.96	50.7	229.7	279.4
1990	19177	282.6	14.76	54.1	244.1	298.2
1991	21310	294.0	13.80	56.5	255.3	311.8
1992(E)	23000	308.0	13.39	57.0	260.0	317.0

E = Estimated

ANNEXURE-V

PLAN-WISE DEVELOPMENT OF ROADS - EXPENDITURE

(Rs. Crore)

	First Plan 1951-56	Second Plan 1956-61	Third Plan 1961-66	Inter Plan 1966-69	Fourth Plan 1969-74	Fifth Plan 1974-78	Inter Plan 1978-80	Sixth Plan 1980-85	Seventh Plan 1985-90
STATES									
Andhra Pradesh	4.23	11.77	25.02	11.19	32.59	52.64	31.10	168.26	313.56
Assam	3.74	13.72	30.38	21.71	34.49	56.53	39.75	177.49	287.82
Bihar	14.15	20.53	50.26	19.51	55.51	130.91	67.39	391.69	576.13
Gujarat	14.66	27.83	28.65	29.25	41.99	110.27	62.57	305.91	360.64
Haryana	-	-	-	6.22	52.83	37.92	29.43	101.72	159.95
Himachal Pradesh	2.99	8.36	11.05	12.58	33.49	55.39	36.33	130.40	166.27
Jammu & Kashmir	3.13	13.89	11.67	10.83	23.96	40.29	32.56	102.70	108.39
Karnataka	5.53	12.56	29.73	7.37	36.08	52.84	32.56	184.17	264.35
Kerala	3.40	8.07	14.66	12.13	26.66	42.61	26.29	125.95	211.10
Madhya Pradesh	7.25	13.06	18.86	32.44	47.50	81.05	48.10	245.66	486.13
Maharashtra	20.26	18.58	39.51	2.92	82.33	166.69	108.58	369.27	477.43
Manipur	0.55	2.03	4.90	-	11.67	25.22	12.44	58.03	122.41
Meghalaya	-	-	-	-	14.67	25.61	13.03	74.16	126.63
Nagaland	-	1.84	3.86	5.22	11.68	33.80	19.69	76.66	129.69
Orissa	4.20	8.75	38.65	16.25	23.79	42.95	27.99	114.17	223.52
Punjab	7.04	15.91	20.11	9.57	65.39	74.09	44.15	109.45	165.89
Rajasthan	5.98	12.68	14.45	25.15	22.32	79.84	47.25	281.00	212.96
Sikkim	0.13	-	0.16	-	-	9.70	8.02	30.18	39.84
Tamil Nadu	5.09	10.04	15.41	9.08	43.21	97.18	51.83	227.58	307.48
Tripura	0.73	3.80	4.50	3.18	6.39	17.82	14.52	54.98	90.41
Uttar Pradesh	7.78	24.10	37.70	24.56	102.73	241.93	174.20	840.23	1399.06
West Bengal	16.96	20.49	23.92	18.86	25.99	53.41	30.25	141.36	237.27
TOTAL 'A'	127.80	248.01	423.45	292.87	795.27	1528.69	953.47	4311.02	6466.93
UNION TERRITORIES									
A&N Islands	-	0.70	2.35	1.55	4.97	9.41	3.67	15.24	29.94
Arunachal Pradesh	-	-	-	-	10.04	22.96	11.99	90.92	195.64
Chandigarh	-	-	-	0.01	0.10	0.19	0.22	0.77	2.26
Dadra & Nagar Haveli	-	-	-	0.14	0.77	0.57	0.33	3.49	8.89
Delhi	0.68	0.90	4.79	6.29	16.34	33.77	19.96	172.91	270.26
Goa, Daman & Diu*	-	-	2.16	2.90	6.61	9.28	6.20	34.67	49.17
Lakshadweep	-	-	-	-	0.01	0.09	0.05	1.89	2.91
Mizoram	-	-	-	-	3.07	15.22	7.97	54.48	105.90
Pondicherry	0.11	0.40	0.53	0.31	1.32	2.47	1.46	8.23	12.59
TOTAL 'B'	0.79	2.00	9.83	11.20	43.23	93.96	51.85	382.60	677.56
OTHERS 'C'	0.81	1.42	1.54	2.26	-	-	-	-	-
TOTAL (A+B+C)	129.40	251.43	434.82	306.33	838.50	1622.65	1005.32	4693.62	7144.49

* Arunachal Pradesh, Goa and Mizoram are now states.

ANNEXURE-VI**TYPICAL FEATURES OF MOBILE MAINTENANCE UNIT****A. TOOLS AND PLANT**

1.	Patcher	2 Nos.
2.	Light Commercial Vehicle (LCV)	1 No.
3.	Air Compressor	1 No.
4.	Bitumen Boiler	1 No.
5.	Mechanical Sprayer	1 No.
6.	Walk behind Roller	1 No.
7.	Plate Compactor	1 No.
8.	Pneumatic Tools	2 Nos.
9.	Grass Cutter	1 No.
10.	Wheel Barrows	3 Nos.

B. LABOUR AND SKILLED OPERATORS**Skilled Operators**

-	Driver	1 No.
-	Operator Patcher	2 Nos.
-	Mechanic	1 No.
-	Operator (Walk behind roller)	1 No.

Labour

-	Mate/incharge	1 No.
-	Labour for patcher	2 Nos.
-	Labour bitumen boiler	4 Nos.
-	Labour pneumatic tools and sweeping	2 Nos.

ANNEXURE-VII-A

**ZONE WISE DETAILS M&R NORMS FOR ONE KM OF SH/MDR
OF HILL ROAD (SINGLE LANE)**

ZONE-I

		Traffic Density			
		Less Than 450 CVD		Over 450 CVD	
		BT	WBM	BT	WBM
(A)	ORDINARY-REPAIRS				
(I)	LABOUR-BELDAR	6480	6480	6480	6480
		(0.3)	(0.3)	(0.3)	(0.3)
	MISTRI	864	864	864	864
		(0.04)	(0.04)	(0.04)	(0.04)
(II)	PATCH AREA	5.5%	5.5%	6.0%	5.5%
(a)	B.T. SURFACE				
	- BITUMEN	9761	-	10664	-
	- AGGREGATES	(227m ² @43/-)	-	(248m ² @43/-)	-
(b)	WBM				
	- METAL	-	4086	-	4086
		-	(227m ² @18/-)	-	(227m ² @18/-)
(III)	ARBORICULTURE	300	300	300	300
(IV)	PARAPET REPAIRS	1500	1500	1500	1500
(V)	STORE HOUSE SHED	500	500	500	500
(VI)	CROSS-DRAINAGE WORKS, BRIDGES, CLEANING OF SCUPPERS, RECONSTRUCTION OF TOE WALL, PROTECTION WALLS	2500	2500	2500	2500
(VII)	SIGN BOARDS, KM. STONES	1000	1000	1000	1000
(VIII)	TRAFFIC CENSUS	300	300	300	300
	TOTAL FOR ORD. REPAIRS	23205	17530	24108	17530
(B)	MAJOR REPAIRS				
(I)	REPAIRS TO RETAINING/ BREAST WALLS	2500	1500	2500	1500
(II)	REMOVAL OF SLIPS & SNOW CLEARANCE (UPTO 1.0m DEPTH)	2500	1500	2500	1500
(III)	REPAIRS TO DRAINS & RECONSTRUCTION OF DAMAGED WORKS	1000	1000	1000	1000

ANNEXURE-VII-A (Contd.)

		Traffic Density			
		Less Than 450 CVD		Over 450 CVD	
		BT	WBM	BT	WBM
(C)	PERIODICAL RENEWALS				
		PC/6	MR/5	PC/5	MR/4
(I)*	SDC/PC & SC/SD	23750	-	28500	-
(II)	METAL RENEWAL	-	15200	-	19000
(D)	SPECIAL REPAIRS	2000	2000	2000	2000
(E)	FLOOD DAMAGE FOR BREACHES & WASHING AWAY OF BRIDGES @ 12.5% OF (A+C)	5869	4091	6576	4566
G. TOTAL		60824	42821	67184	47096
	Say	61000	43000	67000	47000

- * SD - SURFACE DRESSING
 PC & SC- PREMIX CARPET WITH SEAL COAT
 SDC - SEMI DENSE CARPET

- NOTES :
1. THESE NORMS ARE FOR HILL ROAD FALLING IN AREAS HAVING RAINFALL BETWEEN 1500-3000 MM/ANNUM.
 2. "PROVISION FOR MAJOR REPAIRS AS PER (B) ABOVE MAY BE REDUCED BY 15% FOR ROADS IN AREAS HAVING RAINFALL LESS THAN 1500 MM AND INCREASED BY 15% FOR ROADS IN AREAS HAVING RAINFALL MORE THAN 3000 MM. NO REDUCTION WILL BE MADE FOR ROADS IN HIGH ALTITUDE AREAS EVEN IF THE RAINFALL IS LESS THAN 1500 MM".
 3. FOR TWO LANE ROAD AND INTERMEDIATE LANE ROADS, THE ABOVE RATES OF SINGLE LANE SHOULD BE MULTIPLIED BY 1.6 AND 1.3 RESPECTIVELY.

ANNEXURE-VII-B

**ZONE WISE DETAILS M&R NORMS FOR ONE KM OF SH/MDR
OF HILL ROAD (SINGLE LANE)**

ZONE-II

		Traffic Density			
		Less Than 450 CVD		Over 450 CVD	
		BT	WBM	BT	WBM
(A)	ORDINARY-REPAIRS				
(I)	LABOUR-BELDAR	6480	6480	6480	6480
		(0.3)	(0.5)	(0.3)	(0.3)
	MISTRI	864	864	864	864
		(0.04)	(0.04)	(0.04)	(0.04)
(II)	PATCH AREA	5.5%	5.5%	6.0%	5.5%
(a)	B.T. SURFACE				
	- BITUMEN	11804	-	12896	-
	- AGGREGATES	(227m ² @52/-)	-	(248m ² @52/-)	-
(b)	WBM				
	- METAL	-	6583	-	6583
		-	(227m ² @29/-)	-	(227m ² @29/-)
(III)	ARBORICULTURE	300	300	300	300
(IV)	PARAPET REPAIRS	1500	1500	1500	1500
(V)	STORE HOUSE SHED	500	500	500	500
(VI)	CROSS-DRAINAGE WORKS, BRIDGES, CLEANING OF SCUPPERS, RECONSTRUCTION OF TOE WALL, PROTECTION WALLS	2500	2500	2500	2500
(VII)	SIGN BOARDS, KM. STONES	1000	1000	1000	1000
(VIII)	TRAFFIC CENSUS	300	300	300	300
	TOTAL FOR ORD. REPAIRS	25248	20027	26340	20027
(B)	MAJOR REPAIRS				
(I)	REPAIRS TO RETAINING/ BREAST WALLS	2500	1500	2500	1500
(II)	REMOVAL OF SLIPS & SNOW CLEARANCE (UPTO 1.0m DEPTH)	2500	1500	2500	1500
(III)	REPAIRS TO DRAINS & RECONSTRUCTION OF DAMAGED WORKS	1000	1000	1000	1000

ANNEXURE-VII-B (Contd.)

		Traffic Density			
		Less Than 450 CVD		Over 450 CVD	
		BT	WBM	BT	WBM
(C)	PERIODICAL RENEWALS				
		PC/6	MR/5	PC/5	MR/4
(I)*	SDC/PC & SC/SD	28833	-	34600	-
(II)	METAL RENEWAL	-	24300	-	30375
(D)	SPECIAL REPAIRS	2000	2000	2000	2000
(E)	FLOOD DAMAGE FOR BREACHES & WASHING AWAY OF BRIDGES @ 12.5% OF (A+C)	6760	5541	7617	6300
	G. TOTAL	68841	55868	76557	62702
	Say	69000	56000	76500	62500
* SD - SURFACE DRESSING PC & SC- PREMIX CARPET WITH SEAL COAT SDC SEMI DENSE CARPET					

- NOTES :
1. THESE NORMS ARE FOR HILL ROAD FALLING IN AREAS HAVING RAINFALL BETWEEN 1500-3000 MM/ANNUM.
 2. "PROVISION FOR MAJOR REPAIRS AS PER (B) ABOVE MAY BE REDUCED BY 15% FOR ROADS IN AREAS HAVING RAINFALL LESS THAN 1500 MM AND INCREASED BY 15% FOR ROADS IN AREAS HAVING RAINFALL MORE THAN 3000 MM. NO REDUCTION WILL BE MADE FOR ROADS IN HIGH ALTITUDE AREAS EVEN IF THE RAINFALL IS LESS THAN 1500 MM".
 3. FOR TWO LANE ROAD AND INTERMEDIATE LANE ROADS, THE ABOVE RATES OF SINGLE LANE SHOULD BE MULTIPLIED BY 1.6 AND 1.3 RESPECTIVELY.

ANNEXURE-VII-C

**ZONE WISE DETAILS M&R NORMS FOR ONE KM OF SH/MDR
OF HILL ROAD (SINGLE LANE)**

ZONE-III

		Traffic Density			
		Less Than 450 CVD		Over 450 CVD	
		BT	WBM	BT	WBM
(A)	ORDINARY-REPAIRS				
(I)	LABOUR-BELDAR	6480	6480	6480	6480
		(0.3)	(0.3)	(0.3)	(0.3)
	MISTRI	864	864	864	864
		(0.04)	(0.04)	(0.04)	(0.04)
(II)	PATCH AREA	5.5%	5.5%	6.0%	5.5%
(a)	B.T. SURFACE				
	- BITUMEN	13847	-	15128	-
	- AGGREGATES	(227m ² @61/-)	-	(248m ² @61/-)	-
(b)	WBM				
	- METAL	-	6583	-	6583
	- MOORUM	-	(227m ² @29/-)	-	(227m ² @29/-)
(III)	ARBORICULTURE	300	300	300	300
(IV)	PARAPET REPAIRS	1500	1500	1500	1500
(V)	STORE HOUSE SHED	500	500	500	500
(VI)	CROSS-DRAINAGE WORKS, BRIDGES, CLEANING OF SCUPPERS, RECONSTRUCTION OF TOE WALL, PROTECTION WALLS	2500	2500	2500	2500
(VII)	SIGN BOARDS, KM. STONES	1000	1000	1000	1000
(VIII)	TRAFFIC CENSUS	300	300	300	300
	TOTAL FOR ORD. REPAIRS	27291	20027	28572	20027
(B)	MAJOR REPAIRS				
(I)	REPAIRS TO RETAINING/ BREAST WALLS	2500	1500	2500	1500
(II)	REMOVAL OF SLIPS & SNOW CLEARANCE (UPTO 1.0m DEPTH)	2500	1500	2500	1500
(III)	REPAIRS TO DRAINS & RECONSTRUCTION OF DAMAGED WORKS	1000	1000	1000	1000

ANNEXURE-VII-C (Contd.)

		Traffic Density			
		Less Than 450 CVD		Over 450 CVD	
		BT	WBM	BT	WBM
(C)	PERIODICAL RENEWALS				
		PC/6	MR/5	PC/5	MR/4
(I)*	SDC/PC & SC/SD	33500	-	40200	-
(II)	METAL RENEWAL	-	24300	-	30375
(D)	SPECIAL REPAIRS	2000	2000	2000	2000
(E)	FLOOD DAMAGE FOR BREACHES & WASHING AWAY OF BRIDGES @ 12.5% OF (A+C)	7599	5541	8596	6300
G. TOTAL		76390	55868	85368	62702
Say		76500	56000	85500	62500

- * SD - SURFACE DRESSING
 PC & SC - PREMIX CARPET WITH SEAL COAT
 SDC - SEMI DENSE CARPET

- NOTES :
1. THESE NORMS ARE FOR HILL ROAD FALLING IN AREAS HAVING RAINFALL BETWEEN 1500-3000 MM/ANNUM.
 2. "PROVISION FOR MAJOR REPAIRS AS PER (B) ABOVE MAY BE REDUCED BY 15% FOR ROADS IN AREAS HAVING RAINFALL LESS THAN 1500 MM AND INCREASED BY 15% FOR ROADS IN AREAS HAVING RAINFALL MORE THAN 3000 MM. NO REDUCTION WILL BE MADE FOR ROADS IN HIGH ALTITUDE AREAS EVEN IF THE RAINFALL IS LESS THAN 1500 MM".
 3. FOR TWO LANE ROAD AND INTERMEDIATE LANE ROADS, THE ABOVE RATES OF SINGLE LANE SHOULD BE MULTIPLIED BY 1.6 AND 1.3 RESPECTIVELY.

ANNEXURE-VII-D

**ZONE WISE DETAILS M&R NORMS FOR ONE KM OF ODR/VR
OF HILL ROADS (SINGLE LANE)**

ZONE-I

		Traffic Density			
		Less Than 450 CVD			
		BT	WBM	KATCHA	BRIDLE ROAD
(A)	ORDINARY-REPAIRS				
(I)	LABOUR-BELDAR	6480	6480	6480	1080
		(0.3)	(0.3)	(0.3)	(0.5)
	MISTRI	864	864	864	144
		(0.04)	(0.04)	(0.04)	(0.00667)
(II)	PATCH AREA	5.0%	4.0%	-	-
(a)	B.T. SURFACE				
	- BITUMEN	8858	-	-	-
	- AGGREGATE	(206m ² @43/-)	-	-	-
(b)	WBM				
	- METAL	-	2970	-	-
		-	(165m ² @18/-)	-	-
(III)	ARBORICULTURE	150	100	50	-
(IV)	PARAPET REPAIRS	1000	700	300	300
(V)	STORE HOUSE SHED	400	300	200	-
(VI)	CROSS-DRAINAGE WORKS, BRIDGES, CLEANING OF SCUPPERS, RECONSTRUCTION OF TOE WALL, PROTECTION WALLS	1500	1000	500	400
(VII)	SIGN BOARDS, KM. STONES AND WHITE WASH	200	150	100	100
(VIII)	TRAFFIC CENSUS	100	50		
	TOTAL FOR ORD. REPAIRS	19552	12614	8494	2024
(B)	MAJOR REPAIRS				
(I)	REPAIRS TO RETAINING/ BREAST WALLS	1500	1500	1000	400
(II)	REMOVAL OF SLIPS & SNOW CLEARANCE (UPTO 1.0m DEPTH)	1500	1500	1000	1000
(III)	REPAIRS TO DRAINS & RECONSTRUCTION OF DAMAGED WORKS	1000	1000	1000	100

ANNEXURE-VII-D (Contd.)

		Traffic Density			
		Less Than 450 CVD		Over 450 CVD	
		BT	WBM	BT	WBM
(C)	PERIODICAL RENEWALS				
		PC/6	MR/5	-	-
(I)*	SDC/PC & SC/SD	23750	-	-	-
(II)	METAL RENEWAL	-	15200	7600 (0.10m thick in 100 m length)	-
(D)	SPECIAL REPAIRS	1500	1500	1500	1200
(E)	FLOOD DAMAGE FOR BREACHES & WASHING AWAY OF BRIDGES @ 12.5% OF (A+C)	5413	3477	2012	253
G. TOTAL		54215	36791	22606	4977
Say		54000	37000	22500	5000

- * SD - SURFACE DRESSING
PC & SC - PREMIX CARPET WITH SEAL COAT
SDC - SEMI DENSE CARPET

- NOTES :
1. THESE NORMS ARE FOR HILL ROAD FALLING IN AREAS HAVING RAINFALL BETWEEN 1500-3000 MM/ANNUM.
 2. "PROVISION FOR MAJOR REPAIRS AS PER (B) ABOVE MAY BE REDUCED BY 15% FOR ROADS IN AREAS HAVING RAINFALL LESS THAN 1500 MM AND INCREASED BY 15% FOR ROADS IN AREAS HAVING RAINFALL MORE THAN 3000 MM. NO REDUCTION WILL BE MADE FOR ROADS IN HIGH ALTITUDE AREAS EVEN IF THE RAINFALL IS LESS THAN 1500 MM".
 3. FOR TWO LANE ROAD AND INTERMEDIATE LANE ROADS, THE ABOVE RATES OF SINGLE LANE SHOULD BE MULTIPLIED BY 1.6 AND 1.3 RESPECTIVELY.

ANNEXURE-VII-E

**ZONE WISE DETAILS M&R NORMS FOR ONE KM OF ODR/VR
OF HILL ROADS (SINGLE LANE)**

ZONE-II

		Traffic Density			
		Less Than 450 CVD			
		BT	WBM	KATCHA	BRIDLE ROAD
(A)	ORDINARY-REPAIRS				
(I)	LABOUR-BELDAR	6480 (0.3)	6480 (0.3)	6480 (0.3)	1080 (0.05)
	MISTRI	864 (0.04)	864 (0.04)	864 (0.04)	144 (0.00667)
(II)	PATCH AREA	5.0%	4.0%	-	-
(a)	B.T. SURFACE				
	- BITUMEN	10712	-	-	-
	- AGGREGATES	(206m ² @52/-)	-	-	-
(b)	WBM				
	-METAL	-	4785	-	-
		-	(165m ² @29/-)		
(III)	ARBORICULTURE	150	100	50	-
(IV)	PARAPET REPAIRS	1000	700	300	300
(V)	STORE HOUSE SHED	400	300	200	-
(VI)	CROSS-DRAINAGE WORKS, BRIDGES, CLEANING OF SCUPPERS, RECONSTRUCTION OF TOE WALL, PROTECTION WALLS	1500	1000	500	400
(VII)	SIGN BOARDS, KM. STONES AND WHITE WASH	200	150	100	100
(VIII)	TRAFFIC CENSUS	100	50	-	-
	TOTAL FOR ORD. REPAIRS	21406	14429	8494	2029
(B)	MAJOR REPAIRS				
(I)	REPAIRS TO RETAINING/ BREAST WALLS	1500	1500	1000	400
(II)	REMOVAL OF SLIPS & SNOW CLEARANCE (UPTO 1.0m DEPTH)	1500	1500	1000	1000
(III)	REPAIRS TO DRAINS & RECONSTRUCTION OF DAMAGED WORKS	1000	1000	1000	100

ANNEXURE-VII-E (Contd.)

		Traffic Density			
		Less Than 450 CVD			
		BT	WBM	KATCHA	BRIDLE ROAD
(C)	PERIODICAL RENEWALS				
		PC/6	MR/5	-	-
(I)*	SDC/PC & SC/SD	28833	-	-	-
(II)	METAL RENEWAL	-	24300	12150 (0.10m thick in 100m length)	-
(D)	SPECIAL REPAIRS	1500	1500	1500	1200
(E)	FLOOD DAMAGE FOR BREACHES & WASHING AWAY OF BRIDGES @ 12.5% OF (A+C)	6280	4841	2580	253
G. TOTAL		62019	49070	27724	4977
Say		62000	49000	27500	5000

- * SD - SURFACE DRESSING
 PC & SC - PREMIX CARPET WITH SEAL COAT
 SDC - SEMI DENSE CARPET

- NOTES :
1. THESE NORMS ARE FOR HILL ROAD FALLING IN AREAS HAVING RAINFALL BETWEEN 1500-3000 MM/ANNUM.
 2. "PROVISION FOR MAJOR REPAIRS AS PER (B) ABOVE MAY BE REDUCED BY 15% FOR ROADS IN AREAS HAVING RAINFALL LESS THAN 1500 MM AND INCREASED BY 15% FOR ROADS IN AREAS HAVING RAINFALL MORE THAN 3000 MM. NO REDUCTION WILL BE MADE FOR ROADS IN HIGH ALTITUDE AREAS EVEN IF THE RAINFALL IS LESS THAN 1500 MM".
 3. FOR TWO LANE ROAD AND INTERMEDIATE LANE ROADS, THE ABOVE RATES OF SINGLE LANE SHOULD BE MULTIPLIED BY 1.6 AND 1.3 RESPECTIVELY.

ANNEXURE-VII-F

**ZONE WISE DETAILS M&R NORMS FOR ONE KM OF ODR/VR OF
HILL ROADS (SINGLE LANE)**

ZONE-III

		Traffic Density			
		Less Than 450 CVD			
		BT	WBM	KATCHA	BRIDLE ROAD
(A)	ORDINARY-REPAIRS				
(I)	LABOUR-BELDAR	6480	6480	6480	1080
		(0.3)	(0.3)	(0.3)	(0.05)
	MISTRI	864	864	864	144
		(0.04)	(0.04)	(0.04)	(0.00667)
(II)	PATCH AREA 5.0%	4.0%			
(a)	B.T. SURFACE				
	- BITUMEN	12566	-	-	-
	- AGGREGATE	(206m ² @61/-)	-	-	-
(b)	WBM				
	-METAL	-	4785	-	-
		-	(165m ² @29/-)		
(III)	ARBORICULTURE	150	100	50	-
(IV)	PARAPET REPAIRS	1000	700	300	300
(V)	STORE HOUSE SHED	400	300	200	-
(VI)	CROSS-DRAINAGE WORKS, BRIDGES, CLEANING OF SCUPPERS, RECONSTRUCTION OF TOE WALL, PROTECTION WALLS	1500	1000	500	400
(VII)	SIGN BOARDS, KM. STONES AND WHITE WASH	200	150	100	100
(VIII)	TRAFFIC CENSUS	100	50	-	-
	TOTAL FOR ORD. REPAIRS	23260	14429	8494	2024
(B)	MAJOR REPAIRS				
(I)	REPAIRS TO RETAINING/ BREAST WALLS	1500	1500	1000	400
(II)	REMOVAL OF SLIPS & SNOW CLEARANCE (UPTO 1.0m DEPTH)	1500	1500	1000	1000
(III)	REPAIRS TO DRAINS & RECONSTRUCTION OF DAMAGED WORKS	1000	1000	1000	100

ANNEXURE-VII-F

**ZONE WISE DETAILS M&R NORMS FOR ONE KM OF ODR/VR OF
HILL ROADS (SINGLE LANE)**

ZONE-III

		Traffic Density			
		Less Than 450 CVD			
		BT	WBM	KATCHA	BRIDLE ROAD
(A)	ORDINARY-REPAIRS				
(I)	LABOUR-BELDAR	6480	6480	6480	1080
		(0.3)	(0.3)	(0.3)	(0.05)
	MISTRI	864	864	864	144
		(0.04)	(0.04)	(0.04)	(0.00667)
(II)	PATCH AREA 5.0%	4.0%			
(a)	B.T. SURFACE				
	- BITUMEN	12566	-	-	-
	- AGGREGATE	(206m ² @61/-)	-	-	-
(b)	WBM				
	-METAL	-	4785	-	-
		-	(165m ² @29/-)		
(III)	ARBORICULTURE	150	100	50	-
(IV)	PARAPET REPAIRS	1000	700	300	300
(V)	STORE HOUSE SHED	400	300	200	-
(VI)	CROSS-DRAINAGE WORKS, BRIDGES, CLEANING OF SCUPPERS, RECONSTRUCTION OF TOE WALL, PROTECTION WALLS	1500	1000	500	400
(VII)	SIGN BOARDS, KM. STONES AND WHITE WASH	200	150	100	100
(VIII)	TRAFFIC CENSUS	100	50	-	-
	TOTAL FOR ORD. REPAIRS	23260	14429	8494	2024
(B)	MAJOR REPAIRS				
(I)	REPAIRS TO RETAINING/ BREAST WALLS	1500	1500	1000	400
(II)	REMOVAL OF SLIPS & SNOW CLEARANCE (UPTO 1.0m DEPTH)	1500	1500	1000	1000
(III)	REPAIRS TO DRAINS & RECONSTRUCTION OF DAMAGED WORKS	1000	1000	1000	100

ANNEXURE-VII-F (Contd.)

		Traffic Density			
		Less Than 450 CVD			
		BT	WBM	KATCHA	BRIDLE ROAD
(C)	PERIODICAL RENEWALS				
		PC/6	MR/5	-	-
(I)*	SDC/PC & SC/SD	33500	-	-	-
(II)	METAL RENEWAL	-	24300	12150 (0.10m thick in 100m length)	-
(D)	SPECIAL REPAIRS	1500	1500	1300	1200
(E)	FLOOD DAMAGE FOR BREACHES & WASHING AWAY OF BRIDGES @ 12.5% OF (A+C)	7095	4841	2580	253
	G. TOTAL	69355	42070	27524	4977
	Say	69500	49000	27500	5000

- * SD - SURFACE DRESSING
 PC & SC - PREMIX CARPET WITH SEAL COAT
 SDC - SEMI DENSE CARPET

- NOTES :
1. THESE NORMS ARE FOR HILL ROAD FALLING IN AREAS HAVING RAINFALL BETWEEN 1500-3000 MM/ANNUM.
 2. "PROVISION FOR MAJOR REPAIRS AS PER (B) ABOVE MAY BE REDUCED BY 15% FOR ROADS IN AREAS HAVING RAINFALL LESS THAN 1500 MM AND INCREASED BY 15% FOR ROADS IN AREAS HAVING RAINFALL MORE THAN 3000 MM. NO REDUCTION WILL BE MADE FOR ROADS IN HIGH ALTITUDE AREAS EVEN IF THE RAINFALL IS LESS THAN 1500 MM".
 3. FOR TWO LANE ROAD AND INTERMEDIATE LANE ROADS, THE ABOVE RATES OF SINGLE LANE SHOULD BE MULTIPLIED BY 1.6 AND 1.3 RESPECTIVELY.

ANNEXURE-VIII

TYPICAL RATE ANALYSIS OF ORDINARY REPAIRS (COST ANALYSIS FOR 1 KM LENGTH HAVING 3.75 M WIDE CARRIAGEWAY)

1. Labour

- (a) For SH/MDR/ODR/VR (BT OR WBM OR KATCHA)

It shall be 0.3 labour/km

Av. monthly wages = 1800

So yearly wage reqd./km = $0.3 \times 1800 \times 12 =$

6480/-

- (b) For Briddle road

Equivalent Labour of (a) to be employed
only for 2 monthsHence yearly wage/km = $\frac{6480}{6}$

1080/-

2. Mate

- (a) For SH/MDR/ODR/VR(BT)/WBM OR KATCHA)

It shall be 0.04/km

Av. daily wage = 60/- A.V. monthly wage =

1800/-

So yearly wage reqd. = $1800 \times 12 \times 0.04$

864/-

- (b) For Briddle road

As in I(b), it shall also be for 2 months

Hence yearly wage = $\frac{864}{6}$

144/-

3. Arboriculture :- it is taken LS as given in Annexure.**4. Parapet Repairs**

- (a) For SH & MDR

Assuring 120 parapets/km, damaged No. supposing 5/km
Cost of repairs = $5 \times 313 = 1565$

Say

1500/-

- (b) For ODR/VR

- (2) BT Assuring 3 parapets damaged
-
- Cost =
- $3 \times 313 = 939$

Say

1000/-

- (ii) WBM Assuring 2 parapets damaged
-
- Cost =
- $2 \times 313 = 626$

Say

700/-

- (iii) Kacha Assuring 1 parapets damaged
-
- Cost =
- $1 \times 313 = 313$

Say

300/-

- (c) For Briddle road

Assuring 1 parapets damaged
Cost = $1 \times 313 = 313$

Say

300/-

5. Store House and shed

It is provided L5 as given in Annexure.

6. C.D. Works & Bridge

(a) For SH & MDR			
	Clearing of Scuppers 8 Nos./km (a) 125	=	1000/-
	Repair of RW/BW/Toe Wall etc. LS	=	1500/-
			2500/-
(b) ODR/VR			
(2) B.T.	Clearing of Scuppers 6 Nos. @ 200/-	=	1200/-
	Repair of RW/BW/Toe Wall etc. LS	=	300/-
			1500/-
(ii)	Clearing of 4 Nos. Scuppers @ 200/-	=	800/-
	Repair of RW/BW/TW etc. LS	=	200/-
			1000/-
(iii)	Katcha		
	Clearing of 2 Nos. Scuppers @ 200/-	=	400/-
	Repair of RW/BW/TW etc. LS	=	100/-
			500/-
(iv) Briddle Road			
It is taken as L.S. as given in Table.			

7. Sign Board, KM Stones, White Wash etc.

It is taken as L.S. as given in Annexure for ODR/VR and has been analysed for SH/MDR as follows

(2) For SH & MDR			
	Repainting of Sign & Caution Boards 6 Nos. @ 50/-		300/-
(ii)	H.M. Stones 4 Nos. @ 10/-		40/-
	KM Stone 1 No. @ 50/-		50/-
(iii)	Numbering of Scupper 10x4 = 40 Nos. @ 8/-		320/-
(iv)	Repainting of Bridge & Culverts railing LS		100/-
(v)	White washing of Road side driving, edge stone Parapets and Hill sides, 2 times a year with other misc. items LS		200/-
			1010
	Say		1,000

8. Traffic Census

It is taken as L.S. as given in Annexure. No traffic census assumed to be one on Katcha and Briddle roads.

9. Repair to BM/RW/Bed Bars etc.

It is taken as L.S. as given in Annexure.

10. Removal of slips & Snow clearance

		SH & MDR				ODR/VR			Bridle Road
		450CV		450CV					
		BT	WBM	BT	WBM	BT	WBM	Katcha	
1.	Removal of Slips (Manual)	200m ³	200m ³	200m ³	200m ³	50m ³	50m ³	50m ³	100m ³
	Snow	@6/m ³	@6/m ³	@6/m ³	@6/m ³	@6/m ³	@6/m ³	@6/m ³	@6/m ³
		1200	1200	1200	1200	300	300	300	600
2.	Removal by Dozer (LS)	1300	300	1300	300	1200	1200	700	400
	(Slips Snow)	2500	1500	2500	1500	1500	1500	1000	1000

11. Repairs to drains and reconstruction of damaged works

(a) For SH & MDR

(i) 4 persons are reqd. of down and maintain 100 km in a year

$$\text{Hence cost/km} = \frac{4}{100} \times 1800 \times 12 = 864/-$$

(ii) Cost of material required in above LS = 150/-

1014/-
Say 1000/-

(b) For ODR/VR

It is taken L.S. as given in Annexure.

ANNEXURE-IX

Typical Rate Analysis for One Coat Surface Dressing (SD) as a Renewal Coat (Cost Analysis for 1 km length having 3.75 m wide carriageway)

Zone-I

$$\text{Area} = 3.75 \times 1000 + 10\% \text{ for curves} = 4125 \text{m}^2$$

Materials

1. Qty. of Bitumen @ 11 kg/10m²

$$= 4125 \times \frac{11}{1000} \times \frac{1}{10} = 4.53 \text{ MT}$$

2. Qty. of stone chips @ .1m³/10m²

$$= 4125 \times \frac{0.1}{10} = 41.25 \text{ cum}$$

3. Fuel wood for heating Bitumen 4.53T @ 4.5Qtl/MT = 20.38 Qtl

4. Diesel for 3 days @ 8 hrs/day and 8.5 lit/hr = 204 lit.

Cost

1.	Bitumen 4.53 MT @ Rs.6000/- per MT	=	Rs.	27180
2.	Stone chips 41.25 cu.m @ Rs.300/- per cum	=	Rs.	12375
3.	Fuel wood 20.38 Qtl @ Rs.110/- Qtl	=	Rs.	2242
4.	Diesel 204 @ Rs.5.5/- per litre	=	Rs.	1122
5.	Labour charges 4125 sqm @ Rs.1.23/- sqm	=	Rs.	5074
	Labour charges for precoating 41.25 cum @ Rs.25.3/- cum	=	Rs.	1044
6.	Miscellaneous items			
	i) Painting Kits, brushes etc. L.S.	=	Rs.	1000
	ii) Roller charges @ 500 per day for 3 days	=	Rs.	1500
	iii) Renewal of Patris/Edge Filling etc. L.S.	=	Rs.	4500
			Rs.	56037
	Add 10% for contingencies and contractor's profit		Rs.	5604
	Total		Rs.	61641
	Rate per km of single lane	Say	Rs.	61500

ANNEXURE-X

**Typical Rate Analysis for 20mm PC with seal coat (Cost analysis for 1 km length
having 3.75 m wide carriageway)**

Zone-I

$$\text{Area} = 1000 \times 3.75 + 10\% \text{ for curves} = 4125 \text{ m}^2$$

1. Qty. of Bitumen

for tack coat	5.00 kg/10m ²
for P.C.	14.60 kg/10m ²
for seal coat (type B)	6.80 kg/10m ²
	26.4 kg/10m ²

$$= 4125 \times \frac{26.4}{10} \times \frac{1}{1000} = 10.890 \text{ MT}$$

2. Qty. of Stone chips @ 0.27 cum/10m²

$$= 4125 \times \frac{0.27}{10} = 111.38 \text{ cum}$$

3. Qty. of Sand @ 0.60 c.m/10m²

$$= 4125 \times \frac{0.06}{10} = 24.75 \text{ cum}$$

Cost

1.	Bitumen 10.89 MT @ Rs.6000/- per MT	=	Rs. 65340
2.	Stone chips 111.38 cum @ Rs.300/- per cum	=	Rs. 33414
3.	Sand 24.75 cum @ Rs.120/- per cum	=	Rs. 2970
4.	Labour including paver laying and compaction 111.38x1.6 = 178.20 MT @ Rs.130/- per MT	=	Rs. 23166
5.	Labour including consolidation of seal coat 4125 m ² @ Rs.1.10/m ²	=	Rs. 4538
			Rs. 129428
	Add 10% for contingencies and contractor's profit		Rs. 12943
	Total	=	Rs. 142371
	Rate per km of single lane	Say =	Rs. 142500

ANNEXURE-XI

Typical Rate Analysis for 25mm Semi-Dense carpet (SDC) (Cost analysis for 1 km length having 3.75 m wide carriageway)⁽¹⁾

Zone-I

Area = $1000 \times 3.75 + 10\%$ for curves = 4125 sqmwt. of mix $4125 \times 0.025 \times 23 = 237.19$ MT

1. Qty. of Bitumen @ 5.5% by wt. of mix

$$= 237.19 \times \frac{5.5}{100} = 13.05 \text{ MT}$$

Bitumen for Tack Coat @ 5 kg/10m² = 2.06 MT

Total Bitumen = 15.11 MT

2. Wt. of Stone chips
-
- (237.19-13.05)
- $\times 0.7$
- = 156.90 MT

1 cum of chips weights = 1600 kg

$$\text{Qty. of stone chips} = \frac{156.90}{1.6} = 98.06 \text{ cum}$$

3. Wt. of Sand = (237.19-13.05)
- $\times 0.2$
- = 44.83 MT

$$\text{Qty. of Sand} = \frac{44.83}{1.55} = 28.92 \text{ cum}$$

4. Wt. of filler = (237.10-13.05)
- $\times 0.1$
- = 22.41 MT

1 cum of filler weighs = 2200 kg

$$\text{Qty. of Filler} = \frac{22.41}{2.2} = 10.19 \text{ cum}$$

Cost

1.	Bitumen 15.11 MT @ Rs.6000/- per MT	=	Rs. 90660
2.	Stone chips 98.06 MT @ Rs. 300/- per cum	=	Rs. 29418
3.	Sand 28.92 cum @ Rs.120/- per cum	=	Rs. 3470
4.	Filler 10.19 cum @ Rs.500/- per cum	=	Rs. 5095
5.	Laying and compacting 237.19 Mt @ Rs.130/- per MT	=	Rs. 30835
			Rs. 159478
	Add 10% for contingencies and contractor's profit		Rs. 15948
			Rs. 175426
	Rate per km of single lane	Say	Rs. 175500

ANNEXURE-XII

Typical Rate Analysis for 75 mm Metal Renewal (MR 75) (Cost Analysis for 1 km length having 3.75 m wide carriageway)

Zone-I

$$\text{Area} = 1000 \times 3.75 + 10\% \text{ for curves} = 4125 \text{ m}^2$$

1. Qty. of Stone metal

$$= 4125 \times \frac{100}{1000} = 412 \text{ cum (loose)}$$

Cost

1.	Stone metal 412 cu.m @ Rs.150/- per cum	=	Rs. 61800
2.	Labour for consolidation 412 cum @ Rs.18/- per cum	=	Rs. 7416
			Rs. 69216
	Add 10% for contingencies and contractor's profit		Rs. 6922
			Rs. 76138
	Rate per km of single lane	Say	Rs. 76000

ANNEXURE-XIII

Norms for Repair to Semi-Permanent Timber Bridges/Km Length of Road**A. Data (in respect of Assam)**

i)	Total length of S.P.T. bridges	1,48,400 rm
ii)	Length of roads having S.P.T. bridges	30,000 km
iii)	Length of S.P.T. bridges/km length of road	5 rm
iv)	Cost of construction of 5 rm of S.P.T. bridges @ Rs.25,000/rm	Rs. 1,25,000/-
v)	Cost of timber component 65% of the total cost	Rs. 81,000/-
vi)	Cost of timber superstructure and sub-structure (40:60)	
a)	Super-structure	Rs. 32,400/-
b)	Sub-structure	Rs. 48,600/-

B. Cost of Maintenance

i)	Cost of normal maintenance/km/yr considering @ 75% of timber super-structure	Rs. 2,400/-
ii)	Cost of special repair/km/yr considering 12 yr. cycle for replacement of timber component	Rs. 6,750/-
	Total cost	Rs. 9,150/-
	Say	Rs. 9,000/- per km of road having SPT bridges

Note : This would vary if the average of SPT bridges is not 5/rm/km of road.

WORK REPORT

WORK SHEET NO. _____

WEEK FROM _____ TO _____

SECTION _____ FROM _____ TO _____

Quantity and Type of Work Done

- | | | |
|------|-------------------|----------------------|
| i) | Treating bleeding | m ² _____ |
| ii) | Cracks | m ² _____ |
| iii) | Potholes filling | m ² _____ |

Material utilised

Bitumen _____ kg or Tonnes _____

Aggregate _____ m³ _____Sand _____ m³ _____

Note : "Quantity/type of work and materials/resources utilised on repairs/maintenance of parapets, CD works, bridges, breast/retaining/toe walls, drains, slide/snow clearance, km stones/sign boards etc. also may be included as per work done during the week".

ANNEXURE-XV

FORMAT OF PERFORMANCE FOR MAINTENANCE (DIVISION LEVEL)

Date _____ Division _____

Qr _____ Circle _____

Name of road	Budget allotment (Rs. Lakh)	Ordinary Repairs (Rs. lakh)					Special Repairs Renewal/Restoration etc.					Remarks
		Road Gangs (Labour)	Material	Others	Total	Job No.	Targets			Achievements		
							Physical (km)	Financial (Rs. lakh)	Physical (km)	Financial (Rs. lakh)		
1	2	3	4	5	6	7	8	9	10	11	12	

APPENDIX-I

**MAIN RECOMMENDATIONS CONTAINED IN THE REPORT OF THE COMMITTEE
ON NORMS FOR MAINTENANCE OF ROADS, WHICH ARE CONSIDERED
RELEVANT FOR HILL ROADS ALSO**

- 1.1. The actual allocations made available to different States at present are only about 50 to 70 per cent of the requirements as per norms. This needs serious attention of policy makers to improve the situation. The whole attitude towards maintenance needs a change at all levels.
- 1.2. Investments in roads have been going down from a high of 6.5 per cent of public expenditure in First Plan to 3.0 per cent in the Eighth Plan. This inadequate outlay in Roads Sector is having serious impact on the economy. Allocations for roads need to be stepped up suitably. The first charge on the increase in plan outlays should be for strengthening of pavement, adequate drainage measures and reconstruction of weak bridges and culverts. This would in turn help in reducing the maintenance burden. Removal of deficiencies of existing roads should have priority over expansion of road network.
- 1.3. The Committee recommends that the Tenth Finance Commission may devise suitable mechanism so that the State Govts. make adequate provision in the budget for maintenance of roads and release the same so that the maintenance work receives the priority it deserves.
- 1.4. For increasing the efficiency of the road gangs, the scheme of mobile gangs may be introduced in more States on experimental basis and decisions taken for reorganisation of the maintenance operations for improved efficiency on the basis of experience thus gained. The feasibility of introducing some mechanisation in the maintenance operations may also be considered for adoption.
- 1.5. The ban on recruitment of labour should continue and be enforced strictly. In States where the existing road gang establishment is more than the prescribed norms, concerted efforts may be made by the concerned States to bring it down to the norms latest by 1995-96.
- 1.6. Existing gravel roads, where the traffic is more than 450 CVD, should preferably be converted to metalled/black topped road out of plan funds.
- 1.7. Priority in M&R should be given to periodic renewals. In fact a specific portion of the maintenance budget should be set apart for this activity. A minimum of 40 per cent should be aimed at.
- 1.8. Vehicle protective measures on stretches near village ponds needs special attention. These aspects should be kept in view while taking up any improvement works.
- 1.9. For optimum use of available funds, the State may institute Road Maintenance Management Systems so that a scientific assessment of maintenance treatments could be made based on traffic, road condition, climate and budget constraints.
- 1.10. Most of the major bridges were constructed during the Second to Fifth Five Year Plan periods. These bridges have now started showing signs of distress and need major attention for rehabilitation. There is need to have a proper Bridge Maintenance Management System.
- 1.11. The Indian Roads Congress (IRC) has brought out a number of publications on various aspects of maintenance operations which contain detailed instructions on execution and monitoring of the maintenance operations. The State PWDs and other executing agencies should utilise these publications.
- 1.12. The existing system of monitoring of maintenance activities and utilisation of funds in State PWDs need to be improved. The system should also have in-built mechanism of accountability in performance.

1.13. The Central Road Fund needs to be augmented and at least 50 per cent of this should be earmarked for maintenance and other preventive maintenance activities including strengthening.

1.14. The funds for maintenance may also be raised through roadside advertisements and commercial plantation.

1.15. The States may also consider levying some additional agricultural cess. The funds so generated could be spent exclusively on maintenance of rural roads. Also, the local bodies including panchayats should be authorised to levy cess on agricultural, industrial and rural household for maintaining roads within their jurisdiction.

1.16. Rural roads are being constructed through Jawahar Rojgar Yojana (JRY) funds as job creation schemes in rural areas. The Committee recommends that 30 per cent of such allotments should be earmarked for maintenance of assets created as this is equally labour intensive and thus help in job creation.

1.17. The practice of overloading of vehicles needs to be curbed and for this purpose effective enforcement of provisions in the Motor Vehicles Act is required. Strict enforcement need to be exercised. Otherwise roads get damaged rapidly resulting in poor condition requiring heavy outlays for maintenance and rehabilitation.

1.18. In order to improve the productivity of labour and immediate supervisory staff, proper training to maintenance labour/staff is essential and should be provided for.

1.19. The Ministry of Surface Transport (Roads Wing), being nodal Ministry for roads, and the Planning Commission should monitor and review allocation of M&R funds made by the States in their budget on year to year basis.

1.20. The norms for M&R may be reviewed after an interval of every five years to take into account changes in traffic patterns and technological advancements etc.

121.2 DIRECTIONS ON PROJECT PREPARATION AND CO-ORDINATION BETWEEN ROADS AND BRIDGES

Code No.	Circular No. & Date	Brief Subject	Page No.
121.2.51	RW/NH-11060/1/93-DO I dated 30.5.96	Expeditious completion of National Highway Projects	121.2/37
121.3 AGENCY, OTHER CHARGES AND RECEIPTS			
121.3.15	RW/NH-11023/2/94-DO I dated 21.8.95	Centage charges in respect of National Highway works	121.3/8
121.3.16	RW/NH-11023/2/94-DO I dated 12.9.95	Centage charges in respect of National Highway works	121.3/8
121.3.17	RW/NH-11065/9/94-DO I dated 26.9.95	Reimbursement of expenditure incurred by the NH Divisions on the work charged establishment	121.3/8
121.3.18	RW/NH-11065/9/94-DO I dated 9.2.96	Advance payment to Contrator/Supplier for the NH works - Form No. 26 as per C.P.W.A. Code	121.3/9 & 10
121.4 PROCEDURE FOR SUBMISSION OF CASES TO MINISTER, MOF, PIB, EFC & WORLD BANK			
121.4.31	RW/NH-11029/1/97-DO I dated 12.11.97	Guidelines in respect of EFC/PIB procedures and delegation of financial powers to Ministry of Surface Transport for NH Projects - regarding	121.4/36 to 38
121.5 REVISED ESTIMATES, PERMISSIBLE EXCESS AND CHANGE OF SCOPE			
121.5.24	RW/NH-11026/2/97-DO I dated 27.8.99	Revised cost estimates in respect of National Highway (Original) works upto Rs. 50 lakhs sanction reg.	121.5/19

No.RW/NH-11060/1/93-DO I***Dated, the 30th May, 1996***

To

The Secretaries (dealing with National Highways), Public Works Department of all State and Union Territories

Subject: Expeditionary completion of National Highway Projects

Attention is invited to the Ministry's Circular No.RW/NH-11060/1/87-DO I dated 28.8.92 (copy enclosed*) regarding expeditious award and completion of National Highway projects. However, while reviewing the progress of on-going works at a high level in the Ministry recently it was observed that several works are lingering on beyond the completion periods stipulated therein.

2. The matter has been viewed with great concern and it has been decided that all such works be reviewed and the works which are lingering but have progress say 50 per cent after two years and 75 per cent after two and a half years, after sanction, should be accelerated.

3. It is requested that contents of this letter may please be brought to the notice of all officers in Public Works Departments dealing with National Highway works for strict compliance.

* Already printed on page 121.2/34 in Addendum to Ministry's Technical Circulars and Directives on National Highways and Centrally Sponsored Road and Bridge Projects (Aug. 98 to Dec. 92)

No.RW/NH-11060/1/93-DO I***Dated, the 30th May, 1996***

To

The Secretaries (dealing with National Highways), Public Works Department of all State and Union Territories

Subject: Expeditionary completion of National Highway Projects

Attention is invited to the Ministry's Circular No.RW/NH-11060/1/87-DO I dated 28.8.92 (copy enclosed*) regarding expeditious award and completion of National Highway projects. However, while reviewing the progress of on-going works at a high level in the Ministry recently it was observed that several works are lingering on beyond the completion periods stipulated therein.

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* Already printed on page 121.2/34 in Addendum to Ministry's Technical Circulars and Directives on National Highways and Centrally Sponsored Road and Bridge Projects (Aug. 98 to Dec. 92)

No.RW/NH-11023/2/94-DO I***Dated, the 21st August, 1995***

To

The Secretaries (dealing with National Highways), Public Works Department of all States and Union Territories

Subject: Centage charges in respect of National Highway works

I am directed to say that this Ministry has been sanctioning the estimates for National Highway works after adding centage charges on cumulative basis, as per the existing procedure. As this procedure is not in accordance with the CPWD Accounts Code, the question of its revision has been under consideration of the Government. It has now been decided, in modification of this Ministry's circular No. NH-III/P/18/80, dated 17.11.80 that henceforth centage charges i.e. 1% quality control charges, and 1.5% to 2% work-charged establishment charges should be added individually to the estimated cost which includes 3% contingency charges, separately. Nine per cent agency charges will be admissible only on the estimated cost of the work including contingency charges. It may also be ensured that 1% quality control charges should be added only on permissible items.

2. The State PWDs are, therefore, requested to submit the estimates for National Highway works by adding the centage charges separately, as per the revised procedure mentioned above and not on cumulative basis. Nine per cent agency charges may be added only on the estimated cost of the work, including 3% contingency charges. It is also requested that necessary instructions may be issued to all concerned in your Department to follow the above procedure, for preparing the estimates for National Highway Works.

No.RW/NH-11023/2/94-DO I***Dated, the 12th September, 1995***

To

The Secretaries (dealing with National Highways), Public Works Departments of all States and Union Territories

Subject: Centage charges in respect of National Highway Works

In partial modification of this Ministry's letter of even number dated 21st August, 1995 on the subject mentioned above, it is requested that in lines 9 & 10 of Para-1 of the above letter, the words and figures 'and 1.5% to 2% work-charged establishment charges' may be substituted with the words and figures 'and 1% to 2% work-charged establishment charges for road/bridge projects, as the case may be'.

No.RW/NH-11065/9/94-DO I***Dated, the 26th September, 1995***

To

The Secretaries (dealing with National Highways), Public Works Department of all State and Union Territories

Subject: Reimbursement of expenditure incurred by the NH Divisions on the work charged establishment

I am directed to say that the CCA, Ministry of Surface Transport has sought this Ministry's clarification whether the cost of the work charged staff, after being regularised can be met out of the provision for work charged establishment. The matter has been considered and it is clarified that the cost of supervisory staff engaged on the execution

of the National Highway work is to be met out of the 9% agency charges payable to the executing agency. The provision of work charged establishment charges is for meeting the cost of non-supervisory staff employed specifically for the work only. For this purpose, it is necessary that the staff should be non-supervisory and should be meant to work exclusively on the particular job. Once these conditions are satisfied, the State Governments can legitimately charge the expenditure on the provision for work charged establishment, irrespective of the fact whether the staff is regular or casual.

2. It is requested that these instructions may hence-forth be followed strictly.

121.3.18

No.RW/NH-11065/9/94-DO I

Dated, the 9th February, 1996

To

The Secretaries (dealing with National Highways), Public Works Department of all State and Union Territories

Subject: Advance payment to Contractor/Supplier for the NH works - Form No. 26 as per C.P.W.A. Code

I am directed to say that it has been brought to the notice of this Ministry by the Chief Controller of Accounts that heavy advance payments are being made by the State Governments in connection with NH works, in the hand receipt form, which is inherently risky, as it may lead to double payment or advance payment remaining unadjusted due to oversight. So far as advance payment to Contractors/Suppliers is concerned, running account bill form No. 26 is adequate as per para 10.2.14 of C.P.W. Account Code, a copy of which is enclosed herewith. You are, therefore, requested to kindly use form No. 26 as provided in the C.P.W. Account Code for payment to Contractor/Supplier for the NH works. No other form will be acceptable. Suitable instructions may kindly be issued to all concerned in your department in this regard.

Enclosure to Letter No.RW/NH-11065/9/94-DO I dated 9.2.96

(a) Review of Measurements

10.2.11. The entries recorded in each completed measurement books may be subjected to a percentage check by the Divisional Accountant under the supervision of the Divisional Officer. Detailed rules on this subject may be laid down by the Administrative Ministry/Administration concerned who will also prescribe the procedure for a system of test check of recorded measurements by the superior officers of the department.

(b) Bills and Vouchers

(i) Forms of Bills and Vouchers

10.2.12. The authorised forms of bills and vouchers are the following :

- (a) First and final Bill, Form 24
- (b) Running Account Bill, Form 26
- (c) Hand Receipt, Form 28.

The use of the forms is explained in the following paragraphs and a few explanatory footnotes are printed on the forms.

10.2.13. **First and Final Bill, Form 24** : This form should be used for making payments both to contractors for work and to suppliers, when a single payment is made for a job or contract, i.e., on its completion.

10.2.14. **Running Account Bill, Form 26** : This form is used for all running and final payments to contractors and suppliers (other than those relating to lump sum contracts for which Form 27-A and 27-B are prescribed), including cases where advance payments are proposed to be made or are already outstanding in respect of the same work against the contractor. In cases, where secured advances are to be made or are already outstanding in respect of the same work against the contractor, Account of Secured Advances, Form 26-A should be attached to the bill.

10.2.15. **Hand Receipt, Form 28** : This is a simple form of voucher intended to be used for all miscellaneous payments and advances, for which the special form 24 and 26 are not suitable. The claim for refund of lapsed deposit should, however, be preferred in Form G.A.R. 46.

(ii) **Preparation Examination and Payment of Bills**

10.2.16. Before the bill of a contractor is prepared, the entries in the measurement book relating to the description and quantities of work of supplies should be scrutinised and check measured by the Sub-divisional Officer as contained in Para 10.2.9. and the calculations of "Contents or area" should be checked arithmetically under his supervision. The bill should then be prepared, from the measurement entries in one of the forms prescribed in paragraph 10.2.12 applicable to the case. The rates allowed should be entered in the Abstract of measurements and in the bill. Full rates as per agreement catalogue, indent or other order should be allowed only if the quality of work done or supplies made is upto the stipulated specification. When the work or supplies fall short of that standard, and under the agreement it is permissible to make a final payment if the contract is to run on only, such a fraction of the full rate to be determined with regard to the work remaining to be done and the general terms of the agreement.

No.RW/NH-11029/1/97-DO.I**New Delhi, dated the 12th November, 1997**

Subject: Guidelines in respect of EFC/PIB procedures and delegation of financial powers to Ministry of Surface Transport for NH Projects - regarding

Consequent upon the Cabinet Committee on Infrastructure having approved delegated powers to the Ministry of Surface Transport upto Rs. 200 crore, and in the light of the Ministry of Finance (Department of Expenditure) O.M. No. 1(5) PF II/96 dated 8th August, 1997, regarding additional guidelines in respect of EFC/PIB procedures and delegation of financial powers, the existing EFC/PIB procedures applicable to the Ministry of Surface Transport for National Highway Projects shall be as under :

1.1 ENHANCED DELEGATION OF FINANCIAL POWERS

Cost of Plan scheme

Competent Authority to approve the scheme

- | | |
|--|---|
| (a) Upto Rs. 100 crore | Ministry of Surface Transport (RW) in normal course. |
| (b) Beyond Rs. 100 crores and less than Rs. 200 crores | Expenditure Finance Committee of the Ministry of Surface Transport under the Chairmanship of Secretary (Surface Transport) with representatives of Planning Commission, Ministry of Finance and any other related Ministry. |
| (c) Rs. 200 crore and beyond but less than Rs. 500 crore | Expenditure Finance Committee chaired by Secretary (Expenditure). |
| (d) Rs. 500 crore and beyond | Projects/schemes where financial returns are not quantifiable will be considered by the EFC chaired by Secretary (Expenditure). Projects/schemes where returns are quantifiable will be considered by the PIB. In these cases the approval of the recommendations of the EFC would be accorded by the Minister of Ministry of Surface Transport and also the Finance Minister and CCEA approval would be necessary. |

1.2 Investment proposals involving outlays of Rs. 500 crores and above would be required to be posed to the Public Investment Board but all proposals costing Rs. 200 crores and above would be posed to the CCEA.

1.3 The above powers will be exercised only where necessary/requisite funds are available in the Annual Plan and the Five Year Plan Outlay as per phasing of the project/scheme. The powers will further continue to be governed by procedural and other instructions issued by Government from time to time like general economy instructions. Ministry of Finance (Department of Expenditure) O.M. No. F.1(12)-E.II(A)/92 dated 6th November, 1992 has been superseded vide their O.M. dated 6.8.1997 mentioned in para 1.1 above. These orders will not supersede any specific relaxation granted to a Ministry/Department by the Cabinet/CCEA.

2. Costing of the Project

2.1 At present, the costing of the project is done at constant prices. It has now been decided to make it obligatory for the Department to compute the project cost both on fixed cost and completion cost basis so that IRR/ERR can be calculated for both scenarios.

2.2 The completion cost may be worked out by taking into account the average rate of inflation in the following manner :

- (i) Labour component of the project cost may be updated using the average (of 12 months) of consumer price index for industrial workers.
- (ii) For all other components of cost, except labour, the average (of 12 months) of wholesale price index for all commodities may be used.

(Ministry of Finance (Department of Expenditure) O.M. No. 1(5) PF II dated 6.8.97)

3. Revised Cost Estimates (RCEs)

3.1. As far as RCEs are concerned, increase in cost will be approved by Secretary (Surface Transport) if the increase is within 25% of updated cost of the project.

3.2. Where the revised/firmed up cost estimates of scheme/project exceeds the limit of competent authority who approve the original cost of all the scheme, the approval of higher competent authority will be obtained. [Ministry of Finance (Department of Expenditure) O.M. No. 1(5) PF II dated 6.8.97]

4. Committee of PIB

4.1. Powers for preparation of Feasibility Report is being delegated to the Ministry of Surface Transport except where the cost of the project is Rs. 500 crore or more and cost of the preparation of DPR is Rs. 20 crore or more.

4.2. To avoid delays in implementation of project it has been decided to allow initiation of procedure for land acquisition at the Committee of PIB stage. The initiation of land acquisition will be examined by the Committee on a case to case basis. It is, however, to be noted that normally any payment towards compensation etc. will be made only after CCEA approves the project. The Committee of PIB Memo should clearly indicate (i) the area of land required for acquisition and the estimated cost of land are indicated by District/State authorities (ii) The urgency for initiating land acquisition may be indicated. [Ministry of Finance (Department of Expenditure) O.M. No. 1(5) PF II dated 6.8.97]

5. Project Viability

In the case of projects, in which institutional financing is contemplated, the appraisal report of the financial institutions should also be submitted along with the PIB proposals so that it is available before the PIB at the time of the consideration of the proposal. In addition to calculating IRR/ERR on firmed cost, the IRR/ERR may also be calculated on the likely completion cost of the project [Ministry of Finance (Department of Expenditure) O.M. No. 1(5) PF II dated 6.8.97]

6. Project Implementation Scheme

Every proposal should indicate in detail the Project Implementation Schedule (PIS) giving all important milestones following the approval such as various clearances, preparation of DPR, calling and approval of tenders, major construction works, procurement and installation of plant and machinery etc. It should be certified that the PIS is consistent with the projected phasing of expenditure. The PIS programme would be part of the PIB approval. [Ministry of Finance (Department of Expenditure) O.M. No. 1(5) PF II dated 6.8.97]

7. Project Implementation Team

For all major projects, a project implementation team should be established and it should be held fully responsible for project execution within the approved time and cost. The team should not have any concurrent responsibility and its continuity during the project implementation period must be ensured. The PIB Memo should bring this out clearly. No project would be considered without such arrangements being clearly established. [Ministry of Finance (Department of Expenditure) O.M. No. 1 (5) PF II dated 6.8.97]

8. Resettlement Cost

If the project involves dislocation of human settlements, the resettlement costs should be included fully in the project cost. The resettlement Plan should also be indicated in the Project Implementation Schedule. The resettlement cost may be worked out on the following basis :-

- (i) The cost of land required to resettlement would be as indicated by the District/State Authorities.
- (ii) The compensation to be paid to the displaced persons. This compensation cost is dependent on the rates indicated by District/State authorities. Thus the total compensation cost may be worked out on the basis of these rates. [Ministry of Finance (Department of Expenditure) O.M. No. 1(5) PF II dated 6.8.97]

9. **PIB Meeting**

To ensure that the PIB considers projects in a time bound manner, the project may be considered after providing a period of 4 weeks after receipt of PIB Memo. It is reiterated that all the time limits specified in the Ministry of Finance (Department of Expenditure) O.M. No. 1(2) -PF.II/94 dated 25.4.1994 may be strictly adhered to. The Planning Commission is requested to ensure that the project appraisal is completed in a time-bound manner. [Ministry of Finance (Department of Expenditure) O.M. No. 1(5) PF II dated 6.8.97]

10. These orders will be effective from the date of issue.

11. This has the approval of the AS&FA and Secretary (SFT).

No.RW/NH-11026/2/97-DO I***Dated, the 27th August, 1997***

Subject: Revised cost estimates in respect of National Highway (Original) works upto Rs. 50 lakhs-sanction reg.

As per the existing procedure, estimates for National Highway (Original) works costing upto Rs. 50 lakhs are administratively approved by Roads Wing and technical approval and financial sanctions are issued by the respective State Governments. However, the revised cost estimates for these works are sanctioned by the Ministry after obtaining the approval of the Finance Wing.

2. The procedure outlined above causes avoidable delay in the sanction of these estimates. It has, therefore, been decided, in consultation with FA&AS that Project Chief Engineers of Roads Wing may sanction the revised estimates costing upto the ceiling limit of Rs. 50 lakhs without referring to the Finance Wing of the Ministry.

130 TENDERS, CONTRACTS AND ARBITRATION

<i>Code No.</i>	<i>Circular No. & Date</i>	<i>Brief Subject</i>	<i>Page No.</i>
130.60	RW/NH-11024/2/95-DO I dated 14.6.95	Tender for road and bridge works on National Highways	130/90
130.61	RW/NH-11024/2/95-DO I dated 20.6.95	Tender for road and bridge works on National Highways	130/90
130.62	RW/NH-11065/12/96-DO I dated 10.12.96	Security deposits forfeited by the Contractors for National Highways and other Centrally Financed Schemes - crediting of	130/90
130.63	RW/NH-11029/1/97-DO I dated 30.4.97	Revised Delegation of Powers for Processing of Cases for Feasibility Studies/DPR, Land Acquisition, Acceptance of Tender and Revised Cost Estimates	130/91 to 93

No.RW/NH-11024/2/95-DO I**Dated, the 14th June, 1995**

To

The Secretaries (dealing with National Highways), Public Works Department of all State and Union Territories

Subject: Tender for road and bridge works on National Highways

I am directed to refer to this Ministry's Circular No. PL-30(62)/76 dated 26.6.76 on the subject mentioned above and to say that in an EFC meeting held on 22.2.95 the suggestion that projects whose revised cost estimates based on tender are likely to exceed Rs. 5 crores should be cleared by EFC before tenders are accepted, was examined in this Ministry and it was felt that in such situations, the State Governments would have to refer the matter to the Ministry time and again and obtain the approval of EFC, which may cause delay and ultimately affect the validity of tenders. As such, it was decided that the present system of awarding works by the State Governments in cases where the revised cost estimates based on tender exceeded the original estimate upto 15% would continue. However, it was reiterated that all the State Governments must ensure that RCE, EFC cases be submitted to this Ministry as early as possible but by all means within the prescribed time limit i.e. two months.

No.RW/NH-11024/2/95-DO I**Dated, the 20th June, 1995**

To

The Secretaries (dealing with National Highways), Public Works Department of all State and Union Territories

Subject: Tender for road and bridge works on National Highways

In partial modification of this Ministry's letter of even number dated 14th June, 1995 on the subject mentioned above, it is requested that in line 13 of the subject letter words 'original estimate' may be substituted with words 'updated schedule of rates'.

No.RW/NH-11065/12/96-DO I**Dated, the 10th December, 1996**

To

The Secretaries (dealing with National Highways and other Centrally Financed Schemes), Public Works Department of all State and Union Territories, Director General (Works), Central Public Works Department, Director General, Border Roads and Chairman, National Highways Authority of India

Subject: Security deposits forfeited by the Contractors for National Highways and other Centrally Financed Schemes - crediting of

I am directed to say that in the absence of guidelines for crediting the security deposits forfeited by the Contractors for National Highways and other Centrally Financed Schemes, the same was not being credited in the proper head of account by the State Govts. It has now been decided, in consultation with the Chief Controller of Accounts of this Ministry, that the security deposits forfeited by the Contractors for the National Highways and other Centrally Financed Schemes should be credited to the head of account "858 - Suspense Accounts - P.A.O., Suspense - Item adjustable by P.A.O. (N.H.), Ministry of Surface Transport".

2. The above guidelines may kindly be brought to the notice of all concerned for compliance.

No.RW/NH-11029/1/97-DO I**Dated, the 30th April, 1997**

Subject: Revised delegation of Powers for processing of cases for Feasibility Studies/DPR, Land Acquisition, Acceptance of Tender and Revised Cost Estimates

With a view to expedite sanction of works and to reduce delays, it has been decided with the approval of the Cabinet vide its meeting held on 15.1.97 and concurrence of Ministry of Finance, Department of Expenditure vide their D.O. No.24(19)/PF.II/96 dated 18th March, 1997, to increase the power of Ministry of Surface Transport to sanction estimates. Earlier guidelines issued vide their letter No. 1(6)/PF.II/91 dated August 24, 1992, No.1(8)/PF.II/93 dated October 12, 1993 and No.F.1(12)-E.II(A)/92 dated November 6, 1992, in respect of feasibility studies/DPR, approval for land acquisition and Revised Cost Estimate, therefore, stand amended as indicated in this circular. At present, as per rule 3 of the National Highways (Amendment) Rules, 1993, the Executive Agency shall forward to the Central Government for approval only the general abstract of cost in respect of the works contained in the approved annual programme of works costing upto Rs.50 lakhs for a particular year. The Executive Agency shall accord technical approval and financial sanction to the detailed estimate already prepared in advance within three months from the date of according administrative approval by the Central Government. These cases need not be referred to Finance Wing. This will remain unchanged and for works of more than Rs. 50 lakhs, the enhanced power will now be exercised as below :

1. FEASIBILITY STUDIES/DPR

1. Presently, as per Ministry of Finance's circular No.1(6)/PF.II/91 dated August 24, 1992, Administrative Ministry is empowered to sanction preparation of feasibility/DPR report costing upto Rs.1.0 crore, in respect of projects with cost not exceeding Rs.50.0 crores. Where the cost of feasibility/DPR exceeds Rs. 1.0 crore, or where the cost of the project exceeds Rs.50.0 crores, approval of CCEA/PIB is required. **To avoid delay in getting the approval of CCEA/PIB the proposal for Feasibility Studies/DPR in respect of improvement/upgradation of existing National Highways can now be approved by the Secretary, Ministry of Surface Transport with the concurrence of integrated finance subject to overall annual budgetary ceiling.**

The delegated power for technical approval of the same is as under :

COST OF FEASIBILITY/DPR	COMPETENT AUTHORITY TO APPROVE THE SCHEME
(a) Upto Rs.50 lakhs	Executive Engineer
(b) More than Rs.50 lakhs upto Rs. 1.0 crores	Superintending Engineer
(c) More than Rs.1.0 crore upto Rs. 3.0 crores	Chief Engineer
(d) More than Rs.3 crore upto 10 crore	ADG
(e) More than Rs.10 crore and above	DG(RD) & AS

2. ESTIMATE FOR LAND ACQUISITION

- 2.1. As per Ministry of Finance's letter No.F.1(12)-E.II(A)/92 dated 6th November, 1992, present practice for approving the land acquisition estimate is as under :

COST OF PLAN SCHEME INCLUDING COST OF LAND ACQUISITION	COMPETENT AUTHORITY TO APPROVE THE SCHEME
(a) Upto Rs. 50 lakhs	Ministry/Department concerned, in normal course.

(b)	Beyond Rs. 50 lakhs and less than Rs. 5 crores	Ministry/Department with the concurrence of Integrated Finance
(c)	Rs. 5 crores and beyond but less than Rs. 20 crore	Expenditure Finance Committee chaired by the Secretary of the concerned administrative Ministry/Department. Proposals which have a staffing component of more than 10 of the total outlay will be outside the delegated power of the Ministry/Department and are required to be referred to the IFA concerned for clearance on behalf of Ministry of Finance who will obtain orders of Secretary (Expenditure)/Finance Secretary.
(d)	Rs. 20 crores and beyond but less than Rs. 50 crores (including schemes involving outlays of Rs. 20 crores and above where returns are not quantifiable)	Expenditure Finance Committee chaired by Secretary (Expenditure). In these cases, the approval of the recommendations of the EFC would be accorded by the Minister of Administrative Ministry and also the Finance Minister.
(e)	Rs. 50 crores and beyond	These proposals would be required to be referred to Public Investment Board/Cabinet Committee on Economic Affairs.

For projects, costing more than Rs. 20 crores including cost of land, approval of EFC/PIB/CCEA inevitably takes time. To avoid this delay, it has now been decided by the Ministry of Finance vide their above mentioned letter that approval for land acquisition estimates, for projects upto Rs. 100 crores including cost of land will be accorded by the Minister for Surface Transport with the concurrence of the Finance Minister without processing through EFC/CCFA/PIB.

Delegated power for technical sanction shall be same as brought out in para 1.1 above.

3. ACCEPTANCE OF TENDERS

3.1. Presently, where the cost of project is based on the tender exceeds the updated cost of the project by more than 15%, depending upon the delegated power a fresh approval of EFC/PIB/CCEA is required before the contract is awarded. This often leads to delay in the award of contracts, resulting in time and cost over runs. To minimise such delays, Ministry of Finance vide their letter mentioned in opening para has now increased the power of Administrative Ministry. The Secretary, Ministry of Surface Transport is now authorised to decide the award of contract for works with the concurrence of the Integrated Finance subject to the condition that the cost of the project based on tender and the lowest evaluated bid is within 25% of the updated cost of the project, including (a) increase in cost attributable to (i) exchange rate variation, (ii) statutory levies and (iii) price escalation (based on price indices), within the approved project time cycle (b) consequential increase in cost, if any, on account of factor such as (i) interest rate during construction, (ii) working capital margin, (iii) financing cost and (iv) contingencies and (c) a further increase upto 5% of the originally approved cost estimate.

3.2. For work costing less than Rs. 5 crores the present delegated powers of State Governments/State Chief Engineers, as contained in para 2 of Ministry Circular No. NH.III/P/25/78 dated 5th July, 1985, i.e. "State Governments/State Chief Engineers can accept tenders themselves if the excess over the sanctioned estimate does not go beyond the value determined on the basis of current schedule of rates by 15% subject to the condition that there is no material deviation from the approved designs/or specification for the work in which latter case, however, prior approval of the Government of India is necessary", remains unchanged.

4. REVISED COST ESTIMATE FOR FC/PIB/CCEA

4.1. WITHIN PROJECT TIME CYCLE (PTC)

Presently, Ministry of Surface Transport, in consultation with Planning Commission, is empowered to sanction the Revised Cost Estimate amounting to Rs. 5 crores and above within the approved Project Time Cycle (PTC) in respect of the following conditions as brought out in Ministry of Finance letter No. 1(8)/PF II/93 dated 12th October, 1993.

- (A) Increase in cost attributable to (i) exchange rate variations, (ii) statutory levies, and (iii) price escalation (based on price indices); etc.

- (B) Consequential increase in cost, if any, on account of factors such as (i) interest during construction, (ii) working capital margin, (iii) financing cost; and (iv) contingencies; and
- (C) A further increase upto 5% of the originally approved cost estimates.

In respect of second and subsequent revised cost estimates, the increase in cost due to factor mentioned in above para can be sanctioned by the Administrative Ministry in consultation with Planning Commission with the modification that an increase upto 3% of the latest approved cost (In place of 5% for the original cost indicated at para (C) above) shall only be allowed. As the project time cycle is often extended due to various reasons such as employer not being able to fulfil his obligations in the contract, force majeure or on account of any situation beyond the control of either party in such cases processing of cases for approval of EPC/PIB/CCEA further delay the project implementation. In order to reduce the delay in the approval of RCE, the Ministry of Surface Transport with the concurrence of the Finance Minister is now empowered, vide MOF letter mentioned in opening para to approve the RCE amounting to Rs. 5 crores and above even outside the project time cycle in consultation with the Planning Commission and with the concurrence of the F.M. in respect of the conditions brought out in para 4.1(A), 4.1(B) and 4.1(C) above.

4.2. **REVISED COST ESTIMATE COSTING LESS THAN Rs.5.0 CRORES**

Permissible limit, as brought out in Ministry's circular No. PL-30(110)/74 dated 2.2.1976, for admitting excess expenditure over sanctioned estimate without a revised estimate in respect of National Highway (Original) works upto 15% of the sanctioned estimate or Rs.1 crore, whichever is less subject to the condition that excess is caused by routine factors such as increase in cost of labour or material during the period and not to the revision in the scope or enlargement of the work or of the specification already approved remains unchanged.

Revised Cost Estimate not covered under para 4.1, 4.2 and 4.3 above, shall be financially sanctioned by the competent authority under their delegated power as brought out in para 2 above.

143.1 URBAN LINKS

<i>Code No.</i>	<i>Circular No. & Date</i>	<i>Brief Subject</i>	<i>Page No.</i>
143.1.9	RW/NH-11015/1/97-DO I dated 23.6.97	National Highways (Amendment) Act, 1997 - Urban link agreements - reg.	143.1/8

145 UTILITY SERVICES AND CANAL CROSSINGS

145.4	RW/NH III/P/66/76 dated 18/19.11.76	Accomodation of underground utility services like electric cables and pipelines for water/gas/petroleum products along and across National Highways	145/15 to 17
145.15	RW/NH-11037/1/97-DO I dated 4.2.98	Laying of Fibre Optic Cables in National Highway land by private parties - regarding	145/18

No.RW/NH-11015/1/97-DO I***Dated, the 23rd June, 1997***

To

The Secretaries, Public Works Department of all States and Union Territories, Secretary, BRDB and Chairman, National Highways Authority of India

Subject: National Highways (Amendment) Act, 1997 - Urban link agreements - reg.

Section 2(1) of the National Highways Act, 1956 provided as under :

"Each of the highways specified in the Schedule (except such parts thereof as are situated within any municipal area) is hereby declared to be a National Highway"

This has been amended vide National Highways (Amendment) Act, 1997 and the portion in brackets of the above mentioned Section has been deleted. Section 8 of the National Highways Act, 1956, which provided for urban link agreements with State Governments or municipalities, has also been omitted (in the Amendment of the National Highways Act, 1997).

2. Consequently, parts of National Highways, situated within the municipal areas, will now form part of the National Highway network. Agreements entered into with the State Governments for providing central financial assistance for the development and maintenance of urban links stand cancelled.

3. State Governments are accordingly requested to take over the existing urban links immediately and treat the same as part of the National Highways for future development and maintenance of the same.

4. Ministry, however, has provided financial assistance, during the current financial year, in respect of the existing urban links for which agreements have been entered into.

No.NHIII/P/66/76***Dated, the 18th/19th November, 1976***

Subject: Accommodation of underground utility services like electric cables and pipelines for water/gas/petroleum products along and across National Highways

In supersession of instructions contained in the previous letters on this subject noted in the margin, I am directed to convey the following instructions regarding accommodation of underground utility services like electric cables and pipelines for water/gas/petroleum etc., along and across the National Highways, for future guidance.

No. WI-43(16)/64, dated the 7th August, 1964
No. WI-43(22)/64, dated the 6th October, 1964
No. WI-43(23)/64, dated the 7th November, 1964
No. WI-43(22)/64, dated the 22nd March, 1966

2. Utility services like electric cables and pipelines for water etc., should normally not be located longitudinally within the National Highway right-of-way. However, exception to this rule may be made where it is demonstrated to the satisfaction of the State Chief Engineer that any other utility location would be extremely difficult and unreasonably costly, and that the installation within the right-of-way will not adversely affect the design, stability and traffic safety of the highway nor the likely future improvements such as widening of the carriageway, easing of curves etc. For such cases, the State Chief Engineers may themselves accord permission for the laying of utility services provided the conditions set out in the Annexure, are satisfied. If it is considered necessary to relax any condition, prior approval of this Ministry should be obtained.

3. Whenever any permission is accorded in accordance with the conditions in Annexure, a copy of the approval letter along with a certified copy of an index plan showing the utility line should be forwarded to this Ministry for information and accord.

4. It is requested that the contents of this circular may be brought to the notice of all officers in your Department engaged on National Highway works.

5. The receipt of this letter may kindly be acknowledged.

**CONDITIONS TO BE SATISFIED FOR ACCORDING PERMISSION TO LAY UNDERGROUND
UTILITY LINES LIKE ELECTRIC CABLES AND PIPELINES FOR WATER/GAS/PETROLEUM
ALONG AND ACROSS THE NATIONAL HIGHWAYS**

1. Laying of utility lines along the National Highways

1.1. The utility lines shall be located as close to the extreme edge of the right-of-way as possible but not less than 15 metre from the centre-line of the nearest carriageway.

1.2. The utility lines shall not be permitted to run along the National Highway when the road formation is situated in double cutting. Nor shall these be laid over the existing culverts and bridges without the prior approval of Government of India.

1.3. The lines shall be so placed that at no time there is interference with the maintenance of the National Highways.

1.4. These should be so laid that their top is at least 0.6 metre below the ground level or as otherwise directed by the Highway authority so as not to obstruct drainage of the road land.

1.5. For all major bridges of 60 M or more in length to be constructed in future on National Highways, the requirements of the concerned Departments should be ascertained in advance, and suitable provision in the form of ducts etc., made in the Project estimates. Any proposal to lay an electric cable carrying high tension lines should be covered by a certificate that it will not have any deleterious effects on any of the bridge components and roadway safety for traffic.

2. Laying of the Utility Lines Across National Highways

2.1. Location

2.1.1. The lines shall cross the National Highway preferably on a line normal to it or as nearly so as practicable.

2.1.2. Crossings shall not be too near the existing structures on the National Highway, the minimum distance being 15 metre or as specified by the Highway Authority.

2.2. Method of Crossing

The utility lines shall be permitted to cross the National Highway either encased in pipes or through structure or conduits specially built for that purpose at the expense of the agency owning the line. Existing drainage structures shall not be allowed to carry the lines across unless specially permitted by the Government of India.

2.3. Casing (Conduit) Pipe

The casing pipe (or conduit pipe in the case of electric cable) carrying the utility line shall be of steel, cast iron, or reinforced cement concrete and have adequate strength and be large enough to permit ready withdrawal of the carrier pipe/cable. Ends of the casing/conduit pipe shall be sealed from the outside, so that it does not act as a drainage path.

2.4. Length of the Casing/Conduit Pipe

The casing/conduit pipe should, as minimum extend from drain to drain in cuts and toe of slope to toe of slope in the fills.

2.5. Depth of Embedment of the Casing/Conduit Pipe

The top of the casing/conduit pipe should be at least 1.2 metre below the surface of the road subject to being at least 0.3 m below the drain inverts.

2.6. Method of Installation of the Casing/Conduit Pipe

2.6.1. The casing/conduit pipe may be installed under the road embankment either by boring or digging a trench. Installation by boring method shall be preferred specially where the existing road pavement is of cement concrete or dense bituminous concrete type.

2.6.2. The casing/conduit pipe shall be installed with an even bearing throughout its length and in such a manner as to prevent the formation of a waterway along it.

2.7. Installation by Trenching Method

2.7.1. The sides of the trench should be done as nearly vertical as possible. The trench width should be at least 30 cm, but not more than 60 cm wider than the outer diameter of the pipe.

2.7.2. Filling of the trench shall conform to the specifications contained herein below or as supplied by the Highway Authority.

2.7.3. Bedding shall be to a depth of not less than 30 cm. It shall consist of granular material, free of lumps, clods and cobbles and graded to yield a firm surface without sudden change in the bearing value. Unsuitable soil and rock edges should be excavated and replaced by selected material.

2.7.4. The backfill shall be completed in two stages (i) side - fill to the level of the top of the pipe and (ii) overfill to the bottom of the road crust.

2.7.5. The sidefill shall consist of granular material laid in 15 cm layers each consolidated by mechanical tamping and controlled addition of moisture to 95% of the Proctor's Density. Overfill shall be compacted to the same density as the material that had been removed. Consolidation by saturation or ponding will not be permitted.

2.7.6. The road crust shall be built to the same strength as the existing crust on either side of the trench or to thickness and specifications stipulated by the Highway Authority. Care shall be taken to avoid the formation of a dip at the trench.

2.8. Precautions when constructing by Trench Method

2.8.1. The excavation shall be protected by flagman, signs and barricades, and red lights during night hours.

2.8.2. One lane of road shall be kept open to traffic at all times. In case of single lane roads, a diversion shall be constructed at the expense of agency owning the utility line.

3. General

3.1. Prior approval of the Highway Authority shall be obtained before undertaking any work of installation, shifting or repairs, or alterations to the utility lines located in the National Highway right-of-ways.

3.2. Expenditure, if any, incurred by the Highway Authority for repairing any damage caused to the National Highway by the laying, maintenance of shifting of the utility line will be borne by the agency owning the line.

3.3. If the Highway Authority considers it necessary in future to move the utility line for any work of improvement or repairs to the road, it will be carried out as desired by the Highway Authority at the cost of the agency owning the utility line within a reasonable time (not exceeding 60 days) of the intimation given.

*No.RW/NH-11037/1/97-DO I**Dated the 4th February, 1998*

To

The Secretaries, PWD of all States/UTs, Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States and Union Territories, Director General Border Roads, Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Laying of Fibre Optic Cables in National Highway land by private parties - regarding

Some private companies have recently approached this Ministry for permission for laying of fibre optic cables within National Highway land. As per the present policy of this Ministry, permission for laying of such cables is given only to the Government Departments. However, in view of the involvement of the private sector in the field of telecommunication, this Ministry is now in the process of formulating a policy for permitting the private entrepreneurs to lay fibre optic cables along the edge of National Highway land. Detailed terms and conditions under which such permission can be given as also the charges or amount that entrepreneurs would need to pay to the Government for this permission are being finalised.

2. It is likely that some private companies might approach State PWDs directly for necessary permission. It is, therefore, requested that pending the finalisation of the policy in this regard, no permission for laying of such cables within the National Highway land may be given without the prior approval of this Ministry. This may please be brought to the notice of all concerned officers in your Department for strict compliance.

150 LEVEL CROSSINGS AND OVER/UNDER BRIDGES

<i>Code No.</i>	<i>Circular No. & Date</i>	<i>Brief Subject</i>	<i>Page No.</i>
150.20	RW/NH-11064/1/91-DO I dated 22.2.95	Provision of safety measures at approaches to Railways level crossings	150/19
150.21	RW/NH-11064/1/91-DO I dated 27.11.95	Provision of safety measures at approaches to Railway level crossings	150/19

No.RW/NH-11064/1/91-DO I***Dated, the 22nd February, 1995***

To

The Secretaries (dealing with roads), Public Works Department of all State Govts. and Union Territories

Subject: Provision of safety measures at approaches to Railways level crossings

I am directed to refer to this Ministry's letters of even number dated 26.10.93 and 1.11.94 regarding provision of safety measures at railway level crossings falling on National Highways. The measures recommended therein and in earlier circulars issued on the subject are as under :

- (i) Installation of IRC Road Signs (Specified in IRC:67-1977 "Code of Practice for Road Signs)" whether the railway crossing is manned or unmanned;
- (ii) Imposition of speed limits for approaching traffic and installation of relevant road signs;
- (iii) Provision of rumble strips on both sides of the railway crossings. Speed breakers of hump type shall not, however, be permitted; and
- (iv) Speed breakers already provided by the Railways as a temporary measure at these locations should be removed concurrently with the provision of rumble strips.

2. The Specifications for rumble strips were circulated among all State Governments vide this Ministry's letter No. PL-50(8)/72 dated 4th June, 1976. It was also reiterated that rumble strips as per the design and locational details communicated to the State Chief Engineers, vide this Ministry's letter dated 9th January, 1987 may be provided on approaches to railway level crossings.

3. The State Governments were requested to issue urgent instructions to all concerned in the Department engaged in National Highways and other Centrally financed road works, for implementing the above mentioned safety measures on priority and time bound basis so as to complete this work by 31.1.94.

4. It was also requested to send an implementation report in this respect. The implementation report is still awaited from most of the State Governments in spite of reminders. It is, therefore, again requested that the implementation report may please be sent to this Ministry at an early date.

No.RW/NH-11064/1/91-DO I***Dated, the 27th November, 1995***

To

The Secretaries (dealing with Roads), Public Works Department of all State Govts. and Union Territories (Except the State of Sikkim and Union Territory Administration of Lakshdeep, Dadar & Nagar Haveli and Chandigarh)

Subject: Provision of safety measures at approaches to Railway level crossings

I am directed to refer to this Ministry's letters of even number dated 26th October, 1993, 1st November, 1994 and 22nd February, 1995 regarding provision of safety measures at railway level crossings falling on National Highways. A copy of this Ministry's letter dated 22.2.95 is enclosed.

2. The State Govts. were requested to issue urgent instructions to all concerned in the Department engaged in National Highways and other Centrally financed road works for implementing the safety measure mentioned therein on priority basis in order to complete the work by 31.1.94 and to send an implementation report in this respect. The implementation report is still awaited from most of the State Govts. inspite of repeated reminders. It is again requested that the implementation report may please be sent to this Ministry immediately, latest by 31st December, 1995.

Code No.	Circular No. & Date	Brief Subject	Page No.
206.5	RW/NH-33054/4/91-DO II dated 23.10.91	Soil/Sub-surface investigation for road and bridge works on National Highways and under other Centrally Sponsored Schemes - Entrusting to prequalified geotechnical consultants	206/25 to 27
206.6	RW/NH-33054/4/91-S&R dated 14.5.92	Soil/sub-surface investigation for road and bridge works on National Highways and under other Centrally Sponsored Schemes - Entrusting to prequalified geotechnical consultants	206/28
206.7	RW/NH-33044/1/94-DO III dated 9.2.96	Empanelment of Consultants for National Highways and other Centrally Sponsored Projects in the fields of "Highway Project Preparation" and "Traffic & Transportation Engineering/Planning"	206/28 to 31
206.8	RW/NH-33044/1/94-DO II dated 24.7.96	Empanelment of Consultants for National Highway and other Centrally Sponsored Projects in the fields of "Highway Project Preparation"	206/32 & 33

No.RW/NH-33054/4/91-DO II**Dated, the 23rd October, 1991**

To

The Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States and Union Territories, Director General (Works), Central Public Works Department, Director General Border Roads and Chairman, National Highways Authority of India

Subject: Soil/Sub-surface investigation for road and bridge works on National Highways and under other Centrally Sponsored Schemes
- Entrusting to prequalified geotechnical consultants

It has been the experience that a large number of highway projects are being adversely affected due to improper soil investigations resulting in unreliable and inaccurate soil data. The Ministry felt it necessary to prepare a panel of geo-technical consultants in order to ensure that the geo-technical data collected at the time of investigations for road and bridge projects are representative and reliable. Keeping this in view, the Ministry had earlier invited applications from experienced geo-technical consultants through a questionnaire issued to consulting firms known for their capability and expertise, and also through an open advertisement in the leading Newspapers and based on the recommendations of a Committee set up to look into these applications, Ministry issued a list of prequalified geo-technical consulting firms for carrying out soil/sub-surface investigations for road and bridge works on National Highways and under other Centrally sponsored Schemes vide Ministry's letter No. RW/NH-33054/35/88-DO II dated 5th June, 1990 and 25th September, 1990 respectively. Subsequently, with a view for enlarging the list of prequalified geo-technical consultants and also to give an opportunity to those who could not apply earlier for prequalification, the Ministry invited applications for prequalification from geo-technical consultants through a Press Notice issued in leading Newspapers on 25.1.1991. The Ministry appointed a Committee to look into the applications received, who have recommended prequalification of the following firms under each of the categories mentioned below :

Categories (a) & (b)		For road projects, high embankment design, soft ground treatment and minor bridges
(i)	Terracon Engineers, Calcutta-700033	12, Charu Chandra Place (East)
(ii)	C.E. Testing Company	20-D, Dover Place, Calcutta-700019
(iii)	P.K. Dey & Associates, Estate, VIP Road, Calcutta-700054	Flat-123, Block-9, Hudco
(iv)	Constell Consultants Private Ltd. 7, Sristidhar, Dutta Lane, (Hatibagan), Calcutta-700006	
Category (c)		For Major Bridges
(i)	Terracon Engineers, (East), Calcutta-700033	12, Charu Chandra Place
(ii)	C.E. Testing Company, Calcutta-700019	20-D, Dover Place
(iii)	Constell Consultants Pvt. Ltd., 7, Sristidhar, Dutta Lane (Hatibagan), Calcutta-700006	

2. You are requested to refer to Appendix-I of this Ministry's letter No. RW/NH-33054/35/89-DO II dated the 5th June, 1990 issued in the context of the earlier prequalification of geo-technical consultants; wherein a supplementary list of Government Institutions capable of handling geo-technical investigations for the highway sector was given. The following institution may also now be included in Appendix : I "Regional Research Laboratory, Jorhat, Assam".

A modified Appendix I is enclosed herewith. Further, as brought out in the above referred, the State/U.T. PWDs could also consider entrusting the geo-technical investigation work to one of these institutions in their respective regions, subject to the proviso that adequate infrastructure to carry out the investigations meeting the requirements of the specific work, is available with them and they are in a position to take up such works satisfying the prescribed targets for completion.

3. The present prequalification of the above mentioned geo-technical consultants for different categories of work will be in force upto March, 1992, on which date the earlier prequalification of June, 1990 and September, 1990 also terminates.

4. I am, therefore, directed to state that quotations for future geo-technical investigation work for road and bridge works on National Highways and under other Centrally Sponsored Schemes may be taken only from the geo-technical consultants prequalified in para 1 above and the geo-technical consultants already prequalified vide this Ministry's letter No: RW/NH-33054/35/89-DO II dated 5th June, 1990 and RW/NH-33054/35/89-DO II dated the 25th September, 1990 respectively. However, such works could also be entrusted to government institutions listed in Appendix I, subject to the proviso mentioned in para 2 above.

5. Other guidelines/instructions contained in this Ministry's letter No. RW/NH-33054/35/89-DO II dated 5th June, 1990 may please be complied with.

6. The contents of this letter may please be brought to the notice of all officers in your Department dealing with works on National Highways and under other Centrally Sponsored Schemes.

APPENDIX-I

LIST OF GOVERNMENT INSTITUTIONS CAPABLE OF HANDLING GEO-TECHNICAL INVESTIGATIONS FOR THE HIGHWAY SECTOR

- | | |
|--|--|
| 1. Central Soil & Materials Research Station
Olof Palme Marg, Hauz Khas,
New Delhi-110016 | 14. Kerala Engineering Research Institute,
Peechi-680653
(Kerala) |
| 2. Central Water & Power Research Station
Pune-411024
(Maharashtra) | 15. Irrigation & Power Research Institute
Amritsar-143001 (Punjab) |
| 3. Central Road Research Institute,
Mathura Road,
New Delhi-110020 | 16. Department of Civil Engineering
Indian Institute of Science
Bangalore-560012 |
| 4. Maharashtra Engineering Research Institute,
Dindori Marg,
Nashik-400004
(Maharashtra) | 17. Department of Civil Engineering
Indian Institute of Technology
Hauz Khas
New Delhi-110016 |
| 5. Gujarat Engineering Research Institute
Race Course
Vadodara-390007
(Gujarat) | 18. Department of Civil Engineering
Indian Institute of Technology,
Powai
Bombay-400078 |
| 6. Highway Research Station
Guindy
Madras-600025 | 19. L.B.S. Centre for Science & Technology
Extra Police Road
Nandavanam
Trivandrum-695033 |
| 7. Andhra Pradesh Engineering Research Laboratories
Himayetsagar
Hyderabad-500030
(Andhra Pradesh) | 20. Department of Civil Engineering
Motilal Nehru Regional Engineering College
Allahabad-211004 |
| 8. Karnataka Engineering Research Station
Krishnarajasagara-571607
(Karnataka) | 21. Regional Research Laboratory
Jorhat-785006
(Assam) |
| 9. Soil Mechanics & Research Division
Chepauk
Madras-600005 | |
| 10. U.P. Irrigation Research Institute
Roorkee-247667
(Uttar Pradesh) | |
| 11. Central Building Research Institute
Roorkee
(Uttar Pradesh) | |
| 12. River Research Institute
West Bengal, 2nd Floor,
11-A, Mirja Ghalib Street,
Calcutta-700087 (West Bengal) | |
| 13. Irrigation Research,
Narmada Bhavan,
Tulsi Nagar Qtrs. 1250,
Bhopal-462005
(Madhya Pradesh) | |

No.RW/NH-33054/4/91-S&R**Dated, the 14th May, 1992**

To

The Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States, Director General (Works), Central Public Works Department, Director General Border Roads and Chairman, National Highways Authority of India

Subject: Soil/sub-surface investigation for road and bridge works on National Highways and under other Centrally Sponsored Schemes - Entrusting to prequalified geo-technical consultants

I am to refer to this Ministry's letters No. RW/NH-33054/35/89-DO II dated 5th June, 1990, 25th September, 1990 and letter of even number dated 23rd October, 1991 on the above mentioned subject and to add that the date up to which prequalification of geo-technical consulting firms under the different categories mentioned in the letters under reference is in force is extended herewith upto 31.3.1993 subject to the terms and conditions mentioned therein. This extension shall also apply to the Government institutions listed in Appendix-I* of this Ministry's letter of even number dated 23rd October, 1991 subject to the conditions brought out in para 2 therein. The prequalified firms are being intimated separately.

* Please see Circular No.RW/NH-33054/4/91-DO II dated 23.10.1991 for Appendix-I

No.RW/NH-33044/1/94-DO III**Dated, the 9th February, 1996**

To

The Secretary of all State/UTs (Dealing with National Highway), Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all State Govts. and Union Territories, Director General (Works), Central Public Works Department, Director General Border Roads and Chairman, National Highways Authority of India

Subject: Empanelment of Consultants for National Highways and other Centrally Sponsored Projects in the fields of "Highway Project Preparation" and "Traffic & Transportation Engineering/Planning"

In continuation to this Ministry's letter of even number dated 4.8.95 on the above subject it is to state that the validity of consultants previously empanelled by this Ministry (list enclosed Appendices I & II) has been extended upto 31.7.1997.

2. It is requested that contents of this letter may be brought to the notice of all officers in your department dealing with works on National Highways and other centrally sponsored schemes.

APPENDIX I

List of Empanelled Consultants for General Highway Projects including Minor Bridges

Sl.No.	Name of Consultancy Organisation
A.	CONSULTANTS EMPANELLED FOR ALL TYPES OF HIGHWAY PROJECTS INCLUDING FOUR-LANING
1.	Consulting Engineering Services (I) Ltd., 57, Nehru Place (5th Floor) New Delhi-110019 Phone : 6415284, 6415264

2. Development Consultants Ltd.,
24 B, Park Street,
Calcutta-700016
(West Bengal)
3. Gilcon Projects Services Ltd.,
16-17, Local Shopping Centre
Near Pushp Bhavan, Madangir
New Delhi-110062
Phones: 6462488, 6436950
4. Inter-Continental Consultants &
Technocrats Pvt. Ltd.,
A-11, Green Park,
New Delhi-110016
Phones: 668846, 662418
5. Kirloskar Consultants Ltd.
23, Hanuman Road
New Delhi-110001
6. Dr. L.R. Kadiyali & Associates
S-487, IInd Floor,
Greater Kailash I
New Delhi-110048
Phone : 6427785
7. Mahendra Raj Consultants Pvt.Ltd.,
N-7, Kailash Colony,
New Delhi-110048
Phones: 6452567, 6431014
8. National Transportation Planning &
Research Centre,
Sagar Deep, 11/203, 2nd Floor
Local Shopping Centre
Saini Enclave, Karkar Doorna
Delhi
9. RITES
New Delhi House
27, Barakhamba Road,
New Delhi-110001
10. Sheldia Associates & Consultants (India)
Pvt. Ltd.
4, Kuldip Society
Near Ishwarbhuwan, Navrangpura
Ahmedabad-380009
11. Span Traverse Morgan
International Ltd.,/
Span Consultants Pvt. Ltd.,
Flats: 3-5 (II Floor)
Local Shopping Centre, J-Block, Saket
New Delhi-110017
12. STUP Consultants Ltd.,
7, Panch Sheel
Commercial Centre
Panch Sheel Park
New Delhi-110017

13. Phones: 6439681, 6439682
M/s. Kam Engineering (India) Pvt. Ltd.,
A-1/13, Shakti Nagar Extn.
Delhi-110052
14. M/s. Engineers & Management Associates
(Air Ports/Highways/Tourism
Consultants)
3/6, Kalkaji Extension
New Delhi-110019

B. CONSULTANTS EMPANELLED ONLY FOR SMALLER PROJECTS RELATING TO UP-GRADATION/STRENGTHENING OF NATIONAL HIGHWAYS WIDENING FROM SINGLE LANE TO TWO LANE, GEOMETRIC IMPROVEMENTS, REALIGNMENT PROPOSALS ETC. BUT EXCLUDING FOUR-LANING PROJECTS

1. Dalal Consultants & Engineers Ltd.
44, Dr. R.G. Thadani Marg, Worli
Bombay-400018 (Maharashtra)
Phone: 4934821
2. Haq Consultants
"Baitul Fazil"
2527, Agra Road
Jaipur-302003 (Rajasthan)
Phone: 40588
3. Indian Road Construction Corporation Ltd.,
Core-6, Floor-6, Scope Complex-7
Lodhi Road
New Delhi-110003
Phones: 360437, 360441, 360449, 360452
4. Operations Research Group
Dr. Vikram Sarabhai Road
Baroda-390007 (Gujarat)
Phone: 321469, 321461
5. The Hindustan Construction Co. Ltd.,
Construction House
Walchand Hirachand Marg,
Bombay-400838 (Maharashtra)
Phones: 2616958, 2618201, 2620318

CONSULTANTS EMPANELLED ONLY FOR RESEARCH ORIENTED STUDIES AND SPECIALISED HIGHWAY INVESTIGATION/PERFORMANCE RELATED STUDIES NOT INVOLVING EXTENSIVE FIELD WORK

1. Centre of Transportation Engineering
Civil Engineering Department
University of Roorkee
Roorkee-247667 (Uttar Pradesh)
2. Gujarat Engineering Research Institute
Race Course
Vadodara-390007 (Gujarat)
3. Dr. C.E.G. Justo
Department of Civil Engineering
Visveswarayya College of Engineering
University of Bangalore
Bangalore-560056 (Karnataka)
Phone: 355036 Extn. 267

**EMPANELLED CONSULTANTS IN THE AREA OF TRAFFIC AND
TRANSPORTATION ENGINEERING/PLANNING**

S.No. Name of Consultancy Organisation

1. Consulting Engineering Services (I) Ltd.,
57, Nehru Place (5th Floor)
New Delhi-110019
Phone : 6415284, 6415264
2. CRAPHTS
252-A, Shahpur Jat (II Floor)
Opp. Panchsheel Community Centre
New Delhi-110016
Phone: 6429266
3. Dalal Consultants & Engineers Ltd.
44, Dr. R.G. Thadani Marg, Worli
Bombay-400018 (Maharashtra)
Phone: 4934821
4. Development Consultants Ltd.,
24 B, Park Street,
Calcutta-700016
(West Bengal)
5. Inter-Continental Consultants &
Technocrats Pvt. Ltd.,
A-11, Green Park,
New Delhi-110016
Phones: 668846, 662418
6. Kirloskar Consultants Ltd.,
23, Hanuman Road,
New Delhi-110001
7. Dr. L.R. Kadiyali & Associates,
S-487, IInd Floor,
Greater Kailash I,
New Delhi-110048
Phone : 6427785
8. National Transportation Planning &
Research Centre,
Sagar Deep, 11/203, 2nd Floor
Local Shopping Centre
Saini Enclave, Karkar Dooma
Delhi
9. Operations Research Group
Dr. Vikram Sarabhai Road
Baroda-390007 (Gujarat)
Phone: 321469, 321461

- | | | |
|--|---|--|
| <p>10. Pallavan Transport Consultancy Services Ltd.,
5, Greams Road (II Floor)
K.N.O. Complex, Madras-600006
Phones: 477851, 476395</p> <p>11. RITES
New Delhi House
27, Barakhamba Road,
New Delhi-110001</p> <p>12. STUP Consultants Ltd.,
7, Panch Sheel
Commercial Centre
Panch Sheel Park
New Delhi-1100017
Phones: 6439681, 6439682</p> <p>13. Tata Consultancy Services
"Air India" Building
Nariman Point
Bombay-400021 (Maharashtra)
Phone: 2024827</p> <p>14. Centre of Transportation Engineering
Civil Engineering Department
University of Roorkee
Roorkee-247667 (Uttar Pradesh)</p> <p>15. Gujarat Engineering Research Institute
Race Course
Vadodara-390007 (Gujarat)</p> <p>16. Span Traverse Morgan
International Ltd.,
Flats: 3-5 (II Floor)
Local Shopping Centre
J-Block, Saket
New Delhi-110017</p> | <div style="border-left: 1px solid black; border-right: 1px solid black; height: 100px; margin: 0 auto; width: 2px;"></div> | <p>Suitable
for
Research
Oriented
Studies
only</p> |
|--|---|--|

206.8

No.RW/NH-33044/1/94-DO II***Dated, the 24th July, 1996***

To

The Secretaries of States PWDs/UTs (dealing with NH), Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all State Govts. and Union Territories, Director General (Works), Central Public Works Department, Director General Border Roads and Chairman, National Highways Authority of India

Subject: Empanelment of Consultants for National Highway and other Centrally Sponsored Projects in the fields of "Highway Project Preparation"

In continuation of this Ministry's letter of even number dated 4.8.95 and 9.2.96 on the above subject it is to state that following Consultants have also been empanelled under the category indicated against each :

Consultant's name	Category
1. M/s. Consulting Engineers Group Pvt. Ltd., E-12, Moji Colony, Malviya Nagar, Jaipur-302017	Smaller Projects relating to Upgradation of National Highways, widening from single lane to two-lane, Geometric improvements, survey for realignment etc. excluding four laning projects.

Consultant's name	Category
2. M/s. Metallurgical & Engineering Consultants (India) Ltd., Ranchi-834002	Smaller Projects relating to Upgradation of National Highways, widening from single lane to two-lane, Geometric improvements, survey for realignment etc. excluding four laning projects
3. M/s. Tata Consultancy Services, Air India Building, Nariman Point, Mumbai-400021 in joint venture with M/s. Tata Consulting Engineers, 34, Sant Tukaram Road, Carnac, Mumbai-400009	-do-
2. This empanelment shall be valid upto 31.07.1997.	
3. All other stipulations as communicated vide this Ministry's letter of even number dated 4.8.95 shall hold good for these consultants also.	

Consultant's name	Category
2. M/s. Metallurgical & Engineering Consultants (India) Ltd., Ranchi-834002	Smaller Projects relating to Upgradation of National Highways, widening from single lane to two-lane, Geometric improvements, survey for realignment etc. excluding four laning projects
3. M/s. Tata Consultancy Services, Air India Building, Nariman Point, Mumbai-400021 in joint venture with M/s. Tata Consulting Engineers, 34, Sant Tukaram Road, Carnac, Mumbai-400009	-do-
2. This empanelment shall be valid upto 31.07.1997.	
3. All other stipulations as communicated vide this Ministry's letter of even number dated 4.8.95 shall hold good for these consultants also.	

301 SURVEY & INVESTIGATION

Code No.	Circular No. & Date	Brief Subject	Page No.
301.11	RW/NH-33054/3/92-S&R dated 14.5.93	Soil/sub-surface investigations for road and bridge works on National Highways and under Centrally Sponsored Schemes - empanelment of experienced and competent consultants	301/5 & 6
301.12	RW/NH-33054/4/92-S&R dated 14.5.93	Empanelment of consultants for project preparation of major bridges, bridge inspection and rehabilitation and flyovers and grade separators	301/6 & 7
301.13	RW/NH-11052/2/97-DO I dated 7.5.97	Estimate for Feasibility Studies/Consultancy for NH works	301/7
304	EMBANKMENTS AND CUT SLOPES		
304.4	NHVI-50(21)/79 dated 25.1.80	Investigations and design for high embankments at approaches to bridges and overbridges on National Highways and other centrally financed roads	304/15 to 98

No.RW/NH-33054/3/92-S&R***Dated, the 14th May, 1993***

To

The Chief Engineers (dealing with National Highways and other Centrally Financed Schemes), Public Works Department of all States and Union Territories, Director General (Works), Central Public Works Department, Director General Border Roads and Chairman, National Highways Authority of India, Engineer-in-Chief, Municipal Corporation of Delhi, Delhi

Subject: Soil/sub-surface investigations for road and bridge works on National Highways and under Centrally Sponsored Schemes - empanelment of experienced and competent consultants

Please refer to this Ministry's letters No.RW/NH-33054/55/89-DO-II dated June 5, 1990, September 25, 1990 and letter RW/NH-33054/4/91-S&R dated October 25, 1991 and May 14, 1992 on the above mentioned subject.

2. The panel of the geotechnical consultants under different categories mentioned in the letters under reference, has since expired on March 31, 1993. Accordingly, fresh panels of the competent and experienced geotechnical consultants for carrying out soil/sub-surface investigations for the two categories (i) major bridges and (ii) high embankment, road pavement and minor bridges etc., for National Highways and Centrally sponsored projects have been prepared by the Ministry and enclosed as Appendix I & II.

3. The Government Institutions which are considered suitable for taking up geotechnical investigation are listed in Appendix-III. There prequalification will, however, be subjected to the proviso that adequate infrastructure to carry out the investigations meeting the requirements of the specific work is available with them and they are in a position to take up such works satisfying the prescribed targets for completion.

4. The present panels of geotechnical consultants for different categories of work will be in force upto March 31, 1995.

5. The empanelment is subject to condition that there will not be any change in the structure/constitution of the organisation of the consultants during the validity of the panels from that indicated in the applications of the consultants. In case, any firm is empanelled as an association/joint venture/consortium with other firms/individual, such firms shall be asked to furnish MOU/agreement alongwith submission of any proposal.

6. The consultancy proposals for future geotechnical investigation work for road and bridge works on National Highways and under other centrally sponsored schemes shall be taken only from the geotechnical consultants prequalified in para 2 and 3 above, as per their eligibility for the category of work involved.

7. Before calling for quotations for any geotechnical investigations work, the terms of reference detailing with the scope of work, the preferred method of testing, sampling procedure, type and number of samples to be taken, engineering parameters required for design and construction, the target for completion and essential equipment both field and laboratory required to be deployed on the work be clearly specified. The State/UT, PWDs should also supervise the method and the quality of investigation work through experienced Departmental Officers with the help of check list already circulated in this Ministry's letter No.RW/NH-33054/35/89-DO II dated June 5, 1990 (which is not job specific but general only) or by engaging experienced supervision consultants. The check list can be suitably modified as required depending upon the nature of investigations, which will also depend on the TOR for the investigations. A list of suggested essential laboratory and field equipment which the consultants should possess as given at Appendix-III of this Ministry's letter No.RW/NH-33054/35/89-DO II dated June 5, 1990 should be insisted upon by including the same in the tender documents.

8. A record about the performance of the geotechnical consultants covering aspects like adequacy of laboratory and field equipment deployed, expertise of the personnel, quality of investigations, reliability of data collected, completion time etc. should be maintained and this Ministry kept periodically informed particularly with regard to any unsatisfactory performance.

9. The contents of this letter may please be brought to the notice of all officers in your Department dealing with works on National Highways and under other centrally sponsored schemes.

301.12

No.RW/NH-33054/4/92-S&R

Dated, the 14th May, 1993

To

The Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States and Union Territories, Director General (Works), Central Public Works Department, Director General Border Roads and Chairman, National Highways Authority of India, Engineer-in-Chief, Municipal Corporation of Delhi, Delhi

Subject: Empanelment of consultants for project preparation of major bridges, bridge inspection and rehabilitation and flyovers and grade separators

This is in continuation of the Ministry's letter No. RW/NH-34041/62/89-DO.II dated January 12, 1990 forwarding "Interim Guidelines for Engaging Consultants for preparation of Highway Projects"

2. In order to expedite the engagement of consultants for investigation and preparation of major bridge projects for National Highway/other centrally sponsored projects, the Ministry has empanelled consultants on All-India basis under the following categories:

- (i) Project preparation of major bridges
- (ii) Bridge inspection and rehabilitatin
- (iii) Project preparation of flyovers and grade separators

List of the empanelled consultants under each of these categories are given in Appendices I, II and III respectively. The empanelment is subject to condition that there will be no change in the structure/organisation of the consultants during the validity of the panels from that indicated in the application of the consultants. In case, any firm is empanelled as an association/joint venture/consortium with other firms/individual, such firms shall be asked to furnish MOU/agreement alongwith submission of any proposal.

3. This empanelment of consultants will be valid upto 31st May, 1995 unless any changes are made by the Ministry.

4. It is requested that henceforth, consultancy proposals for NH works or other Centrally Sponsored Projects may be invited where needed, only from the empanelled list of consultants as per their eligibility for the type of work involved.

5. The following procedure may please be adopted for final selection of consultants :

- (i) As soon as Ministry's consent to engagement of consultancy services for any specific project has been obtained, the terms of reference (TOR) outlining the modalities and other requirements for the study, (i.e. scope of work, methodology, work plan, schedule of activities, reporting and manpower deployment, engineering parameters to be considered in design and construction techniques etc.) should be finalised in association with the Ministry. Para 6 of "Interim Guidelines for Engaging Consultants" may be kept in view while drawing up the TOR.
- (ii) Simultaneously with (i) above, a letter of enquiry briefly outlining the scope of consultancy services should be sent to empanelled eligible consultants, asking them to indicate their interest for the consultancy services, keeping in view that availability of requisite personnel and sufficient capacity to handle the job will be critical to the firm's selection. While expressing their interest, the firm should give a clear confirmation in regard to both these aspects.
- (iii) Based on expression of interest by the prospective consultants vide (ii) above, the letter of invitation (LOI) including the TOR for submission of detailed proposals should be issued to them as spell out in the Interim Guidelines referred to in para 1.

- (iv) Thereafter the proposals as received may be evaluated, and suitable consultant selected in consultation with this Ministry as outlined in the Interim Guidelines.

6. The performance of the empanelled consultants is proposed to be monitored by the Ministry regularly. It is, therefore, requested that a record about the performance of the consultants on various jobs undertaken in your State may be furnished to the Ministry on a regular basis.

7. It may be added that under emergent situations, the process of selection explained in para 5 could be cut short and proposals invited direct from one or more consultants picked out of the empanelled list, depending upon the complexity and urgency of the jobs. In such cases, a reference should be made to the Ministry to give the select list.

8. It is requested that contents of this letter may be brought to the notice of all officers in your Department dealing with works on National Highways and under other Centrally Sponsored Schemes for appropriate action.

301.13

No.RW/NH-11052/2/97-DO I

Dated, the 7th May, 1997

To

The Chief Engineers, PWD of all States/UTs (dealing with National Highways Projects)

Subject: Estimate for Feasibility Studies/Consultancy for NH works

I am directed to say that once the estimate for feasibility studies/consultancy for the National Highway projects is sanctioned by the Ministry, the concerned State Chief Engineer will be responsible for operating the sanction upto the permissible limit over the sanctioned cost without making further reference to the Ministry. Also, no further sanction will need to be issued by the Ministry till the expenditure remain within the permissible limits.

2. The above instructions may please be kept in mind in respect of the feasibility studies/consultancy of NH projects in future.

No. NHVI-50(21)/79

Dated the 25th January, 1980

To

The Chief Engineers dealing with National Highways and other centrally financed works in States/Union Territories.

Subject: Investigations and design for high embankments at approaches to bridges and overbridges on National Highways and other centrally financed roads.

There have been many instances where inordinate delays, increases in cost and other execution difficulties (including some cases of inadequate performance) have been associated with the construction of high approaches to bridges over river crossings and to railway overbridges on National Highways and other centrally financed roads. There have been even cases where completed bridge or overbridge structures had remained unutilised for some time because of the approaches not having been completed in time. Such difficulties have been found to be mostly associated with adequate or timely attention not having been paid to the planning and design of high embankments constituting the approaches.

2. High embankments at approaches to bridges and over-bridges should be appropriately treated as critical project components, since they usually involve large outlays, large volumes of work, large right-of-way widths and, quite often, problems of site constraints in the form of restricted spaces, non-availability of local borrow areas, weak substrata (requiring in some cases construction in stages), susceptibility to erosion, etc. In addition, there is the vital requirement of coordination between approach and bridge components, particularly, as regards design and construction programming.

3. The requirement of soil investigations and embankment design for high approaches as mentioned above was earlier dealt with in this Ministry's letter No. PL-86(41)/72-SP, dated 13.8.73. In the light of the experience gained since then, the updating of the earlier recommendations was called for. Accordingly a Note has been prepared in this Ministry for highlighting important aspects of investigations and design for high embankments on approaches to bridges and overbridges. Part I of the note outlines in brief the basic steps and procedures involved, while in Part II of the note, the details of procedures and technical considerations are explained. A copy of this Note is enclosed for your information and guidance. It is requested that the suggestions contained in the enclosed Note may kindly be kept in view while formulating proposals for high approach components of bridge-cum-approach projects on National Highways and other centrally financed roads. As regards the broader technical aspects of embankment design, your attention is invited to the forthcoming Indian Roads Congress publication entitled "Guidelines for High Embankment Design".

4. You may also kindly get prepared a list of bridges and overbridges involving high approaches that are likely to be taken up for execution during the current five years plan period, and initiate appropriate actions for taking up soil investigations design etc. in good time. This will not only avoid unforeseen delays and difficulties in execution of the type mentioned in para 1 above, but also make it possible to effect economies in construction costs through adoption of advanced methods of design combined with proper phasing of construction in the light of actual site conditions.

5. Suggestions for additions and alterations to the enclosed Note with a view to improving its usefulness will be welcome.

**NOTE ON PROCEDURE OF INVESTIGATIONS AND DESIGN FOR HIGH EMBANKMENTS
ON APPROACHES TO BRIDGES AND OVERBRIDGES ON NATIONAL HIGHWAYS AND
OTHER CENTRALLY FINANCED WORKS**

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ANNEXURES	:	17 NOS. MARKED 'A' TO 'P' AND 'Z'

**NOTE ON PROCEDURE OF INVESTIGATIONS AND DESIGN FOR HIGH EMBANKMENTS ON
APPROACHES TO BRIDGES AND OVERBRIDGES ON NATIONAL HIGHWAYS AND OTHER
CENTRALLY FINANCED ROADS**

PART I - BASIC STEPS AND PROCEDURES

1. Identification of embankment reaches requiring investigation and design

Embankments of height equal to or less than 6m may in general be constructed according to conventional cross-sections found economical and stable in particular regions. For embankments of height more than 6m, the derivations of the cross-section should be based on a method of design, preceded by appropriate soil investigations. Simplified methods of design, based on published charts, can be adopted for embankments resting on firm foundations. On the other hand, under certain special circumstances, such as poor ground conditions and appreciable difference of water head between the two sides of the embankment, comprehensive soil investigations and detailed design may be required even for embankments of height less than 6m. Thus, the term high embankment is a relative one and should be properly construed in relation to the strength of the foundation soil.

2. Drawing up list of high embankment reaches requiring soil investigations and embankment design

Based on the criteria mentioned in para 1 above, Statewise lists may be drawn up of the high embankment stretches requiring soil investigation and design. This will cover sanctioned works for which embankment design is not yet available and all other proposed works involving high embankments provided in the inescapable lists and in the current Five Year Plan. The high embankment design cases so selected may be listed according to their priority, taking due account of their status as regards sanction, execution target, dates of commencement and completion, coordination with the programme of sanction and execution of related bridge/overbridge structures, etc. Proformae for preparing these lists, separately for works that are sanctioned and works not yet sanctioned, are suggested as below:

PROFORMA - I

**List of embankment design cases in respect of sanctioned works for which
embankment design is not available.**

State _____							
Sl. No.	Name of work	NH No/ Name of road	Job No. Date of sanction Sanctioned amount	Date of commencement of execution	Target date of completion of execution	Present position of execution	
1.	2.	3.	4.	5.	6.	7.	
Length of high embankment stretch involved, with maximum and minimum heights of embankment		Position of estimate for soil investigation		Targets for soil investigation and embankment design			Remarks including whether related bridge work sanctioned need for coordinated progress
				Date of commencement of soil investigation	Date of completion of soil investigation	Date of finalisation of embankment design	
8.		9.		10.	11.	12.	13.

Note:- Where the high embankment falls, in a reservoir impounded by a dam, the present stage and target date of completion of dam should be indicated in Col. 13.

**NOTE ON PROCEDURE OF INVESTIGATIONS AND DESIGN FOR HIGH EMBANKMENTS
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PROFORMA - I

**List of embankment design cases in respect of sanctioned works for which
embankment design is not available.**

State _____						
Sl. No.	Name of work	NH No/ Name of road	Job No. Date of sanction Sanctioned amount	Date of commencement of execution	Target date of completion of execution	Present position of execution
1.	2.	3.	4.	5.	6.	7.
Length of high embankment stretch involved, with maximum and minimum heights of embankment		Position of estimate for soil investigation		Targets for soil investigation and embankment design		Remarks including whether related bridge work sanctioned need for coordinated progress
				Date of commencement of soil investigation	Date of completion of soil investigation	Date of finalisation of embankment design
8.		9.		10.	11.	12.
						13.

Note:- Where the high embankment falls, in a reservoir impounded by a dam, the present stage and target date of completion of dam should be indicated in Col.13.

PROFORMA - II**List of embankment design cases for works included in inescapable lists or draft Sixth Five Year Plan, but not yet sanctioned**

Sl. No.	Name of work	NH No./ Name of road	Esti- mated amount	Present position of pre- paration/ submission of estimates (soil inves- tigation & works	Target for execution	
					Date of commen- cement	Date of comple- tion
1	2	3	4	5	6	7
Length of high embankment stretch involved, with probable maximum and minimum heights of embankment	Targets for soil investigation and embankment design					Remarks including need for coordination with any related bridge works
		Date of commence- ment of soil investigation	Date of comple- tion of soil investigation	Date of finalization of embankment design		
8	9	10	11	12		

Note: Where the high embankment falls in a reservoir impounded by a dam, the present stage and target date of completion of dam should be indicated in Col. 12.

Lists as per proforma I and II above may be updated from time to time and copies of such lists should be sent to Roads Wing and its concerned Regional Office.

3. Stages of soil investigation and embankment design

Soil investigation and design assessment for high embankments may be carried out in stages, corresponding to those applicable for general project preparation. In particular, it should be ensured that soil investigations for high approaches to bridges and overbridges do not lag behind those for the bridges and overbridges proper. Reconnaissance soil survey, mainly based on visual assessment and study of available documentary information, should be routinely carried out for all high embankment stretches as soon as possible after the projects have been identified or approved in principle. In certain simpler cases (e.g. for embankment of 6 to 9m heights on firm foundations), it may even be possible to arrive at a design assessment on the basis of reconnaissance soil survey. Mostly, however, the reconnaissance soil survey will have to be followed by preliminary soil investigation and/or detailed investigation, depending upon the nature of the design problem and the time available for investigations. The preliminary investigation may mainly consist of field tests, auger boring and tests on disturbed soil samples. The results of preliminary soil investigations may be definitive enough in some cases (e.g. for embankments on firm foundations) for deriving the embankment cross-section. Where this is not so or where the preliminary soil investigation has been omitted for some reason or other, the detailed phase of soil investigations, consisting of collection of undisturbed samples and associated field and laboratory tests will have to be undertaken for furnishing the basis of detailed design, stability analysis, settlement analysis, etc. All field and laboratory work related to soil investigations should be carried out in accordance with the relevant ISI Codes/Specifications, specifications issued by this Ministry and widely accepted current practice in geotechnical engineering, as applicable. (For details of different types of soil investigations vide Paras 2,3,5 and 7 of Part II of this Note).

4. **Selection and testing of fill materials**

Selection of borrow areas and testing of fill materials are an integral part of soil investigations. The required selection and testing should be carried out as early as possible, preferably at the reconnaissance or preliminary investigation stage. (For details, vide Para 9 of Part II of this Note).

5. **Agency for soil investigation**

Soil investigations may be carried out either departmentally or by engaging specialist firms having proven capacity and experience in geotechnical investigations. It is not desirable to be absolutely dependent on private firms for carrying out soil investigation, especially when these have to be carried out at short notice or at out-of-way places and from this point of view, each State P.W.D. should maintain departmental facilities and trained personnel for carrying out soil investigations. Supervision of soil investigations, whether carried out departmentally or by engaging specialist firms, should be exercised by a specialist geotechnical engineer of the department. (For details vide para 12 of Part II of this Note).

6. **Design of embankment**

As already mentioned in para 3 above, it may be possible in certain simple situations to arrive at meaningful design decisions on the basis of data collected during the reconnaissance and preliminary phases of soil investigations. (For details vide Paras 4 & 6 of Part II of this Note). In other cases, embankment design should be finalized on the basis of detailed soil investigations. There are several aspects of embankment design, including derivation of the cross-section from stability analysis, phasing of construction, treatment of ground under embankment (where found necessary), settlement analysis, performance monitoring related to design and slope protection. The relative importance of these aspects may vary from site to site, depending upon field conditions and overall project features. For embankments on poor ground, the needs of economy and/or feasibility may dictate the adoption of the effective stress method of design, which requires that the embankment should be constructed in stages and the performance of the embankment should be monitored during construction. (For details of embankment design procedure, vide Para 8 of Part II of this Note).

7. **Agency for design**

The design exercise relating to embankment should mainly be carried departmentally under the charge of the specialist geotechnical engineer. By way of supplementing the departmental capacity, design work can also be entrusted to reliable geotechnical consultants.

8. **Control of construction**

Control of construction is a factor relevant to design. The raising of the embankment in stages and minimum waiting period between the stages of construction may be sometimes explicitly specified in terms of design. Besides, it must be ensured through quality control that the type of soil, degree of compaction and placement at moisture content prevalent during the construction correspond to or are better than those assumed in design. In case these requirements are not or cannot be satisfied in actual construction, revision of the embankment design should be sought. For embankments on poor ground, the actual programming of construction may sometimes be intended to be controlled by instrumented performance monitoring, in which case good liaison should be maintained between the engineers in charge of construction and design. Any mishap or unexpected embankment behaviour met with during construction should, of course, call for immediate design review. (For details, vide para 10 and 11 of Part II of this Note).

9. **Flow chart illustrating investigations and design for high embankment**

The various steps and procedures involved in the process of investigations and design of high embankments, and their inter-relationships, are illustrated in the flow chart at Annexure Z. This may be used as a basis for time scheduling of investigations and design phases.

**NOTE ON PROCEDURE OF INVESTIGATIONS AND DESIGN FOR HIGH EMBANKMENTS ON
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PART - II DETAILS OF PROCEDURES AND TECHNICAL CONSIDERATIONS

1. Importance of investigations and design for high embankment on approaches to bridges

1.1 Economy and safety considerations

Approaches to bridges and overbridges have to be commonly taken along high embankments, particularly for roads in plain and rolling terrain. In the context of present day requirements of geometrics and performance, the cost of providing high approaches to new bridges, or even remodelling existing approaches to bridges being reconstructed can be very substantial, sometimes approaching or even exceeding the cost of the bridge itself. (Hereinafter the term 'bridges' will be taken to include overbridges also for purposes of this note, unless otherwise stated). Investment on this scale obviously makes it worthwhile to pay detailed attention to design, which in turn has its basis in proper investigations, so that excessive or unforeseen expenditure may be avoided and the ends of economy served in general. Then, there is the essential requirement of taking care of the stability of high approaches, especially where the approach alignment may traversing weak grounds, like alluvial flats or marshy areas, as is quite frequently the case. Thus, for reasons for both safety and economy, it is essential that construction of high approaches to bridges is proceeded by adequate investigational and design exercise.

1.2 Coordination between bridge and approach components

Deficiencies in investigations and design for high approaches are apt to result in various execution complications, such as delays and cost excesses, affecting the progress and commissioning of not only the approach itself, but also of the bridge proper. In fact, viewed in the proper perspective, a bridge and its approaches are but the complementary components of a single overall project and hence, the need for their coordinated planning and execution in all stages becomes apparent. In recognition of this, it has earlier been pointed out with this Ministry's circular letter No. NHI-40(3)/71, dated the 29th January, 1971 that there is "an urgent need for planning, design and execution of both components of the project with a view to achieving overall economy, sound engineering results and speedy execution of the entire job". This view has been reiterated with this Ministry's circular letter No. NHII/MISC/120775(1) dated 20.3.76 with the further stipulation that the estimates for the bridge and approach components" should be forwarded simultaneously and under the same covering letter". The requirements of soil investigations and embankment design for high approaches had been earlier dealt with in this Ministry's letter No. PL-86(41)/72-SP, dated 13.8.73. All these only serve to emphasize the importance already being attached to carrying investigations and design of high embankments at approaches to bridges in a systematic and well thoughtout manner so that the objective of coordinated planning and execution of bridge and approach components is not impaired due to non-availability of the design for the embankment in time. This objective has, of course, remained a continuing pre-occupation over the past several years and is reiterated. The updated recommendation in respect of soil investigation and embankment design for high approaches are contained in the subsequent paragraphs of this Note read with the Annexures referred to therein. In this connection, reference may also be made to the forthcoming Indian Roads Congress publication entitled "Guidelines for High Embankment Design".

2. Stages of investigations and design

2.1 Necessity for investigation in stages

If the alignment and longitudinal profile for the bridge-cum-approaches and the locations of the ends of the bridge structure are straightaway available, then the investigations and design for high approach embankment can proceed more or less as a single stage operation. Quite frequently, however, the cost and the feasibility of the embankment are themselves factors influencing the selection of the alignment, longitudinal profile and even bridge length (to the extent that viaduct spans are or are not considered necessary). The importance of these factors in determining the overall project feasibility increases, and may even become critical, in situations involving very high embankments, poor subsoil conditions, restricted road land, non-availability of adequate borrow areas within reasonable leads or combinations

NOTE ON PROCEDURE OF INVESTIGATIONS AND DESIGN FOR HIGH EMBANKMENTS ON APPROACHES TO BRIDGES AND OVERBRIDGES ON NATIONAL HIGHWAYS AND OTHER CENTRALLY FINANCED ROADS

PART - II DETAILS OF PROCEDURES AND TECHNICAL CONSIDERATIONS

1. Importance of investigations and design for high embankment on approaches to bridges

1.1 Economy and safety considerations

Approaches to bridges and overbridges have to be commonly taken along high embankments, particularly for roads in plain and rolling terrain. In the context of present day requirements of geometrics and performance, the cost of providing high approaches to new bridges, or even remodelling existing approaches to bridges being reconstructed can be very substantial, sometimes approaching or even exceeding the cost of the bridge itself. (Hereinafter the term 'bridges' will be taken to include overbridges also for purposes of this note, unless otherwise stated). Investment on this scale obviously makes it worthwhile to pay detailed attention to design, which in turn has its basis in proper investigations, so that excessive or unforeseen expenditure may be avoided and the ends of economy served in general. Then, there is the essential requirement of taking care of the stability of high approaches, especially where the approach alignment may traversing weak grounds, like alluvial flats or marshy areas, as is quite frequently the case. Thus, for reasons for both safety and economy, it is essential that construction of high approaches to bridges is proceeded by adequate investigational and design exercise.

1.2 Coordination between bridge and approach components

Deficiencies in investigations and design for high approaches are apt to result in various execution complications, such as delays and cost excesses, affecting the progress and commissioning of not only the approach itself, but also of the bridge proper. In fact, viewed in the proper perspective, a bridge and its approaches are but the complementary components of a single overall project and hence, the need for their coordinated planning and execution in all stages becomes apparent. In recognition of this, it has earlier been pointed out with this Ministry's circular letter No. NHI-40(3)/71, dated the 29th January, 1971 that there is "an urgent need for planning, design and execution of both components of the project with a view to achieving overall economy, sound engineering results and speedy execution of the entire job". This view has been reiterated with this Ministry's circular letter No. NHII/MISC/120775(1) dated 20.3.76 with the further stipulation that the estimates for the bridge and approach components" should be forwarded simultaneously and under the same covering letter". The requirements of soil investigations and embankment design for high approaches had been earlier dealt with in this Ministry's letter No. PL-86(41)/72-SP, dated 13.8.73. All these only serve to emphasize the importance already being attached to carrying investigations and design of high embankments at approaches to bridges in a systematic and well thoughtout manner so that the objective of coordinated planning and execution of bridge and approach components is not impaired due to non-availability of the design for the embankment in time. This objective has, of course, remained a continuing pre-occupation over the past several years and is reiterated. The updated recommendation in respect of soil investigation and embankment design for high approaches are contained in the subsequent paragraphs of this Note read with the Annexures referred to therein. In this connection, reference may also be made to the forthcoming Indian Roads Congress publication entitled "Guidelines for High Embankment Design".

2. Stages of investigations and design

2.1 Necessity for investigation in stages

If the alignment and longitudinal profile for the bridge-cum-approaches and the locations of the ends of the bridge structure are straightaway available, then the investigations and design for high approach embankment can proceed more or less as a single stage operation. Quite frequently, however, the cost and the feasibility of the embankment are themselves factors influencing the selection of the alignment, longitudinal profile and even bridge length (to the extent that viaduct spans are or are not considered necessary). The importance of these factors in determining the overall project feasibility increases, and may even become critical, in situations involving very high embankments, poor subsoil conditions, restricted road land, non-availability of adequate borrow areas within reasonable leads or combinations

thereof. In many situations, therefore, soil investigations and design assessment pertaining to high embankments require to be carried out in stages, corresponding to those for general project preparation. Accordingly, the programme for the usual reconnaissance and preliminary phases of general project investigation should contain integrated provisions for the corresponding categories of soil investigations, to be carried out with the assistance of a specialist geotechnical engineer. This should lead to the finalization of the alignment, longitudinal profile and bridge position and may thereafter be followed by detailed soil investigations to furnish the basis of final embankment design and construction planning. Such detailed soil investigations may be carried out separately, but hand-in-hand with general survey and investigations, under the direct charge of a specialist geotechnical engineer.

2.2 Planning the stages in soil investigations

The nature and extent of investigations and design exercise to be carried out at different stages of high embankment planning might vary from project to project, depending upon the scale of the project, site conditions, time and facilities available, etc. The general objective in planning the investigations in stages should be to identify the broad problems and possibilities of embankment construction at as early a stage as possible, so that the investigational effort might be closely directed towards finding the appropriate solutions. For this purpose, the outcome of an earlier stage of investigation should be utilised for defining (and if possible, narrowing down) the scope of the next stage of investigations and, at the same time, progressively eliminating alternatives or uncertainties in the area of design assessment. It is not necessary, however, that all the three stages of investigations mentioned above have to be gone through for all high embankments. There may be situations, like the one mentioned at the beginning of para 2.1 above and others mentioned subsequently, where one or more stages of investigations can be eliminated.

3. Reconnaissance soil survey

3.1 Objectives

Reconnaissance soil survey may be done along the probable alignments or corridors identified on the basis of general reconnaissance survey. The broad objectives of the reconnaissance soil survey may be stated as:

- i) Identifying embankment stretches requiring investigated design;
- ii) Broad assessment of embankment feasibility and costs;
- iii) Outlining the scope for further investigations and analysis.

Reconnaissance soil survey should be routinely carried out for all cases of approaches to bridges/overbridges and as soon as possible after the projects have been identified. If more than one bridge site/approach alignment combinations are under consideration, then reconnaissance soil survey will have to be carried out for each of them.

3.2 Sources of information

For reconnaissance soil survey, main reliance may be placed on the study of existing information and site observations. The sources of existing information may include (according to availability and applicability):

- i) Topographical maps;
- ii) Geological maps and reports;
- iii) Agricultural soil survey maps and reports;
- iv) Aerial photographs;
- v) Data collected in course of general reconnaissance survey;
- vi) Meteorological, hydrological and seismological data;
- vii) Reports of previous soil investigations in the same locality;
- viii) Records of performance of earlier constructed embankments and foundations of structures in the same locality.

Site observations may include:

- i) Ground reconnaissance along the proposed alignments;
- ii) Inspection of probable borrow areas and quarries;
- iii) Study of exposed soil profiles (at cuts, gullies, etc.);
- iv) Observation of water table at existing wells;
- v) Observation of performance of existing embankments in the same locality.

These observations may be supplemented by simple soil explorations from trial pits and auger holes, followed by laboratory tests for the identification of soil types and determination of natural moisture contents within the explored depth. Handy portable equipments like pocket penetrometer, torvane (portable vane shear apparatus), rapid moisture meter, etc. can be made use of in the field for approximate assessment of soil characteristics. Geophysical methods of investigation (like those using seismograph and soil resistivity meter) can also be employed, if the requisite facilities are available, for obtaining rather approximate but fairly quick ideas about the subsoil stratification.

3.3 Report on results of reconnaissance investigation

The report of reconnaissance soil survey should provide information on the following points:

- i) Rough assessment of length and location of stretches involving embankments of heights between 3 to 6m, 6 to 9m, 9 to 12m and beyond 12m. The corresponding embankment locations may be indicated on an index map (to scale 1:20,000 or 1:50,000), also showing locations of proposed bridge structures and topographical features;
- ii) Terrain conditions;
- iii) Subsoil conditions;
- iv) Relevant climatic and hydrological data (e.g. rainfall, temperature, H.F.L., L.W.L. water table, etc.);
- v) Availability of land for accommodating embankment;
- vi) Availability of different types of fill materials, their leads and unit costs;
- vii) Requirement and availability of slope protection measures;
- viii) Typical cross-sections and description of performance of existing embankments in the same locality;
- ix) Special problems of embankment construction, if any;
- x) Available facilities for preliminary and detailed soil investigations;
- xi) List of references consulted (copies or extracts may be attached, where appropriate).

4. Design assessment at the end of reconnaissance soil survey

4.1 Identification of high embankment reaches

As an aid to route location, a broad assessment is to be arrived at on the basis of reconnaissance soil survey as regards the extent, feasibility and rough cost of high embankment reaches along the route (or routes) under consideration. Stretches where the embankment heights are 6m or less need not be normally identified as high embankment reaches. However, embankments of lower heights, say, of the order of 3 to 6m, may sometimes have to be classified as high embankments if the sub-soil conditions are poor (e.g. marshy deposits) or if existing embankments of less than 6m height in the same locality have exhibited poor performance or if special circumstances like appreciable difference of water table between the two sides of the embankment may be involved, etc.

4.2 Embankments not classified as high embankments

For embankments not classified as high embankments, conventional cross-sections based on judgement and local practice may be adopted without recourse to further soil investigations or formal design. The side slope of the embankment in such cases should not be normally steeper than IV: H so that requirements of traffic safety and erosion protection are satisfied. Any doubts in individual cases about the adequacy of conventional cross-sections should be settled through proper investigation and design, especially if indications of instability (e.g. cracking, sliding, heaving, excessive settlement, etc.) are encountered during construction. Further, the selection of soil for the shoulders and for the top 0.6-1 m height of the embankment lying below the subgrade level should be based on the requirements of pavement design (vide para 9 below).

4.3 Embankments of height between 6 and 9 m on firm foundations

For embankment heights between 6 and 9 m, it may be assessed from available information and local knowledge (including by studying performance of existing embankments in the same locality) if the ground under the embankment can be treated as 'firm', i.e. unlikely to yield or suffer excessive settlement under the weight of an embankment of 6-9 m height. If the ground can be thus treated as firm, then further subsoil investigations may be dispensed with. However, representative samples of selected fill materials may be tested for the range of tests listed in Annexure 'A' (also vide para 9) and the side slopes of the embankment may be derived with the help of Taylor's chart (method described in Annexure 'B').

4.4 Rough design assessment for other high embankment reaches

For assessing rough costs and feasibility, a rough design assessment based on information collected during reconnaissance soil survey can be attempted for embankments of height exceeding 9m and those of less height but having foundations that may not be treated as 'firm'. However, such assessments should be treated as purely tentative, not providing a basis for execution and liable to be superceded by designs evolved on the basis of later investigations and analysis. The scope of such further investigations needed may be broadly indicated, as far as possible.

5. Preliminary soil investigations

5.1 Objectives

Preliminary soil investigations represent an intermediate stage between reconnaissance soil survey and detailed soil investigations. The broad objectives of preliminary soil investigations may be stated as:

- i) Narrowing down the range of alternatives and uncertainties;
- ii) Identification of likely sources of fill materials;
- iii) Derivation of cross-sections in suitable cases;
- iv) Defining scope of detailed investigations;

5.2 Where preliminary soil investigations are specially indicated.

Preliminary soil investigations are desirably carried out wherever feasible. However, they are particularly indicated in the following situations;

- i) Where the cost and feasibility of embankment construction is a major consideration in the choice between alternative alignments/bridge sites;
- ii) Where substitution of high embankment by viaduct is an alternative under consideration on account of doubts about the feasibility of embankment construction;
- iii) Where subsoil conditions are highly non-uniform, so that preliminary soil investigations are useful for optimizing locations of boreholes for detailed soil investigations;
- iv) Where it is desired to effect savings in cost of construction through sophistications in investigations and designs;
- v) For important projects in general.

5.3 Scope of testing in preliminary soil investigation

5.3.1 Field tests

Preliminary soil investigations should result in a fairly accurate idea of stratification, detection of weak strata and an approximate assessment of the strength and consolidation characteristics of embankment foundation soils for a depth of 20-30m below G.L. This type of information can be mainly obtained by relying on one or more of the various types of field tests in common use, e.g. standard penetration test, static cone penetration test, dynamic cone penetration test and field vanes shear test. Field tests have the advantage of being simple, quick and fairly reliable, if properly planned and interpreted. Tests points may be generally located as at 50-100 m intervals along the C.L. Field tests may be supplemented by selection of disturbed samples by auger boring and testing of the same for classification and natural moisture content. If the probable toe-to-toe width may be large say, in excess of 50m, locating additional field test points/auger holes away from the C.L. of the alignment should be given consideration, particularly if the ground is sloping across the alignment or there is appreciable variation in soil stratification, as revealed from the initial few field tests or auger borings. The additional test points may be located 20 to 40m away from the C.L. on either side and staggered with respect to test points on C.L. If standard penetration tests are conducted, the samples recovered from the SPT spoon may be used for carrying out classification tests, determination of natural moisture content and, on a less reliable basis, determination of void ratio and unconfined compression strength. Recourse may also be had to geophysical methods (mentioned earlier in para 3 above) for conducting preliminary soil investigations. Choice regarding the mode of investigation will depend upon the availability of equipments, type of subsoil stratification, importance of the project, etc.

5.3.2 Testing of fill materials

As regards fill materials, representative samples of different types of soils met with in the borrow areas under consideration may be tested for the range of tests listed in Annexure 'A'. In collecting representative samples, due consideration should be given to variation of the soil within the borrow area, both horizontally and in depth (upto the envisaged depth of excavation). Consideration relevant to selection of fill materials have been dealt with in Para 9 below.

5.3.3 Collection and testing of undisturbed samples

For important projects or more problematic site conditions, collections of undisturbed samples, followed by laboratory testing may have to be undertaken on a limited scale. The depth of bore-holes may be 20-30m.

5.4 Reporting results of preliminary investigations

The report on preliminary soil investigations may include:

- i) Plans and longitudinal sections showing locations of field tests/boreholes, heights of embankment and borrow area locations.
- ii) Borelogs and results of field tests (in the form as per Annexure 'C').
- iii) Results of laboratory tests (for the range of tests listed in Annexure 'D'), on borehole samples (in the form as per Annexure 'E').
- iv) Results of laboratory tests on fill materials (in the form as per Annexure 'F').

6. Design assessment at the end of preliminary soil investigations.

6.1 Selection among alternatives

Where more than one alignment is being investigated, the comparative merits of the different alignments in terms of cost and feasibility should be assessed, so that the final selection among the alternatives is facilitated. If consideration is being given to viaducts or retained fills as alternatives to normal unretained embankments (whether involving berms or not), then the relative necessity and merits of each alternative may be spelt out. Selection among alternative sources of fill materials may be mainly decided at this stage (also vide discussions in para 9 below). For the purpose of rough cost estimation, tentative embankment cross-sections may have to be assumed on the basis of the guidance available from the preliminary soil investigation data. It may also have to be provisionally assessed at this stage whether or not the procedure of 'stage construction', i.e. building up the embankment from the ground level up in discrete stages separated by time gaps, would have to be adopted.

6.2 Derivation of embankment cross-section using Taylor's chart.

In some cases, preliminary soil investigations may yield definitive data to indicate that the foundation of the embankment may be treated as 'firm' i.e. not liable to yield or suffer excessive settlement under the load imposed by the embankment heights proposed. Typical examples are fairly stiff residual soil overlying rock at shallow depth as revealed from auger boring and dense to medium dense sand or sand-gravel extending to great depths as revealed by consistently high N-values yielded by the standard penetration test. Further sub-soil investigations may be dispensed with in such cases and the side slopes of the embankment may be derived by using Taylor's chart (Annexure 'B'), after soil data have been obtained in respect of representative samples of fill materials (vide para 5.3.2 and 9).

6.3 Assessing the requirement of detailed investigations

Where it is assessed from the preliminary investigations that the embankment foundations may not be treated as firm, that is, potential failure planes are liable to pass through the embankment foundations, the design of the embankment is to be based on the results of detailed soil investigations, a programme for which should be drawn up. This should include tentative decisions regarding alternative design approaches, since these may affect the scope and the content of the detailed soil investigations. Such design alternatives may include total stress vs. effective stress method (Para 8.2.3 below), possibilities of treating the ground under the embankment (para 8.3 below), use of light weight fill material, etc. For highly sensitive clay soils in the foundation, laboratory determination of strength is not dependable and hence, the programme of detailed soil investigations should lay stress on in-situ determination of strength through field vane shear test or static cone penetrometer test. For cohesionless type of soil, it may not be possible to collect undisturbed

samples for laboratory testing and hence the in-situ strength of such soils has to be mainly assessed through field tests e.g. standard penetration test and static or dynamic cone penetrometer test. For cohesion-less deposits in a loose state, the static cone penetrometer test is more suitable.

7. Detailed soil investigation

7.1 Scope of detailed soil investigations

As earlier indicated (para 4.2, 4.3 and 6.2), the embankment design may get decided in simpler cases on the basis of the reconnaissance or preliminary stages of soil investigations. In the remaining cases, the embankment design has to await the results of detailed soil investigations. The alignment plan, longitudinal profile and the bridge location should be finalized before detailed soil investigations are taken up. The following are the main points to be considered in determining the extent and scope of detailed soil investigations:

- i) Location of boreholes;
- ii) Depth of boreholes;
- iii) Procedure of boring, sampling and associated field tests (e.g. S.P.T. and vane shear test);
- iv) Nature and quantum of laboratory testing.

7.2 Location and depth of boreholes

Decision on the points mentioned above are greatly facilitated if preliminary soil investigations have been done. In any case, accumulating information regarding subsoil conditions as revealed from the initial borings and field tests during detailed soil investigation stage itself should be continuously evaluated and utilized to adjust the location/depth of boreholes, while the detailed soil investigations are in progress. For initial planning of detailed investigations, the following general guidelines may be suggested:

- (a) The spacing of the boreholes along the alignment may ordinarily range between 30 to 80m, depending upon the variability of soil strata as assessed from geological appreciation, preliminary soil investigations, evaluation of the initial borelogs of detailed soil investigations, etc.
- (b) Boreholes may be generally located along the C.L. of the alignment. However, if the probable toe-to-toe width (inclusive of the estimated widths of berms) may be large, say, in excess of 50m, locating additional boreholes off from the centre line of the alignment needs consideration, particularly, if there is appreciable variation in ground levels across the alignment or in soil stratification from borehole to borehole, as revealed from preliminary investigations or initial borehole information. A less exacting procedure may be to locate boreholes for collection of undisturbed samples along the C.L. and assess the variability of stratification across the toe-to-toe width by conducting field tests (vide para 5.3.1) or by examining disturbed samples obtained from auger boring.
- (c) For approaches to river bridges, at least two boreholes should be located for each approach. For approaches to overbridges, at least two boreholes should be established for the high embankment stretch for both the approaches taken as a whole. The number of boreholes can, of course, be more depending upon the spacings adopted vide (a) and (b) above.
- (d) The depth of boreholes should not be normally less than 3 times the height of the embankment, nor less than 20m. Where it has been ascertained from preliminary soil investigations and/or geological interpretation that strata at depths exceeding 20m comprise of cohesionless sand or better materials, the depth of boreholes can be proportionally reduced to 2 times the height of the embankment, but not less than 20m. However, boreholes may be terminated at shallower depth, if a hard impenetrable stratum is met with. Mere obstruction to the progress of boring should not, however, be taken to be indicative of a continuous hard stratum having been encountered. Isolated boulders impeding boring operations, for example, are liable to be mistaken as rock. It should, therefore, be ensured from geological assessment and by coring or chiselling through the hard stratum for at least 2m depth that the hard stratum encountered is continuous and of sufficient thickness.

7.3 Boring, sampling and field tests

Certain pertinent information as regards the procedure of boring, sampling and field tests are contained in Annexure 'G'. For guidelines as regards methods of boring and sample collection, reference may also be made to Section 3 to 7 of the Indian Standard Code of Practice for Site Investigations for Foundation (ISI 1892-1962).

7.4 Laboratory testing

The scope and quantum of laboratory testing of borehole samples should be finally decided after borelogs and results of field tests have been studied and a broad idea of the design requirements have been formed. This is necessary

with a view to avoiding undue elaboration in laboratory testing and at the same time tailor the testing to the design objectives (e.g. whether total stress or effective stress method of design is proposed to be adopted). The range of laboratory tests that may be performed on borehole samples has been listed in Annexure 'D'.

7.5 Fill material testing

At the stage of detailed investigations, the fill materials to be used for forming the embankment and their sources are to be definitely identified (also see para 9 below). The range of tests to be performed on fill materials is the same as that mentioned earlier in Para 5.3.2. Where the same type of fill material is to be used in large quantities, one representative sample should be tested for every 20,000 cubic metre of fill material or less. To the extent that testing of fill materials has been done at the stage of preliminary soil investigations the testing of fill materials at the stage of detailed soil investigations can be suitably curtailed.

7.6 Reporting results of detailed investigations

Borelogs and results of field tests, results of laboratory tests on borehole samples and results of laboratory tests on fill materials should be completed in forms shown in Annexures 'C', 'E' and 'F' respectively. The various types of plots associated with the reporting of laboratory tests results (e.g. particle size distribution curve, moisture-density relationship curve, stress strain plots, Mohr circle diagrams, void ratio vs. time and void ratio vs. effective consolidation pressure curves, etc.) are to be enclosed with the test results. These should also be prefaced with a suitable report giving descriptive information on the planning and implementation aspects of field exploration and laboratory testing operations, particularly to the extent that such information may be of relevance to the interpretation and application of the compiled results of soil investigations. For important projects and/or complex sub-soil conditions, the report of detailed soil investigations should preferably contain a geological appreciation of the subsoil stratification and its significance to embankment design and performance. Index map, plans and longitudinal section showing locations of field tests/boreholes, heights of embankment, H.F.L./L.W.L. borrow area locations and location of bridge structures may be collected and attached along with detailed soil investigation report. A consistent system of chainage reference and datum reference should be used for indicating locations and levels respectively.

8. Design of embankment after detailed soil investigations

8.1 Aspects of embankment design

There are several aspects of embankment design and these include derivation of the cross-section, treatment of ground under the embankment, settlement analysis, construction programming and performance monitoring related to design. Each of these aspects can be dealt with in design to varying degrees of detail and accuracy, depending upon the demands of performance and economy on the one hand and the availability of facilities for investigation, computation and performance monitoring on the other. Proper treatment of embankment design and securing the necessary data from detailed investigation call for expertise and experience, including familiarity with local conditions, and should be handed by or in consultation with specialist geotechnical engineers. Broad descriptions only of the common aspects of embankment design are given in the subsequent paragraphs.

8.2 Derivation of embankment cross-section

8.2.1 Basic procedure

Two important elements of the cross-section, viz. roadway width and the height above G.L., are determined by general project requirements. The side slopes and the dimension of berms, if any, required, are derived from stability analysis. Data regarding HFL/LWL, water table, loading, sub soil stratification and soil characteristics (both for the sub soil and the fill material) may commonly enter into stability analysis. All such data should be available from the previous investigation and project specification. The basic procedure of analysis consists in assuming one or more likely cross-sections and computing the minimum factor of safety of the assumed cross-sections against failure by rotational and/or block sliding for different assumed trial surfaces of sliding. A cross-section that satisfies the requirement of safety, provides relative economy and is in tune with the general project requirements provides the desired solution. Within the ambit of this basic procedure, different methods of analysis have been developed, with variations as regards complexity of computations and accuracy of results. Whether to use a relatively simple method (e.g. ordinary method of slices) or a more rigorous method (e.g. that due to Bishop) depends upon the computing facilities available and also to what extent

retain an option for) effective stress analysis requires to be decided prior to taking up laboratory testing in the detailed investigation stage, so that the programme of laboratory testing may include the specific types of tests required to furnish the data for effective stress design. Preliminary characterization of the sub-soil conditions from a study of the borelogs and the results of field tests will provide the basis for taking such decisions.

8.2.4 **Accounting for variations in embankment height, soil profile and fill material**

As a practical procedure, stability analysis may be initially carried out for the maximum height of the approach embankment, but separately for the two approaches lying on either side of a river bridge, and appropriate embankment cross-sections derived. Additional stability analyses may have to be carried out for taking care of variations in height, sub-soil profile and fill material (if different types of fill material) are utilised for different stretches of the embankment. Both judgement and economic considerations will be factors in taking decisions in this regard. For example, if the cross-section derived for the maximum embankment is a heavy one, envisaging provision of berms and/or side slopes flatter than IV:2H, it would be desirable in the interest of economy to have the cross-section reduced for lower heights of embankment through separate stability analyses. Similarly, systematic variation in sub-soil conditions may be taken care of by varying the cross-section suitably on the basis of separate stability analyses for different sub-soil profiles. However, abrupt variations in sub-soil profiles from borehole to borehole may call for judgement to be exercised in the selection of the sub-soil profiles to be adopted for design purposes. For reducing the labour in computations, locations should be so chosen for carrying out stability analyses that variations due to height, sub-soil profile and fill materials are taken care of coincidentally as far as possible. For this purpose, the points of change from one type of fill material to another should not be left to site decision, but decided in advance by the designer after taking due account of the availability of different types of fill materials as advised by the engineer in charge of general project preparation or construction, as the case may be.

8.2.5 **Factor of safety**

The factor of safety (F) to be allowed for in embankment design should be such as to compensate at least for probable errors or variations in evaluating soil properties and loading conditions. It should also allow for the effect of the assumptions and simplifications inherent in the design method employed. The effect of such uncertainties is the least for embankments of fairly compacted sand resting on firm foundation and the factor of safety in such cases may be as low as 1.10. In other situations, the factor of safety should not be generally less than 1.30, whereas it may be increased to 1.50 or even 1.75 if the design is based on incomplete or doubtful data, local overstressing of the soil is likely to occur, control of construction is liable to be inadequate, soil conditions are unpredictably variable, etc. Factor of safety may be further increased by 10 to 25 per cent to account for conditions like seismicity, rapid drawn down possibility of shrinkage crack in the embankment, etc., if these eventualities have not been explicitly allowed for in stability calculations (It may not be feasible, if relying on manual computations, to carry out stability analyses for all the variations of loading conditions). Factor of safety can be lowered as compared to the values mentioned above by way of indirectly taking into account favourable conditions, or, if arrangements can be made maintaining a check on the performance of the embankment during construction. For example, a practice sometimes followed in total stress design is to take implicitly account of the gain in soil strength during construction by adopting a low factor of safety (of the order of 1.10 to 1.30) and to rely on the results of observation during construction for detecting impending slides and to prevent/rectify slides by slowing down construction and/or local modifications of the cross-section. This approach is workable if the risk of occasional slides can be taken. Such a risk may not be acceptable, for example, if any distress in the embankment under construction may affect an existing vital installation (e.g. a railway line lying across or parallel to a road embankment under construction). Where factor of safety is chosen to be lower than 1.60, it is desirable that the performance of the embankment is monitored during construction (vide para 11 below) so that advance indication of any developing distress may be obtained and the construction halted for taking remedial measures.

8.2.6 **Drainage layer**

Where the embankment and the substratum just below the ground level may both be composed of soils of low permeability (e.g. clay, silty clay, etc.), the lowest 0.30 - 0.45m height of the embankment adjacent to the ground level may consist of granular fill of good permeability (sand or coarser material) designed to act as a drainage layer, i.e. to allow a horizontal drainage path for the escape of porewater from the consolidating subsoil. Such drainage layer should extend under the berms also, if any provided. It is not essential for the granular material constituting the drainage layer to satisfy filter criteria and it may be laid in 0.15m thick compacted lifts, following normal embankment construction practice.

investigational data are reliable so that a real improvement in the final accuracy is made possible by adopting sophisticated computational procedures. The stability analysis for road embankments is normally carried out for the end-of-construction condition. This may refer to the condition prevailing when toe full it has been reached, if total stress method of design is adopted and to conditions prevailing at the end of pre-determined stages of construction, if the 'effective stress' method of design is adopted (vide Para 8.2.3 below). For sites subject to fluctuation of water table the position of the highest water table (upto or below the G.L.) may normally be taken as critical in design. Partial or full submergence condition (i.e. water level lying above the ground level) with stable or slowly changing water-level is not critical, unless the fill material is liable to lose strength on submergence and the reduction is of such magnitude that it may outweigh the beneficial effect of loss in unit weight of embankment material lying below the water level. However, if the water level is liable to fall rapidly and appreciably, the stability may be checked for the well-known's draw down condition. Where the embankment has also to serve as a water-retaining or flood-protection structure (involving difference between water levels on the two sides of the embankment), the effect of external water pressure and internal seepage conditions on stability may need to be checked. The steps involved in stability analysis by the ordinary method of slices and by sliding block method are illustrated by typical worked out examples (Annexure 'H').

8.2.2 Computer methods of stability analysis

While methods of stability analysis in common use are fairly straightforward mathematically (subject to given assumptions), they usually involve lengthy and repetitive computations which are highly time consuming if carried out manually. This factor alone may often limit the number of analyses that can be carried out, which in turn may lead to compromises in safety or economy. Such computational difficulties are easily overcome by adopting computer methods of stability analysis, which offer saving in time and gain in accuracy at modest cost. Therefore, efforts should be made to develop access to locally available computer facilities for carrying out stability analysis by computer methods.

8.2.3 Total stress and effective stress methods of analysis

Certain types of soil, particularly the weaker ones like soft clays so frequently encountered in the foundations of embankments, undergo progressive consolidation, i.e. densification accompanied with reduction in water content, under the load imposed by the embankment in position. Densification in turn leads to gain in strength of the sub-soil. Therefore, an important question to be decided in connection with carrying out stability analysis is whether or not to take account of the gain in strength of the soil with time, leading to two different design approaches known as 'total stress analysis' and 'effective stress analysis' respectively. Total stress analysis is basically appropriate where the construction time is short, during which no appreciable gain in strength of the soil is to be expected. The relevant procedure of analysis as also the tests required for furnishing the design data are relatively easier to carry out. The application of this method to situations where the embankment may be gradually raised, as is quite frequently the case, may lead to conservative design. This may still be an acceptable procedure so long as it does not necessitate the provision of stabilizing berms and/or slopes flatter than, say, IV:2.54. It is quite likely, however, that at problematic sites (e.g. those involving high embankments founded on soft or very soft clays and organic silts), the adoption of the total stress method is likely to result in uneconomic cross-sections, also involving large scale land acquisition for accommodating flat side slopes and/or stabilizing berms. In such cases, it is quite feasible and, of course, in the interest of the economy to reduce cross-sections by resorting to effective stress design combined with a programme of stage construction. This means that the embankment is built-up in several stages from G.L. upwards and for the cross-section prevailing at the end of each stage of construction, stability analysis is carried out after taking account of the gain in soil strength that should occur during the time elapsed since the start of the construction. The progressive increase in soil strength with time (due to dissipation of pore water pressures generated by imposed embankment load) will obviously allow progressively higher embankments to remain stable. It is commonly found necessary to allow time intervals (during which earthwork is suspended) between successive stages of construction in order that adequate gain in strength may be achieved. Such spreading over of construction period should not pose a problem if planned in advance, since execution of bridge-cum-approach projects usually go on for two years or more. In some cases, it would be even worthwhile to take up the construction of the approach embankment in advance of the bridge proper to secure more time or spacing of the stages of construction, since this may enable costly alternatives like viaducts or embankments with wide berms to be avoided. Along with this type of complexity in construction programming, effective stress analysis requires relatively sophisticated and involved procedures of testing, computation and monitoring of performance. This last may include field instrumentation for checking on design parameters, in particular those relating to generation and dissipation of pore pressures, which are fundamental to effective stress analysis, but difficult to determine reliably on the basis of laboratory tests. The details of such procedures require handling by specialists and need not be discussed here. It may only be mentioned that whether or not to adopt (or at least,

retain an option for) effective stress analysis requires to be decided prior to taking up laboratory testing in the detailed investigation stage, so that the programme of laboratory testing may include the specific types of tests required to furnish the data for effective stress design. Preliminary characterization of the sub-soil conditions from a study of the borelogs and the results of field tests will provide the basis for taking such decisions.

8.2.4 Accounting for variations in embankment height, soil profile and fill material

As a practical procedure, stability analysis may be initially carried out for the maximum height of the approach embankment, but separately for the two approaches lying on either side of a river bridge, and appropriate embankment cross-sections derived. Additional stability analyses may have to be carried out for taking care of variations in height, sub-soil profile and fill material (if different types of fill material) are utilised for different stretches of the embankment. Both judgement and economic considerations will be factors in taking decisions in this regard. For example, if the cross-section derived for the maximum embankment is a heavy one, envisaging provision of berms and/or side slopes flatter than IV:2H, it would be desirable in the interest of economy to have the cross-section reduced for lower heights of embankment through separate stability analyses. Similarly, systematic variation in sub-soil conditions may be taken care of by varying the cross-section suitably on the basis of separate stability analyses for different sub-soil profiles. However, abrupt variations in sub-soil profiles from borehole to borehole may call for judgement to be exercised in the selection of the sub-soil profiles to be adopted for design purposes. For reducing the labour in computations, locations should be so chosen for carrying out stability analyses that variations due to height, sub-soil profile and fill materials are taken care of coincidentally as far as possible. For this purpose, the points of change from one type of fill material to another should not be left to site decision, but decided in advance by the designer after taking due account of the availability of different types of fill materials as advised by the engineer in charge of general project preparation or construction, as the case may be.

8.2.5 Factor of safety

The factor of safety (F) to be allowed for in embankment design should be such as to compensate at least for probable errors or variations in evaluating soil properties and loading conditions. It should also allow for the effect of the assumptions and simplifications inherent in the design method employed. The effect of such uncertainties is the least for embankments of fairly compacted sand resting on firm foundation and the factor of safety in such cases may be as low as 1.10. In other situations, the factor of safety should not be generally less than 1.30, whereas it may be increased to 1.50 or even 1.75 if the design is based on incomplete or doubtful data, local overstressing of the soil is likely to occur, control of construction is liable to be inadequate, soil conditions are unpredictably variable, etc. Factor of safety may be further increased by 10 to 25 per cent to account for conditions like seismicity, rapid drawn down possibility of shrinkage crack in the embankment, etc., if these eventualities have not been explicitly allowed for in stability calculations (It may not be feasible, if relying on manual computations, to carry out stability analyses for all the variations of loading conditions). Factor of safety can be lowered as compared to the values mentioned above by way of indirectly taking into account favourable conditions, or, if arrangements can be made maintaining a check on the performance of the embankment during construction. For example, a practice sometimes followed in total stress design is to take implicitly account of the gain in soil strength during construction by adopting a low factor of safety (of the order of 1.10 to 1.30) and to rely on the results of observation during construction for detecting impending slides and to prevent/rectify slides by slowing down construction and/or local modifications of the cross-section. This approach is workable if the risk of occasional slides can be taken. Such a risk may not be acceptable, for example, if any distress in the embankment under construction may affect an existing vital installation (e.g. a railway line lying across or parallel to a road embankment under construction). Where factor of safety is chosen to be lower than 1.60, it is desirable that the performance of the embankment is monitored during construction (vide para 11 below) so that advance indication of any developing distress may be obtained and the construction halted for taking remedial measures.

8.2.6 Drainage layer

Where the embankment and the substratum just below the ground level may both be composed of soils of low permeability (e.g. clay, silty clay, etc.), the lowest 0.30 - 0.45m height of the embankment adjacent to the ground level may consist of granular fill of good permeability (sand or coarser material) designed to act as a drainage layer, i.e. to allow a horizontal drainage path for the escape of porewater from the consolidating subsoil. Such drainage layer should extend under the berms also, if any provided. It is not essential for the granular material constituting the drainage layer to satisfy filter criteria and it may be laid in 0.15m thick compacted lifts, following normal embankment construction practice.

8.2.7 Design considerations regarding use of cohesive fill materials

Use of cohesive fill materials, viz., clay and predominantly clayey soils, may pose certain problems in embankment construction or performance of the embankment under service conditions, an assessment in which respect needs to be made and taken account of in the design stage. The formation of a failure surface in a cohesive fill may be facilitated by the formation of tension cracks, partly as a result of high mobilization of available strength (due to stress concentration, especially when the factor of safety is low) and partly due to effects of alternate swelling and shrinking caused by seasonal moisture changes within the fill. The latter aspect is likely to be of importance if the P.I. of the fill material exceeds 20. Another aspect of the problem of cohesive fills is that it is quite difficult in construction to control the placement moisture content, whereas the strength of cohesive soils may be highly sensitive to changes in moisture content. Adding to the problem of control of placement moisture content is the possibility that the long-term moisture content of the fill may be different from that at the time of construction and further, it may fluctuate under conditions of prolonged drought, submergence, etc. Definite guidelines for assessing and remedying the problems mentioned above will have to await systematic studies on performance of embankments made up of clayey soils under Indian conditions. For the present, the following tentative recommendations may be made:

- (i) Use of clay soils with P.I. exceeding 20 as fill materials for high embankments may be generally avoided. If such soils have to be used, on grounds of availability and economy, especially for embankments of height more than 8m, prior consultations may be held with Roads Wing before finalising the choice of fill material.
- (ii) Factor of safety to be adopted in the design of cohesive fills should be 1.50 or above.
- (iii) The shear strength parameters of the cohesive fill material to be used in design may be realistically assessed with due regard to the moisture content of the fill material likely to prevail in the field. For controlled earthwork where the moisture content of the cohesive fill material can be controlled with 2 per cent of the O.M.C., the moisture content for design purpose may be taken as O.M.C. + 2 per cent. For any variation beyond this range in placement moisture content, the design should be revised with reference to actual site position regarding the control of moisture content.
- (iv) In the exceptional situations where clays with inherent swelling capacity in high and very high ranges (approximate P.I. ranges 20-35 and above 35 respectively) must be used as fill material, the effects of swelling can be minimized by placing the clay at a relatively high moisture content, account being taken of the consequent loss of strength. Further, the side slopes and the shoulders of the embankment may be covered with 0.6 - 1.0m thickness of locally available non-swelling soil. (This need not cause any increase in the overall dimensions of the embankment cross-section).

8.3 Treatment of ground under the embankment

Normally, embankments are constructed on the existing natural ground, after clearing the same of vegetation and 0.15 - 0.30m thickness of top soil, which may be kept stacked for being spread later to a thickness upto 0.30m on the side slopes to help growth of vegetation there. For clayey embankments founded on clayey substratum extending upto G.L., a permeable drainage layer may be added as mentioned earlier in Para 8.2.6. These are essentially superficial treatments without any alteration of natural sub-soil conditions. Sometimes, however, it may become necessary to improve the natural subsoil conditions by resorting to deeper and more elaborate ground treatment for reasons of economy and/or feasibility. Some of the situations calling for ground improvement and the corresponding methods of treatment are listed below:-

Sl. No.	Situation calling for treatment	Type of treatment	Benefits of treatment
1.	Very weak stratum (like muck) lying between G.L. and hard stratum (like gravel or dense sand) at shallow depth. Excavation or dredging of weak layer feasible.	Complete or partial removal of weak soil & its replacement by borrowed soil of better quality e.g. sand, sand gravel.	Foundation of the embankment may be treated as firm. Berms may be eliminated or reduced. All-eviates uneven settlement.

Sl. No.	Situation calling for treatment	Type of treatment	Benefits of treatment
2.	Deep stratum of soft or very soft clay extending from G.L. downwards. Construction time short.	Installation of sand drains to expedite consolidation and gain in strength.	Berms may be reduced or eliminated. Little post-construction settlement. Construction time can be reduced. May help avoid costly alternative like viaducts.
3.	Very weak stratum (like muck) lying between G.L. and hard stratum at shallow to moderate depth. Embankment construction by normal method not feasible due to heavy and unpredictable sinking or yielding. Not feasible to excavate or dredge muck.	Sidewise displacement of muck from under the embankment by relatively rapid dumping of fill materials, Displacement of muck may sometimes be assisted by controlled blasting under the dumped fill.	Embankment construction rendered feasible. Post-construction settlement reduced.
4.	Embankment founded on loose underwater fill formed by dumping medium or fine sand in water.	Compaction of underwater fill by controlled blasting of charges.	Avoids risk of sudden liaison faction of underwater fill and consequent failure, due to rapid changes in water level, earthquakes and other kinds of shocks.

Improvements to embankment foundation by electro-osmotic and chemical treatments have also been adopted under special circumstances. Schemes for ground improvements call for meticulous design assessment and should not be proposed in an adhoc manner. Proposals in these regards should be formulated only on the basis of thorough examination by a specialist as to their necessity, feasibility and economy. The implementation of ground improvement also requires a high degree of execution control, arrangements for monitoring of the effect of ground improvements carried out and the readiness to adopt intermediate design decisions based on performance studies. This latter aspect implies flexibility in construction programming in accordance with the intermediate design decisions. This also requires the incorporation of suitable provisions in the contract agreement. Ground treatment can be supplemented (or sometimes substituted) by the use of lightweight fill materials, like cinder and flyash which impose less load on the ground (vide para 9 below).

8.4 Protection of side slopes

8.4.1 Protection against rain erosion

For facilitating protection against rain erosion, the side slopes are preferably made not steeper than IV:2H. While fill materials are rarely chosen on the criterion of susceptibility to erosion, it may all the same be noted that cohesive fill materials are less prone to erosion than cohesionless fill materials. Climatological, hydrological and soil conditions are all factors influencing the selection of measures for side slope protection. To some extent, assessment in these regards has to be empirical and based on local knowledge, including that of availability of materials, types of grasses grown, etc.

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For side slopes not liable to come into contact with open bodies of water, vegetative cover by turfing or by seeding should provide adequate protection. Wherever necessary, the advice of the local agricultural or forest authority may be sought regarding selection, establishment and maintenance of vegetative cover. Cohesionless fill materials may not support good vegetative growth, in which case a 0.30m thick layer of loamy soil, which may include stripped top soil, can be placed on the side slopes before grassing. In areas of heavy to moderate rainfall, the first 1.0m ht. of the side slope above G.L. of a cohesionless embankment should be pitched rather than covered with fine soil in order to assist in the escape of internal seepage. Side slopes of embankments in desert areas may be highly susceptible to erosion during rains following long hot spells and this may call for protection by pitching underlain with filter. Stretches of side slopes liable to carry concentrated runoff (as at the lowest points of valley curves and adjacent to bridge ends where the bridge deck may be on a summit vertical curve) may be pitched in the form of saucer drains at least 3m wide. Longitudinal drains of adequate capacity may be provided at the junction along the side slope between the main embankment and adjacent berm, if any. The longitudinal drain may be relieved at intervals by suitable, cross-drains running across the berm and its side slope. Such a system of longitudinal and cross-drains should be hydraulically design and suitably lined.

8.4.2 Protection of side slopes in contact with standing water

For the height of the embankment liable to prolonged submergence (i.e. for about 4-7 days, beyond which grass may not survive, depending upon the type of grass) and for a freeboard of 1.0m beyond, the side slope may be protected by pitching underlain with filler. In areas of high wind velocity and large open bodies of water (e.g. lakes, reservoirs), the free board may have to be in excess of 1.0m, as determined from local experience or rational determination of design wave height. The pitching may be ordinarily 0.30m thick made up of handpacked single stones of not less than 40 kg weight each. The gaps between the stones should be packed with smaller stones of size 25 mm and above. For the rest of the requirements regarding pitching and filler, clause 2502.2 of Ministry of Transport and Shipping (Roads Wing) Specification for Road and Bridge Works (First Revision, 1978) may be referred to. Typical procedure for filter design is illustrated in Annexure 'I'.

8.4.3 Protection of side slopes in contact with flowing water

The recommendations in this regard issued with this Ministry's letter No. PL/67(17)/76 dated 24.7.78 may be followed.

8.5 Shoulder treatment

For blocking ingress of water through the shoulders, the unpaved part of the shoulders may be given 4 to 5 per cent outward slope and rendered relatively impervious, either by being made up of non-swelling fine soil or by introducing a 7.5 cm thick layer of compacted stone metal lying 0.15 to 0.30 mm below the surface. Any drainage blanket used at the subgrade level should extend under the shoulders also.

8.6 Settlement analysis

8.6.1 Importance of settlement analysis

Settlement undergone by an embankment is important in several contexts, viz.

- i) Effective height of the embankment is increased by the amount that the ground settles, the road level remaining the same and account of this has to be taken in stability analysis;
- ii) Calculation of earthwork, quantity should allow for settlement;
- iii) Where the period of settlement extends beyond the time of completion of the embankment, the laying of the permanent pavement may have to be deferred till the remaining settlement is of an order which will not affect vertical geometrics, surface drainage or riding quality;
- iv) The rate of settlement is an indicator of the rate of gain of strength of subsoil;
- v) Approaching failure of embankment may be indicated by a spurt in settlement towards the centre of the embankment, possibly accompanied with heave in the toe region of the embankment.

Settlement undergone by an embankment arises from different processes, of which those due to primary and secondary consolidations of the foundation soil are of major importance in the contexts mentioned above.

8.6.2 Settlement due to primary consolidation

Conventional consolidation test provides data for calculating settlement mainly due to primary consolidation, i.e. consolidation accompanied with dissipation of excess pore water pressure. A typical procedure for calculation of settlement due to primary consolidation is shown in Annexure 'J'. The actual total settlement is likely to be less than that calculated for overconsolidated soils, since the effect of over consolidation might not be properly reflected in laboratory tests due to sample disturbance. As regards rate of settlement, the actual rate is apt to be appreciably faster than that calculated on the basis of one-dimension consolidation test for stratified soil due to additional drainage in the horizontal direction which expedites consolidation. These are factors to be kept in mind when comparing actual settlements with calculated ones based on conventional consolidation tests.

8.6.3 Settlement due to secondary consolidation

For some types of soils, the consolidation process may continue even after the excess pore pressure has been fully dissipated, giving rise to what is known as secondary consolidation. The settlement due to secondary consolidation can be roughly estimated from normal consolidation test data (vide procedure given in Fig.3.18 and related text in "Soil Mechanics and Foundations" by Sowers and Sowers, 1979 Ed.). More reliable estimation of settlement due to secondary consolidation is, however, desirable for organic clays and silts. For these types of soils, the contribution to settlement from secondary consolidation may overshadow that due to primary consolidation. Reliable estimation of the settlement due to secondary consolidation will require long duration laboratory tests and some what involved calculations (for reference vide "Analysis of Primary and Secondary Consolidation" by Harvey E. Wahls, Journal of Soil Mechanics and Foundations Division, Proceedings of ASCE, No. SM 6, December 1962, pp. 207-231). These are to be considered as justified, however, for high embankments founded on organic silts and clays.

8.6.4 Verification and refinement of settlement analysis

Inherent uncertainties in conventional settlement analysis makes it desirable that predictions regarding amount and rate of settlement should be verified by actual site observations. The results of initial observations in this regard may also enable the design parameters to be suitably modified for more realistic estimation as regards both settlement and stability. Methods are available for refined prediction of rate and amount of settlement, after taking into account factors like elastic compression, relative influence of primary and secondary consolidation processes, field permeability in horizontal and vertical directions, distribution of stresses within the foundation soil, etc. Adoption of such methods, requiring special tests and, usually, computer analysis, may be justified for special studies like evaluating the performance of trial embankments (vide para 8.7 below).

8.7 Trial embankments

Embankment design has often to deal with a certain amount of incompleteness, or even conflicts, in soil data. This is in consequence of limitations in methods or facilities of sampling and testing compounded with inherent distributional variability of soil at site. A conservative approach to the utilisation of soil data would be to base design on the worst values; this would produce safe but uneconomic solutions. On the other hand, a bolder approach to design may throw up doubts about safety. A satisfactory way of reconciling safety with economy in embankment design is to get the design evaluated in the field by observing the performance of trial embankments. The validity or otherwise of the data base and procedure of design can be ascertained by comparing the predicted behaviour of the trial embankment with the actual observed behaviour as regards vertical and horizontal movements, generation and dissipation of pore-pressures, etc. Such findings of trial embankment observations translated to design decisions and construction programming may mean considerable savings in time and money. For example, laboratory tests tend to overestimate generation of pore pressure and under-estimate dissipation of pore pressures because of inherent limitations of simulating site conditions in laboratory tests. On both these counts, the strength of the soil in-situ gets under estimated and the embankment is computed to be less stable than it actually is. Such distortions in design can only be rectified by systematic observations of an actual embankment in the field. Hence, wherever there is the necessity for improving feasibility and for effecting economy or expediting progress of construction through non-conservative design approach, it is desirable to provide for the validation and refinement of the design by studying the performance of the trial embankment constructed as head of the main embankment. Trial embankments may also be utilised to perform compaction trials, derive unit costs, fix norms for quality control etc. A trial embankment may typically be at least as long as its toe-to-toe width and its location should be representative of the geological conditions in the stretch/stretches under consideration in design. Trial embankments should be equipped with arrangements for observation of settlement and generation/dissipation of pore pressures in all

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8.7 Trial embankments

Embankment design has often to deal with a certain amount of incompleteness, or even conflicts, in soil data. This is in consequence of limitations in methods or facilities of sampling and testing compounded with inherent distributional variability of soil at site. A conservative approach to the utilisation of soil data would be to base design on the worst values; this would produce safe but uneconomic solutions. On the other hand, a bolder approach to design may throw up doubts about safety. A satisfactory way of reconciling safety with economy in embankment design is to get the design evaluated in the field by observing the performance of trial embankments. The validity or otherwise of the data base and procedure of design can be ascertained by comparing the predicted behaviour of the trial embankment with the actual observed behaviour as regards vertical and horizontal movements, generation and dissipation of pore-pressures, etc. Such findings of trial embankment observations translated to design decisions and construction programming may mean considerable savings in time and money. For example, laboratory tests tend to overestimate generation of pore pressure and under-estimate dissipation of pore pressures because of inherent limitations of simulating site conditions in laboratory tests. On both these counts, the strength of the soil in-situ gets under estimated and the embankment is computed to be less stable than it actually is. Such distortions in design can only be rectified by systematic observations of an actual embankment in the field. Hence, wherever there is the necessity for improving feasibility and for effecting economy or expediting progress of construction through non-conservative design approach, it is desirable to provide for the validation and refinement of the design by studying the performance of the trial embankment constructed as head of the main embankment. Trial embankments may also be utilised to perform compaction trials, derive unit costs, fix norms for quality control etc. A trial embankment may typically be at least as long as its toe-to-toe width and its location should be representative of the geological conditions in the stretch/stretches under consideration in design. Trial embankments should be equipped with arrangements for observation of settlement and generation/dissipation of pore pressures in all

cases. In addition, instruments may be desirably incorporated for measure of horizontal ground movement, earth pressure, stress distribution, etc., depending upon the facilities available. Planning of trial embankments, recording of performance observations and interpretation of data collected call for a high degree of expertise and should be handled by specialists. Whether or not to include trial embankment studies as part of the overall design exercise should be decided at an early enough stage, preferably during design assessment at the end of preliminary investigations (vide para 6 above), so that the construction of the trial embankment can be taken up sufficiently in advance without upsetting the time schedule of the main construction.

9. **Selection of fill material**

Both design and construction considerations enter into the selection of fill materials. For a designed embankment, it is necessary that the source of fill materials be identified in advance, so that the characteristics of the chosen fill materials may be taken into account in design. Based on local knowledge and information gained from survey and investigations, one or more borrow areas estimated to yield sufficient quantity of soil required for forming the embankment should be selected. It should be ensured at this stage itself that the eventual exploitation of the selected borrow areas should not be offensive from environmental or public health points of view. Organic soils and highly plastic clays should be avoided as fill materials. Subject to this, economy and availability of adequate quantity of fill material should be the main criteria in selecting borrow areas. Where more than one borrow area involving nearly comparable total costs (including that for lead) are available, the borrow areas yielding comparatively better soils from design and compatability points of view should be selected. Soil characteristics relevant in this context are strength, shrinkage and swelling, initial moisture content in relation to desired placement moisture content, time and effort needed for wetting or drying the soil, susceptibility to compaction by available compaction equipments, etc. In these respects, soils that are friable and having natural moisture contents nearabout O.M.C., are highly advantageous and should be preferred even if involving somewhat longer leads. The extra cost of carriage will be offset by less effort needed for compaction and better service performance. Fill material for the top 0.6 - 1m height of the embankment lying below the pavement and for the shoulders should be specially selected from considerations of pavement design (not within the purview of this Note). For forming underwater fills, sand is to be used as the fill material and as far as possible, the sand should be coarse and graded. Cinder and flyash, being the end products of the burning of coal, are suitable for use as fill material. Being light weight (60 to 70 per cent lighter as compared to soil), these materials are sometimes preferentially used as backfill behind abutments and retaining walls (with a view to reducing earth pressures). They are particularly useful for forming high embankments on poor foundations. The selection of fill materials and related investigations (for list of laboratory tests to be done on fill materials, vide Annexure 'A') should be completed as far as possible by the stage of preliminary soil investigations (vide para 5 earlier).

10. **Control of construction**

10.1 **Programming**

Earthwork should be so organized that the embankment is raised layer by layer over the full width of the designed cross-section (inclusive of berms, if any). In the method of effective staging design (Para 8.2.3), raising of the embankments in stages and minimum waiting periods between the stages are explicitly specified and these should be observed as such. In other cases also, the earthwork activity should be so spread out horizontally that the rate in rise of embankment height is slowest for the section having the maximum height, with due regard, however, to the target date of completion. Embankment construction may be attempted to be completed 6 months to one year ahead of laying the final pavement layer, so that the effect of embankment settlement on riding quality is minimized. For embankment foundations experiencing secondary consolidation (Para 8.6.3), it may be necessary to defer the laying of the permanent pavement till the rate of settlement has come down to say, 25 mm/year or less. The overall programme of construction of embankment and pavement (permanent or temporary, as the case may be) should be so correlated that the approach component is functional by the time the bridge is ready for being opened to traffic. In certain cases, the programme of bridge construction is interlinked (for facility of bridge design or construction) with the programme of approach construction. This should be made explicit and taken account of at the time of finalization of embankment design and the overall construction programming should be derived therefrom.

10.2 **Quality control**

Quality control in the selection and placement of fill material is of special importance in the construction of designed embankments, since these factors determine the in-place strength of the fill material, which must not be inferior to that assumed in design. It is, therefore, necessary to ensure through systematic quality control checks that the type of soil, degree of compaction and range of moisture content at placement correspond to or are better than those assumed in evolving the design. In case these requirements are not satisfied in actual construction the engineers concerned with supervision of construction should get the design of the embankment reviewed to take account of the actual soil type and placement conditions. Any mishap or unexpected embankment behaviour met with during construction (whether due to deficiencies in quality control or otherwise) should also call for immediate design review. It is desirable that the design assumptions regarding the conditions of fill material placement (i.e. density and moisture content of placement) should be verified as regards field feasibility from trial compaction. Guidance regarding type and frequency of quality control tests for embankment construction may be obtained from "Handbook of Quality Control for Construction of Roads and Runways", IRC Special Publication No. 11 (published by Indian Roads Congress, Shahjahan Road, New Delhi).

11. **Monitoring performance of embankments**

11.1 **Necessity**

It has been mentioned that embankment design has routinely to deal with uncertainties (Para 8.7). Keeping a check on the performance of the embankment during and after construction is a convenient way of dealing with investigational and design limitations, particularly so where there might be gaps in the investigations, site conditions are variable or it has been found necessary to operate on a low factor of safety. The basic procedure is to compare design assumptions/expectations regarding ground movements, soil stresses and pore pressure generation/dissipation with those actually recorded at site through instrumentation. Such monitoring of embankment performance encourages a bolder approach to design and confidence in construction management, since impending failures can be detected in advance (e.g. through indications of excessive lateral movement, accelerating settlement, high pore pressures, etc.) and remedied in time through modifications in design or by delaying construction. Besides, data obtained from monitoring performance of embankments under construction provide invaluable guidance for handling future design and construction with economy and speed.

11.2 **Settlement plate**

This is a simple device usually placed at ground level for recording the settlement of the ground under the embankment. A simple design of settlement plate suitable for road embankments and the procedure for recording observations are given in Annexure 'K'. It is recommended that settlement plates should be routinely installed along centre lines of high embankments at 30 to 100m intervals, depending upon the severity or variation of site conditions. In special cases, the designer may specify closer spacing of settlement plates, including settlement plate locations at offsets from the centre line of the embankment. Settlement plates can also be located within the subsoil for separating the contributions to settlement by different strata.

11.3 **Toe pegs**

Toe pegs provide a simple arrangement for recording surface movements, both lateral and vertical, near the toes of embankments. These are very useful observations, since failures of embankments are preceded in many cases by appreciable ground movements near the toe. Procedure for installation of the pegs and recording of observations is given in Annexure 'L'. Toe pegs should be invariably installed where the design is based on incomplete or doubtful investigations, factor of safety provided is low, ground conditions are variable, stage construction is being used or in other cases as specified by the designer.

11.4 **Sophisticated instrumentation**

The practical benefits of study of performance of embankments on weak ground from economic and feasibility consideration has led to the development of a wide range of sophisticated ground instruments making use of modern instrumentation technology over the last few decades. Of these, the following are more common:

- i) Piezometers for recording pore-water pressures within the soil;

- | | | | |
|------|----------------------------------|---|---|
| ii) | Pressure Cells | - | for recording the distribution of stresses within the embankment or in foundation strata; |
| iii) | Inclimeters | - | For measuring horizontal ground movements within the embankment or in foundation strata; |
| iv) | Remote reading settlement gauges | - | For recording settlements at one or more points along the cross-section, hydraulic-cum--electrical principles being used for effecting measurement. |

The selection, installation and use of ground instruments mentioned above (of which there are many makes and types) can be handled by specialists and need not be elaborated here. This type of sophisticated instrumentation is mainly used for monitoring the performance of test embankments (Para 8). However, piezometers are also used in routine control of construction on difficult ground.

11.5 **Evaluation of monitoring data**

Data from settlement plate and toe peg installations should be sent to the designer for evaluation at intervals not exceeding 1 month or whenever there is any abrupt change in the trend of the readings. Data from instrumentation of the type mentioned in para 11.4 above should be recorded under the supervision of the designer and evaluated by him as often as considered necessary.

12. **Agency for soil investigation and design**

12.1 **Agency for investigation**

Reconnaissance and preliminary phases of the investigations should be carried out departmentally as far as possible. Departmental capability should also exist for carrying out detailed soil investigations, at least, on a limited scale. A suggested list of field exploration and testing items that a departmental soil investigation unit can be expected to handle is given in Annexure 'M'. However, it may not be possible for a departmental investigational unit to handle the work at all sites, especially since the quantum of work may vary from year to year. So, reliable and capable firms specialising in soil exploration may be also engaged for carrying out detailed soil investigations. The agreement entered into with such specialist firms should include, inter alia, the special conditions listed in Annexure 'N'. It is preferable, however, that borrow area investigations are carried out departmentally. Departmental investigations should, of course, be carried out by a properly trained and fully equipped unit under the charge of a specialist geo-technical engineer.

12.2 **Agency for design**

Design of embankments (incl. related performance studies) is expected to be mainly carried out departmentally under the charge of a specialist geo-technical engineer. By way of supplementing the department capacity, part of such work can also be entrusted to reliable geo-technical consultants.

12.3 **Funding of investigations**

Funds for soil investigations for National Highways and other centrally financed works, whether carried out departmentally or through specialist firms, can be obtained against estimates showing cost of soil investigations, to be submitted by the concerned State P.W.D. and sanctioned by Roads Wing. Typical list of items for use in framing soil investigation estimate is attached as Annexure 'O'.

13. **Applicability of ISI codes/specifications relating to soil explorations and testing**

Soil exploration and testing work referred to in earlier paragraphs should be carried out in accordance with the applicable ISI Codes/Specifications, an available list of which is enclosed as Annexure 'P'. Since ISI codes/specifications are liable to revision/additions/deletions from time to time, the currently applicable ISI Codes/Specification should be ascertained and made use of. For aspects of work not covered in ISI Codes/Specifications, the criterion of widely accepted current practice in geotechnical engineering should be applicable. For works pertaining to National Highways and other centrally financed road schemes, relevant specifications and guidelines issued by the Ministry of Shipping and Transport (Roads Wing) from time to time will also be applicable.

LIST OF LABORATORY TESTS TO BE CONDUCTED ON FILL MATERIALS TO BE USED FOR FORMING HIGH EMBANKMENTS

1. Obtaining Samples of Fill Materials

One 30 kg. representative sample for every 20,000 cubic metre or less of each type of soil encountered within the likely depth of excavation in the selected borrow areas should be collected. The exact location and depth of the samples should be noted. Corresponding to each 30 kg. sample, one small sample from the selected location (of one kg. weight or so) may be collected in airtight glass jars for the determination of natural moisture content.

2. Laboratory tests to be done

(a) Tests to be done on each sample

- i) Grain size analysis (as per IS 2720 Part IV-1975).
- ii) Natural moisture content (As per IS 2720 Part II -1972)
- iii) LL and PL (As per IS 2720 Part V - 1970)

(N.B. for soils suspected to be organic in nature by virtue of colour, texture, odour etc. LL on fresh soils as well as on Oven-dry specimens may be separately found out).

- iv) Moisture density relationship using light compaction, commonly known as Proctor's test (as per IS 2720 Part VII - 1974).

(b) Strength Tests on Selected Samples

On the basis of tests conducted as per (a) above, the samples may be grouped into categories, each showing the same or very similar soil characteristics. One sample out of each such category may be judiciously selected as the representative one and subjected to the following tests:-

- i) Determination of c & ϕ from unconsolidated undrained (UU) triaxial tests (as per IS 2720 Part XI - 1970) on specimens remoulded to 95% Proctor's density at O.M.C. plus 2%. If the fill material is cohesionless, ϕ may be determined from the direct shear tests (as per IS 2720 Part XIII - 1972) on specimens remoulded to 95% of Proctor's density at O.M.C. For cohesive fill materials selected for use in the embankments likely to remain under prolonged submergence, the specimens in the triaxial Cell may be fully saturated by applying back-pressure (and the degree of saturation checked by verifying if B-factor is close to 1) before applying deviator stress.
- ii) Where the method of stage construction based on effective stress design is under consideration, determination of C , ϕ and A factor from consolidated undrained tests with measurements of pore pressure (CU tests, as per IS 2720 Part XII - 1975) on specimens remoulded to 95% of Proctor density at O.M.C. plus 2% may also be done. If the fill material is cohesionless, this test need not be performed.
- iii) For tests mentioned at (i) and (ii) under (b) above, bulk density, void ratio and moisture contents before and after triaxial tests should be concurrently determined.

Special Remarks

- i) Laboratory tests should be carried out in accordance with applicable I.S.I. Specifications and Codes and under the supervision of a specialist geo-technical Engineer.
- ii) Full laboratory records (of measured values, particle size distribution curves, moisture density plots, stress-strain curves, Mohr Circle plots, etc.) should be available in minimum two sets, one of which should be furnished to Roads Wing.
- iii) The left-overs of samples, after testing, should be carefully preserved till the design of embankments has been finalised and preferably till the construction has been completed.

DERIVING SIDE SLOPE OF EMBANKMENTS WITH THE HELP OF TAYLOR'S CHART

1. **Reference:** Fundamentals of Soil Mechanics,
by D.W. Taylor, 1948 (Asia Publishing House, Bombay), pp.455-462.

2. **Symbols Used**

c	=	cohesion of fill material
ϕ	=	angle of internal friction of fill material
c_d	=	mobilized cohesion of fill material
ϕ_d	=	mobilized angle of internal friction of fill material
v	=	bulk density of fill material
H	=	height of embankment
F_c	=	$\frac{C}{c_d}$ = factor of safety with respect to c
F_ϕ	=	$\frac{\phi}{\phi_d}$ = factor of safety with respect to ϕ
F	=	common factor of safety with respect to c and ϕ both
i	=	slope angle (i.e. angle maintained by the side slope with respect to the horizontal)

3. **Stability Numbers**

This method of embankment design is based on the use of stability number, which is a dimensionless ratio defined as cd/vH . Taylor has brought out charts from which the value of the stability number can be read out, if the values of ϕ_d and i are known. These charts are applicable where the base of the embankment is composed of material as strong as or firmer than the material used in the embankment itself. The charts in their original and directions for their use are given in the reference quoted above and should be consulted in carrying out actual designs. For the common values of slope angle used for road embankments, the following table has been extracted from Taylor's chart:

Side slope (Vertical: horizontal)	i	Value of stability number for θ_d equal to					
		0°	5°	10°	15°	20°	25°
1:1.5	33.7°	.181*	.117	.084	.055	.034	.017
1:2	26.6°	.181*	.105	.068	.040	.018	.003

(* These are the worst values applicable for the case where the material constituting the embankment and the base is of the same type and extends to a considerable depth below the G.L. Lower values of stability numbers are applicable for the case where a ledge i.e. firm stratum may exist at ground level or at some depth below it. For this case and for values of ϕ_d less than 5° , the reference cited above may be seen in original for finding out appropriate stability numbers).

The use of stability numbers for embankment design is shown in the illustrative examples given below. It may be noted in this connection that the values of c and ϕ are to be derived from tests on the fill material. v is derived both from soil test data and from project specification regarding the degree of compaction and moisture content to be attained in the field.

4. **Illustrative Examples**

- 4.1. Example 1
- | | | |
|--------|---|------------|
| H | = | 8m |
| ϕ | = | 15° |
| c | = | 3t/sq.m. |
| v | = | 2t/cu.m. |

It is desired to find out the factor of safety, if the side slope is chosen is 1V:2H.

$$\begin{aligned} \text{Let } F_\phi &= 1.5 \\ \phi_d &= \frac{15^\circ}{1.5} = 10^\circ \\ i &= \tan^{-1} 1/2 = 26.6^\circ \end{aligned}$$

For $\phi_d = 10^\circ$ and $i = 26.6^\circ$, $\frac{cd}{vH} = .068$, from the table given above.

$$\begin{aligned} c_d &= .068 v H \\ &= .068 \times 2 \times 8 = 1.09 \text{ t/m}^2 \\ F_c &= \frac{c}{c_d} = \frac{2}{1.09} = 1.93 \end{aligned}$$

Calculations along the above lines, using different values of F_ϕ , yield F_c as below.

F_ϕ	ϕ_d	c_d	F_c
1	15°	0.64	3.12
1.5	10°	1.09	1.93
3	5°	1.68	1.19

The values of F_ϕ vs. F_c as listed on pre-page are plotted on a graph paper and the points so obtained are joined by a smooth curve, Fig. B.1. A 45° line with respect to the horizontal is drawn to intersect the curve. For the point of intersection.

$$\begin{aligned} F_\phi &= F_c = 1.75 \\ &= F \end{aligned}$$

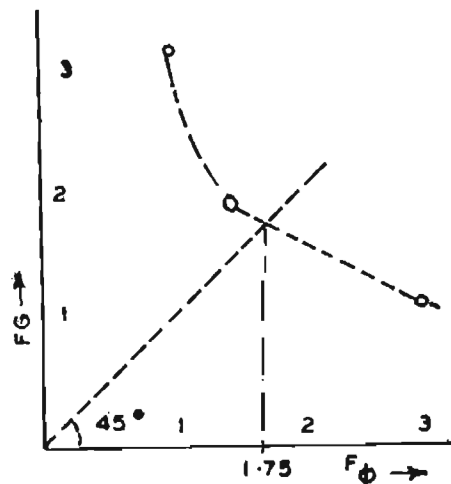


Fig. B.1

So, 1.75 is the overall factor of safety obtainable for the embankment.

4.2. Example 2

$$\begin{aligned} v &= 1.9 \text{ t/m}^3 \\ c &= 3 \text{ t/m}^2 \\ \phi &= 7.5^\circ \\ \text{Side slope} &= 1:1.5 \end{aligned}$$

What maximum height of embankment can be constructed so that the factor of safety is 1.5.

$$\phi_d = \frac{7.5^\circ}{1.5} = 5^\circ$$

$$c_d = \frac{3}{1.5} = 2 \text{ t/m}^2$$

$$i = \tan^{-1} \frac{1}{1.5} = 33.7^\circ$$

For $\phi = 5^\circ$ and $i = 33.7^\circ$, $\frac{c_d}{vH} = 0.117$, from
the table given above

$$H = \frac{c_d}{0.117} = \frac{2}{0.117 \times 1.9} = 9 \text{ m}$$

4.3. Example 3

$$\begin{aligned} H &= 7.5 \text{ m} \\ v &= 2 \text{ t/m}^3 \\ \phi &= 15^\circ \\ c &= 1.5 \text{ t/m}^2 \end{aligned}$$

What should be the side slope designed to give an overall factor of safety, $F=2$

$$\phi_d = \frac{15^\circ}{1.5} = 10^\circ, c_d = \frac{1.5}{1.5} = 1.0 \text{ t/m}^2$$

$$\text{Stability number} = \frac{c_d}{vH} = \frac{1.0}{2 \times 7.5} = 0.67$$

From the table of stability numbers given above, the required side slope is 1:2, since this gives a stability number of 0.068 (very close to 0.067) for $\phi_d = 10^\circ$.

5. Special remarks

The method of design of embankment by using Taylor's chart is not valid when the material constituting the base of the embankment may be weaker than the material of the embankment itself. The method also does not allow for the action of seepage and pore pressures. For cohesionless soils ($c = 0$), the stability number is always zero. The slope angle (i) of an embankment made-up of cohesionless soils (and not subject to seepage forces) may be derived as follows:

$$i \leq \phi_d$$

where

$$\phi_d = \frac{\phi}{F}$$

and $F =$ chosen factor of safety

For example, for a cohesionless silt with $\phi = 26^\circ$ as fill material and $F = 1.2$, the slope angle will be $26^\circ/1.2 = 21.8^\circ$. This is equivalent to a side slope of 1V:2.5H and holds good for any height of embankment.

BORE LOG AND FIELD TEST DATA SHEET

General Borehole Information

(i) Method of boring	(vi) Name of Project	(xii) Terrain
(ii) Dia of borehole	(vii) Agency conducting boring	(xiii) Land use
(iii) Type, length, I.D. and C.D. of sampler*	(viii) Agency supervising boring	(xiv) H.F.L.
(iv) Types of field tests done @	(ix) Borehole No.	(xv) Special remarks if any.
(v) Date & time of boring/	(x) Location ——— Km.	
(a) Started on	(xi) RL's	
(b) Completed on	(a) Ground level	
	(b) Upto which boring done	
	(c) Water table (i) Initial	
	(ii) Final	
	within borehole	

R L.	Depth below G.L. (shown to scale)	Field identification		Date from field tests			Details of samples				Misc. borehole information	Remarks	
		Description of strata	Pictorial Representation	RL	'N' value from SPT.	Field vane shear	Other test data, if any	Sample No.	Type of sample (Undis- turbed or disturbed)	Sample R.L.'s top & bottom and sample length (mts.)			
						kg/m ²							
1	2	3	4	5	6	7	8	9	10	11	12	13	14

* This information may be preferably supplemented with sketches showing details of samples used.

@ Field tests may include S.P.T. field vane shear test, static/dynamic cone penetration test, field permeability test, etc. Of these S.P.T. and field vane shear test are usually done as a matter of routine.

Annexure C (contd.)

** Details like encountering gas, artesian conditions, loss of water in borehole, loss of sample, premature termination of boring (if any) and reasons thereof, etc. may be reported alongwith the corresponding depth of borehole to which the information relates.

Notes

1. Site plan showing borehole No. and locations may be attached.
2. Long-sections along the C.L. of the road showing road level, G.L.s, borehole locations and pictorial profile of strata at the borehole locations may be supplied.
3. For description and pictorial representation of soil strata, I.S. 1498-1970 may be followed.
4. The sampling and field tests are to be done according to relevant I.S. Codes (vide Annexure P).

Signature of boring-in-Charge
(for agency conducting boring)

Signature of Officer-in-Charge
(for agency supervising boring)

ANNEXURE 'D'

LIST OF LABORATORY TESTS TO BE CONDUCTED ON BOREHOLE SAMPLES**1. Test on Undisturbed Samples**

Undisturbed samples are considered here to be those collected in 100 mm dia thin-walled tubes conforming to IS 2132-1972. These should be tested in the laboratory for the determination of following soil properties:

- i) Grain size analysis (as per IS 2720 Part IV - 1975)
 - ii) Natural moisture content (as per IS 2720 Part II - 1972)
/
 - iii) LL and PL (as per IS 2720 Part V - 1970)
- N.B. For soils suspected to be organic in nature by virtue of colour, odour texture etc., LL on fresh as well as on oven-dry specimens may be separately found out).
- iv) C & ϕ from unconsolidated, undrained (UU) triaxial tests (as per IS 2720 Part XI - 1972).
 - v) Where the method of stage construction based on effective stress design is under consideration, consolidated undrained triaxial tests with measurement of pore-pressure (cu tests, as per IS 2720 Part XII - 1975) may be carried out for finding C , ϕ and A-factor.
 - vi) For cohesive samples not very sensitive or not very soft, the unconfined strength, viz. q_u may be optionally determined (IS 2720 Part X - 1973).
 - vii) C_c and C_v from consolidation tests (according to IS 2720 Part XV - 1965).
 - viii) For tests mentioned in (iv) and (v) above, bulk density, void ratio and moisture contents before and after triaxial tests should be concurrently determined.

2. Test on Disturbed Samples

Samples recovered from the S.P.T. spoon should be retained in glass jars sealed air-tight. These samples may be treated as disturbed samples and should be tested in the laboratory for the determination of following soil properties:

- i) Grain size analysis (as per IS 2720 Part IV - 1975).
 - ii) Natural Moisture Content (as per IS 2720 Part II - 1972).
 - iii) LL & PL (as per IS 2720 Part V - 1970)
- (N.B. for soils suspected to be organic in nature by virtue of colour, odour, texture etc., LL on fresh soils as well as on oven-dry specimens may be separately found out).
- iv) For cohesionless type of disturbed samples ϕ value may be determined from direct shear test (as per IS 2720 Part XIII - 1972) on representative samples moulded to estimated field density at natural field moisture content.

3. Special Remarks

- i) Laboratory tests should be carried out in accordance with the prescribed ISI Specifications/Codes and under supervision of a specialist geo-technical engineer.
- ii) Full laboratory records (of measured values, particles size distribution curves, stress-strain curves, Mohr circle plots e-log P Curves, e-log T curve, etc.) should be available in minimum 2 sets - one of which should be furnished to Roads Wing.
- iii) As regards tests mentioned in (iv) and (v) under Para 3.1. above, the test specimens should be got fully saturated in the triaxial Cell by applying back pressure (and the degree of saturation checked by verifying if the factor is close to 1) before applying deviator stress, if the undisturbed samples have been collected above the water table or if there is any doubt otherwise about the state of sample saturation.

ANNEXURE 'E'

RESULTS OF LABORATORY TESTS ON BOREHOLE SAMPLES

Name of Project _____ Dates of sampling _____

Location _____ Dates of testing _____

Agency for testing _____

Bore-hole No.	R.L.	Depth below G.L.	Field identification		N from SPT	Su from van shear test kg/cm ²	Sample No. & type	Sample R.L.'s (top and bottom)	Grain size analysis			
			Description of strata	Pictorial representation					Gravel >4.75mm	Sand 4.75mm to .075mm	Silt .075mm to .002mm	Clay <.002mm
	m								p.c.	p.c.	p.c.	p.c.
1	2	3	4	5	6	7	8	9	10	11	12	13

[illegible]

ANNEXURE-E (Contd.)

A-factor from CU test	Consolidation test results		Other test data, if any (Specify)	Remarks
	Maximum pore pressure P_{max} kg/sq cm.	Compression Index C_c @ Coefficient of consolidation C_v cm ² /sec.		

- These data should be reported only for borehole samples collected above the water level or if there is any doubt otherwise about the state of saturation of the sample.
- @ These values may be reported for different ranges of consolidation pressures.
- N.B.
1. Relevant laboratory records of measured values, particle size distribution curves, stress strain curves, Mohr circle plots, e-log P curves, e-log T curves etc. should accompany this compilation of laboratory test results.
 2. A plan showing location of boreholes should accompany.

RESULTS OF LABORATORY TESTS ON FILL MATERIALS

Name and location of project _____ Agency by whom samples collected _____

Borrow area location(s)⁽¹⁾ _____ Agency by whom samples tested _____

Date(s) when sample(s) collected _____ Remarks (if any) _____

Borrow area identification				Sample identification			Natural moisture content
Borrow area location ⁽¹⁾	Approx. quantity of fill material available cu.m	Lead from project location ⁽¹⁾ km	Terrain and land use of borrow area	Sample No.	Location within borrow area ⁽²⁾	Sampling depth m	
1	2	3	4	5	6	7	8

Classification						Data from compaction test according to IS 2720, Part VII-1974 ⁽³⁾	
P.C. passing			L.L. p.c.	P.I. p.c.	Classification according to IS 1498-1970		
4.75 sieve	2mm sieve	425 micron sieve	75 micron sieve			Maximum dry density gnu/cc	O.M.C. p.c.
9	10	11	12	13	14	15	16
							17

Annexure F (Contd.)

Data from shear tests							Data from other tests, if done			Remarks
Sample preparation			Type of shear test done ⁽⁵⁾	Cohesion (C or C' as applicable) ⁽⁶⁾ kg/cm ²	Angle of internal friction (ϕ or ϕ' as applicable) ⁽⁵⁾	B. factor and A. factor (if measured)	Type of test ⁽⁷⁾	Results of test		
Dry density of remoulding	Moisture content of remoulding	Whether back pressure saturation applied or not ⁽⁴⁾								
18	19	20	21	22	23	24	25	26	27	

(1) May be shown on an index map to scale 1:50,000.

(2) May be shown on detailed map to scale 1:10,000.

(3) Where heavier compaction is called for and is achievable, compaction test may be done according to IS 2720 Part VIII - 1974.

(4) Saturation by applying back pressure in the triaxial cell may be carried out for samples of soil unsaturated when compacted, but likely to get submerged during construction or service. Saturation should be checked by determining B-factor, which should be 0.90 or above at the state of saturation.

(5) Type of test should be direct shear test for cohesionless samples and triaxial shear test for cohesive samples. Triaxial test may again be of UU, CU, CU or CD types according to design objective in view.

(6) Report C and ϕ for UU or CU tests and C', ϕ' for CU or CD tests.

(7) This may be test for consolidation, organic content, sulphate content, soluble salt content, pH, etc. if needed to be carried out, depending on type of soil, environmental conditions, design objectives, etc.

Annexure F (Contd.)

Data from shear tests							Data from other tests, if done		Remarks
Sample preparation			Type of shear test done ⁽⁵⁾	Cohesion (C or C' as applicable) ⁽⁶⁾ kg/cm ²	Angle of internal friction (ϕ or ϕ' as applicable) ⁽⁵⁾	B. factor and A. factor (if measured)	Type of test ⁽⁷⁾	Results of test	
Dry density of remoulding	Moisture content of remoulding	Whether back pressure saturation applied or not ⁽⁴⁾							
18	19	20	21	22	23	24	25	26	27

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(6) Report C and ϕ for UU or CU tests and C', ϕ' for CU or CD tests.

(7) This may be test for consolidation, organic content, sulphate content, soluble salt content, pH, etc. if needed to be carried out, depending on type of soil, environmental conditions, design objectives, etc.

PART 'A'**BRIEF GUIDELINES REGARDING PROCEDURE OF BORING, SAMPLING AND FIELD TESTS****1. Methods of boring and sampling**

The techniques and precautions commonly involved in boring and sampling are outlined in Part 'B' of this Annexure. Reference may also be made in this connection to paras 3 to 7 and Appendices 'A' to 'D' of the 'Indian Standard Code of Practice for Site Investigation for Foundations' (IS 1892-1978).

2. Collection of undisturbed samples

The first undisturbed sample in a borehole may be collected at a depth of 0.5 m to 1.5 m below the G.L. Then onwards, undisturbed samples should be collected for every change of stratum, subject to the condition that in thicker strata, the depth intervals between sampling levels should not exceed 2 m for the first 6 m below ground level and 3m thereafter. Thin-walled tube samplers of 100 mm internal diameter conforming to IS:2131-1973 should be used for collection of undisturbed samples. The length of the sampling tube should be 0.6 m or more. Attempts of collecting undisturbed samples not found successful (due to cohesionlessness, looseness or hardness of strata, etc.) should also be recorded. Each type of soil met with within the borehole should be identified and classified in the field according to IS 1498-1970 'Classification and Identification of Soils for General Engineering Purposes'. The position of water table encountered within the borehole (including any variation in water table or loss of wash water encountered during boring) should be carefully observed and recorded. Collection of undisturbed samples at depth intervals closer than the ones mentioned above, including continuous sampling, may sometimes have to be undertaken for meeting special requirements, if so provided for in the soil exploration programme.

3. Field Tests

Every collection of undisturbed sample (including unsuccessful attempts thereof) should normally be followed by both field vane shear test (according to IS:4334-1978) and standard penetration test (according to IS:2131-1963) in that order. However, in cohesive strata of less than 2 m thickness, undisturbed sampling may be followed by field vane shear test only and the SPT can be omitted. But, if collection of undisturbed sample has not been successful (due to cohesionlessness, looseness or hardness of strata, etc.) both field vane shear test and standard penetration test may be carried out at 1.5 m depth intervals. Attempts of conducting field tests not found successful (e.g. due to hardness of strata) should also be recorded. Wherever practicable static cone penetrometer tests (according to IS:4968 Part III - 1977) may be carried out, preferably before undertaking boring for collection of undisturbed samples, so that the locations of the boreholes can be judiciously decided upon. This type of field test is particularly indicated if the stratification is highly variable, or if the ground conditions are such that undisturbed samples cannot be reliably collected or collected at all. Where undisturbed sampling may have to be carried out at depth intervals closer than 2 m, it may be necessary to establish separate borehole (adjacent to one used for collecting undisturbed samples) for conducting field tests like S.P.T. and vane shear test.

4. Collection of disturbed samples

The samples entering within the S.P.T. spoon in course of carrying out the standard penetration tests should be recovered and carefully preserved at their initial moisture contents within air-tight glass jars, to be treated as disturbed samples.

5. Bore logs

Bore logs, including results of field tests, should be compiled as soon as the field soil exploration has been done. A form for compilation of bore log and results of field test has been suggested in Annexure 'C'. Descriptive information about subsoil conditions observed during boring operations (e.g. colour of soil consistency of strata, position of water table, artesian conditions, obstructions in boring, presence of concretions/organic matter/gas, etc.) usually prove to be of vital assistance in subsequent interpretation of test data and may even influence design decisions. So, such

descriptive information about subsoil conditions should be meticulously observed and incorporated in the bore log under specific column headings or in the 'Remarks' column, as appropriate. One set of the bore logs may be sent to the Roads Wing for preliminary assessment of sub-soil conditions as early as possible.

6. **Programme of boring and field tests**

A programme of boring and field tests should be drawn up in advance and intimated to all concerned. Any changes called for in the scope or quantum of boring and testing from what might have been envisaged earlier should be brought to the notice of the concerned authorities before implementation.

7. **Supervision of boring and field tests**

No part of boring and field tests should be carried out except in the presence of a departmental officer of the rank of Assistant Engineer or better. A geotechnical specialist should be associated with the overall technical supervision of boring and field tests. The bore logs and results of field tests should be continually evaluated by the geotechnical specialist and the results of such evaluation at any stage should be made use of in controlling or modifying, if necessary, the remaining stages of the boring and field test operations.

PART 'B'**PROCEDURE FOR BORING FOR SUBSOIL INVESTIGATIONS FOR HIGH EMBANKMENTS AND PRECAUTIONS TO BE OBSERVED IN COLLECTING UNDISTURBED SAMPLES****1. Necessity for obtaining undisturbed samples**

For analysing the stability of embankments and estimating settlement, it is necessary that the engineering characteristics of the soil are determined accurately. For this purpose, it is essential that samples of the soil in undisturbed condition are obtained for laboratory testing. Strength tests, such as triaxial tests, and tests for consolidation characteristics are very sensitive to the state in which the samples have been obtained. No efforts should, therefore, be spared for obtaining the samples in fairly intact or even virtually undisturbed conditions.

2. Access to sampling depth

Subsoil sampling has to be carried out at varying depths below the G.L. For shallow sampling depths, usually not exceeding 3 m, it may be practicable to obtain samples from trial pits. For getting access to deeper sampling levels, a borehole becomes necessary. Boreholes may be of different diameters, cased or uncased or filled with drilling mud and advanced by a variety of drilling equipments, as determined by equipments available, sampling requirements, site conditions, etc.

3. Making boreholes**3.1. Method of boring**

Some commonly adopted methods of boring are:

- i) Auger boring,
- ii) Wash boring,
- iii) Rotary drilling,
- iv) Open drive tube casing with flap valve bailer.

3.2. Auger boring

Auger holes without casing pipe can be made upto about 3 m depth in water bearing strata and upto 6 m or a little more in dry strata. For greater depths the hole is likely to get damaged by the soil caving in. Then it becomes necessary to use a casing pipe for lining the hole. The casing pipe is driven in advance and the auger worked to clear the hole. For making holes deeper than about 10 m, it may be found necessary to use a power driven auger. Augers are difficult to use below water level, but they are quite useful in obtaining a clean dry hole above the water table.

3.3. Wash boring

This method involves an outer casing pipe for lining the hole and an inner wash pipe for delivering water to the bottom of the hole. Using an auger, a hole about 3 m deep below G.L. is initially made and into this is inserted the casing pipe. The wash pipe is then inserted into the casing, with its end containing a chopping bit with holes in it for water jets. Water is forced under pressure in the wash pipe and the chopping bit is agitated and rotated, causing the soil lying below it to be disturbed and churned. The slurry containing the loosened bits of earth flows up into the annular space between the casing pipe and wash pipe and is collected at the top. When undisturbed samples are required to be collected, the washing operation is suspended and the special attachment for collecting undisturbed samples is lowered into the borehole.

3.4. Rotary drilling

In this method, a high speed revolving cutter is attached to the lower end of an assembly of jointed drill rods. The rotation of the drilling rod causes the cutting bits to dig into the soil. As in the wash boring method, water under pressure is forced down the hollow drill rod, which then churns up the loosened earth. The slurry flows up through the annular space between the drilling rod and the casing pipe. In this method of drilling, cores can be obtained by replacing the rotary bit with a coring tool.

3.5. Open drive tube with flap valve bailer

In this method, the casing pipe is driven in the usual manner as described in para 3.3., but the soil from the bottom of the hole is removed by dropping a bailer with a flap valve at its lower end. The flap valve opens when it gets pushed down into soil, which then fills up the space inside the bailer. The flap valve remains closed while the bailer is lifted up. This procedure is useful for loose or soft soils.

4. Precautions to be observed in driving the casing

4.1. The casing pipe is essential where it is apprehended that the hole might cave in. Strata which are loose, soft or contain cavities should be dealt with by driving a casing pipe.

4.2. Wherever casing is used, it shall not be driven below the sample elevation. When the casing is extended to sample depth, all soil must be cleaned out at least upto the casing tip and preferably about 100 mm below the tip.

4.3. In cohesionless soils in particular, utmost care should be exercised in the advancement of the casing pipe. The pipe should be advanced very gently, so that the soil is least disturbed.

4.4. The driving of the casing pipe should be done in stages not exceeding 1.5 m between cleanouts.

4.5. The weight used for driving depends upon the type of strata to be driven through and normally ranges between 100 to 175 kg.

5. Use of drilling fluid

5.1. As an alternative to casing pipe for providing hole support, a mixture of water and bentonite clay is used as a drilling fluid. This material forms a layer of cohesive substance around the borehole wall and prevents caving in of the soil. The bentonite - water mixture should be sufficiently viscous so as to prevent the penetration of the bentonite clay particles into the soil sample. For this purpose, the specific gravity of the drilling fluid may be about 1.09 to 1.15.

5.2. The use of drilling fluid is not suitable where it is required to obtain information on the water table and the permeability characteristics of soil strata.

6. Sampling methods

6.1. Periodic sampling procedure

In the periodic sampling procedure commonly followed, the boring operation is suspended at periodic intervals and the borehole is cleaned upto the desired sampling level. Then a special attachment for undisturbed sampling is lowered into the borehole and the sampling is done. Depth intervals between successive samples should be as recommended in para 2, part 'A' of this Annexure. The two main methods for obtaining undisturbed samples are:

- i) Thin-walled tube sampler,
- ii) Piston sampler

6.2. Thin-walled samplers

- Thin walled seamless tubes of 40 mm to 125 mm internal dia. made of steel, brass or aluminium or any other suitable metal are used in this process for collecting the undisturbed samples. From the point of view of obtaining adequate number of specimens for strength tests, 100 mm dia. of sample tube is required and should be adopted unless otherwise

specified. Since the walls of the tube are of thin section, the degree of disturbance in collecting the samples is kept to a minimum. The length of the tube should be about 0.6 m or more generally. Indian Standard Code of Practice for Thin-Walled Tube Sampling of Soils (IS:2132-1972) contains detailed guidance about this method of sampling. For collecting a sample, the tube is forced into the soil in one continuous operation, whereupon the soil enters the full depth of the tube. The sampling tube should be pushed hydraulically or by using jacks and not driven by falling weights or hammers.—Thin wall tube sampler is suitable for all soils having some cohesion, unless they are too hard, cemented or gravelly for sampler penetration. It may not be successful in soils which are too soft or loose so that the tube cannot hold them.

6.3. **Piston sampler**

An improvement over the thin walled sampler is the piston sampler in which a piston is operated through a piston rod passing through the central hole of the drilling rod. The piston blocks the lower end of the sampling tube during its descent into the borehole, so that no slurry may enter the tube. With the piston resting on the bottom of the hole, the tube slides past the piston while it penetrates into the soil so that at the end of the sampling process, the piston is blocking the upper end of the tube. This helps create a suction while the sampling tube is withdrawn and results in better sample retention. This method of sampling is particularly suited for soft or loose soils. An Indian Standard 'Code of Practice for Sampling of Soils by Thin Wall Sampler with Stationary Piston' is under preparation (as in November, 1979).

7. **Essential requirements for sampling devices**

7.1. The thin-walled tube should be smooth and truly round, without bumps, dents or scratches and shall be clean and free from dirt and rust. It may be made out of seamless or welded tubes. In the latter case, the welds should not project at the seam.

7.2. The cutting edge of the sampler should be carefully machined and have sharp edge with an outside taper not exceeding 10° . Blunt cutting edge should not be permitted.

7.3. In thin-walled sampling tubes, the inside diameter above the cutting edge is kept slightly more than the inside diameter of the cutting edge, resulting in an inside clearance to facilitate entrance of the sample. The inside clearance ratio should be between 1% to 3%. Smaller clearances are desirable for sandy soils and clearances upto 3% are required for good recovery in expansive clayey soils. The clearance ratio is defined as

$$\frac{D_s - D_e}{D_e} \times 100$$

Where, D_s = internal dia. of the tube above the cutting edge, and
 D_e = internal dia. of the cutting edge.

It is desirable that each drilling assembly should include tubes of varying clearance ratios so that a tube with proper clearance is available for each of the soil types encountered.

7.4. The area ratio of sampler, defined as annular cross-sectional area of sampling tube divided by inside area of sampler, should be less than 20 per cent.

7.5. A ball check valve is provided in the sampler head to check the entry of drilling mud or water during withdrawal and to assist in creating a partial vacuum above the soil, which aids in retaining the soil core. In order to ensure its intended action, the ball should be thoroughly cleaned before and after the sampling operation.

8. **Precautions to be observed during the cleaning of the hole**

8.1. Before sampling is done, it is necessary to clean the hole upto the sampling elevation, so that all loose soils are removed. Suitable tools for this purpose may be used for ensuring that the loose soil particles do not get mixed with the samples to be obtained.

8.2. When a casing pipe is used, the hole should be cleaned out to its bottom or a little lower. A cleanout auger may be used to clean the bottom of the hole.

8.3. Cleaning the hole with open-end drill rods or sampling spoon should be avoided.

8.4. One of the usual methods of cleaning the borehole is to resort to jetting of water through the drilling bits. Downward or sideward jetting should not be used below the casing pipe. Upward discharging type bits should be used.

8.5. Bailer fitted with flap valve should not be used within 0.3 m of the intended top of the sample.

8.6. Sampling should be done as soon as possible after the cleaning of the hole. Leaving the cleaned-out hole overnight and collecting the sample the next day should not be done. It is good practice to attempt cleaning of the hole only if it is possible to take out the sample immediately thereafter.

8.7. If the sampling is to be done above the water table, the borehole should be maintained dry.

8.8. If the sampling is to be done below the water table, the borehole should be maintained full of water or drilling fluid upto a little above the water table.

9. **Precautions to be observed during sampling**

9.1. After the borehole is cleaned out, the sampling tube is brought to rest on the bottom of the hole and is hydraulically pushed or by jacking into the soil by a continuous and fairly rapid motion, without twisting or causing any impact to the soil being sampled. The tube must not be pushed beyond the effective length provided for the sample so as to ensure that the sample does not get packed into the tube. Actually, the penetration of the tube into the soil should stop a little short of its full length, so as to leave out 75 mm length at the top end of the tube for accommodating soil cuttings, loose mud, etc.

9.2. After the sampler is pushed to the designated depth, it may be left as it is for atleast 10 minutes. This aids sample recovery, particularly in sensitive clay. Thereafter, the tube should be given atleast two full turns to shear the sample off at its bottom. The sample withdrawal should be done slowly, by giving an upward pull on the drill rod. Sudden acceleration, shock or vibrations should be strictly avoided.

9.3. For good quality sampling, the 'recovery ratio' (the length of undisturbed sample recovered divided by the length of sampling push) should be 95% or better. Every care should be taken to ensure that the recovery ratio is kept as high as possible.

9.4. The sampler tube after withdrawal should not be dropped on the ground and should be handled very carefully so as not to disturb the soil samples within.

9.5. The time required for penetration of the sampler and the pressures applied would give a good indication of the nature of the strata and these details should be recorded.

10. **Precautions to be observed in preparing the sample for shipment**

10.1. Once the sample is retrieved from the borehole, the length of the sample in the tube should be measured and recorded. The length of penetration should also be recorded and the recovery ratio determined.

10.2. The disturbed material towards the upper end of the tube should be completely removed. The length and type of the material so removed should be noted.

10.3. The ends of the tube should be reamed to a distance of at least 25 mm and impervious discs, slightly smaller than the bore of the tube, may be inserted. Thereafter both the ends should be cleaned and waxed. The wax should not be heated for more than a few degrees above its melting temperature. The thickness of wax seal may be about 2 cm at the lower end and 3 cm at the upper end of the tube (or more). After waxing, the ends should be fitted with snugly fitting metal caps to prevent breakage of the seals during transit and handling.

10.4. For proper identification of the samples, details such as the job designation, boring number, sample number, sampling depth, description of the soil, date of sampling, measured recovery of the undisturbed soil, etc. should be written on a piece of paper, to be pasted on the outside of the sample tube. Duplicate copies of these records should be preserved separately. Job designation, boring number and sample number should also be written with water proof paint on the outside of the tube.

10.5. The sample tubes should be packed with saw dust in sturdy boxes; not more than six tubes may be packed in one box. Care should be taken to protect the samples from vibrations or disturbances during transit. Samples should be protected from the sun and stored in a cool place.

11. **Recording of water level within the borehole**

Recording of water level within the borehole during the various stages of boring is an important operation, both as a matter of record (vide items (xv) to (xviii) under Para 12 below) and in consideration of its effect on the procedure of boring and sampling. Water level within a borehole may not be visible to the eye and in such circumstances, its accurate determination requires great care. Hence, use of electrical or electronic water level indicators, in which a sensing probe is suspended from a cable wound around a spool, for determining water level within a borehole is preferable.

12. **Information to be recorded in the field during boring operation**

Every boring operation (together with the associated operations of sampling and field tests) constitutes a unique sequence of events, each aspect of which is indicative of the subsoil conditions in some way or other. Therefore, every significant detail of the boring operation should be meticulously observed and recorded as the boring proceeds. A list of items for which boreholewise information is commonly recorded in the field is given below:

- i) Borehole location
- ii) R.L. of ground at borehole location
- iii) Terrain and land use
- iv) Procedure and equipments used for boring, sampling and field tests
- v) If casing/drilling fluid used and from what R.L.
- vi) Diameter of borehole.
- vii)
 - a) Date and time of commencement of boring.
 - b) Daily record of progress of boring (depth bored) and reasons for non-uniform progress suspension of boring (if any).
 - c) Date and time of termination of boring.
- viii) R.L. at which boring terminated (if premature termination, state reasons thereof).
- ix) R.L. at which changes in strata encountered.
- x) Descriptions of soil strata encountered (indicating colour, texture, consistency, odour, presence (if any) of gas/organic matter/concretions/seams/fissures, etc.) and visual classification of soil according to IS:1498-1970.
- xi) R.L.'s at which sampling done, type of sample and sample identification No. (if sampling unsuccessful, state reason).
- xii) Time required for penetration of sampler and pressures applied.
- xiii) Recovery ratio of undisturbed samples.
- xiv) Records of field tests, indicating type of field test and R.L. at which done (if field test omitted or abandoned after starting, state reasons thereof).
- xv) R.L. at which water table met.
- xvi) R.L.'s at which wash water was lost/artesian conditions met (if any).
- xvii) Water level in the borehole before and after insertion of casing.
- xviii) Water level in the borehole:
 - a) immediately after casing is pulled out;
 - b) 30 minutes after the casing is pulled out;
 - c) 24 hours after the casing is pulled out.
- xix) Daily record of equipments available or out-of-order, skilled and unskilled manpower employed, hours of working, weather conditions etc.
- xx) Miscellaneous information (if any).
- xxi) Name and designation of the borehole supervisor representing the agency carrying out boring.
- xxii) Name and designation of the borehole supervision representing the client organisation.

TYPICAL WORKED OUT EXAMPLE OF STABILITY ANALYSIS BY THE ORDINARY METHOD OF SLICES AND BY SLIDING BLOCK METHOD

1. Design problem statement

1.1 Figure H.1 shows the tentative cross-section of a highway embankment (derived from functional considerations without taking account of stability) along with subsoil stratifications and relevant soil properties ascertained from appropriate soil investigations. It is required to check the adequacy or otherwise of the tentative embankment cross-section from stability analysis for an end-of-construction factor of safety not less than 1.3 in respect of failure involving foundation strata and if the cross-section is found to be not adequate, to re-design it after providing flatter side slopes and/or stabilising berms, as found necessary from stability analysis.

1.2 The following are certain relevant items of given information and their implications as concerning stability analysis :

Given information

- (i) The site is flooded with H.F.L. rising to 4m above G.L. The flood subsides gradually, over a period of a few days.

Implication in stability analysis

The fill material to be used (silty sand) is fairly permeable. For this type of fill material and for gradual subsidence of flood draw down is not a critical design consideration. The lowest factor of safety is likely to be obtained when the water level has risen upto the G.L. For this condition, the full bulk unit weight of the embankment material lying above the G.L. and the submerged unit weight of the subsoil strata lying below the G.L. may be considered in stability analysis.

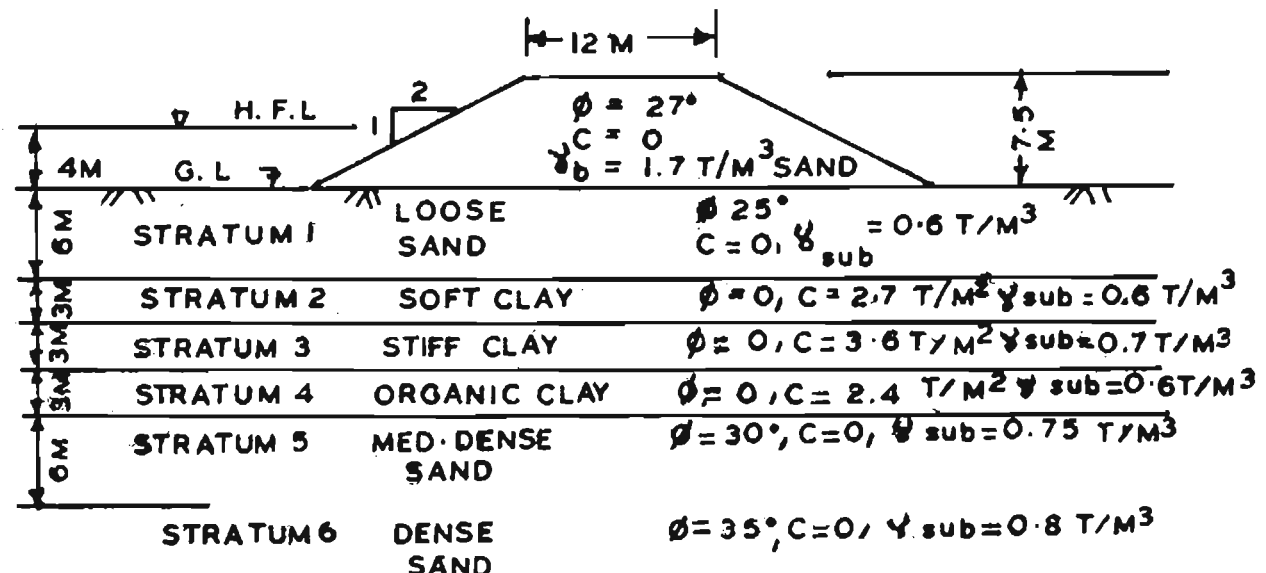


Fig. H.1

- (ii) The construction of the embankment will be completed within a single working season.

In respect of the clayey strata underlying the embankment (Fig. H.1), strength parameter derived from undrained shear tests may be used and 'total stress' analysis carried out.

- (iii) It has been ascertained from separate settlement analysis that the foundation under the embankment will settle by about 0.5 m during and after construction.

The final embankment height with respect to the depressed ground level will be 7.5 m (Fig. H.1) + 0.5 m = 8 m which may be taken as the design height.

2. Preliminary considerations

2.1 For the cohesionless fill material to be used for forming the embankment, $\tan \alpha \propto (V/H$ in Fig. H.2) should not exceed $1/F \cdot \tan \phi$, where F is the chosen factor of safety. Restricting our consideration for the movement safety, the possibility of sloughing of the side slopes lying above the ground level, the factor of safety against this mode of failure for a cohesionless fill material may be relatively low. Assuming $F=1.2$,

$$\begin{aligned} \frac{1}{F} \tan \phi &= \frac{1}{1.2} \tan 27^\circ \\ &= 0.42 \\ \text{Therefore, } \frac{V}{H} &\nless 0.42 \end{aligned}$$

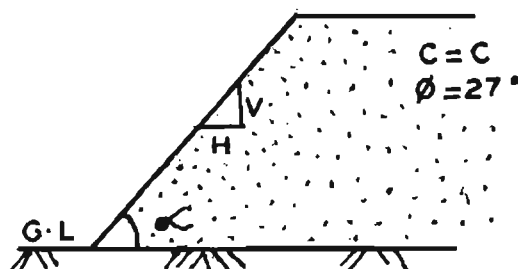


Fig. H.2

But according to the tentative cross-section shown in Fig. H-1, $V/H = 0.5$, which is greater than 0.42 and hence, the side slope requires to be flattened from the point of view of safety against sloughing above ground level. Adopt 1 v : 2.5 H side slopes, i.e. $V/H = 0.4$. This is less than 0.42 and hence adequate.

2.2 Keeping in view this consideration and the one mentioned in (ii) under Para 1 above, the tentative embankment cross-section is modified as shown in Fig. H-3.

2.3 It may now be checked whether the cross-section as per Fig. H.3 is adequate in itself to provide a factor of safety not less than 1.3 against failure involving embankment foundation, or addition of stabilizing berms needed for this purpose. Inspection of the subsoil profile under the embankment (Fig. H.1) indicates that the clay strata at 3-6 m and 9-12 m depths below G.L. have fairly low strengths, which may well prove critical in sliding block type of failure mechanism. Therefore, an adequate trial cross-section may firstly be derived from sliding block analysis (N.B. It may be noted here for general information that for simplifying calculations, stability analysis is carried out for a unit length of embankment in the direction perpendicular to the orientation of the design cross section. This means that the dimension perpendicular to the cross-section being equal to unity, need not be explicitly entered into the calculations).

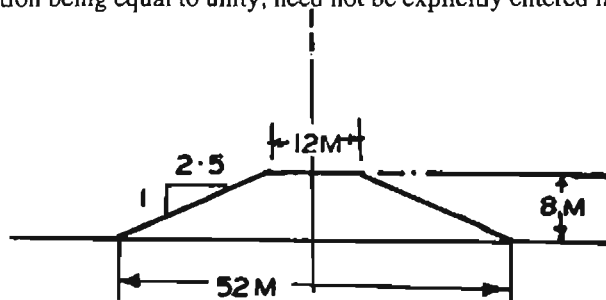


Fig. H.3

3. Sliding block analysis

3.1. In this type of analysis, the basic assumption is that the probable failure surface consists of a combination of planar segments. The 'base' of the failure surface polygon (as seen in the cross-section) is made to pass through a weak stratum along the direction of its stratification and the strata lying above the weak stratum are intersected by the sides of the polygon at angles of $45^\circ + \phi/2$ on the roadway side and $45^\circ - \phi/2$ on the toe side, with respect to the horizontal. The procedures of analysis followed vary to a certain extent in respect of the details and the one adopted here is described in "Design Manual: Soil Mechanics, Foundations and Earth Structures" (Publication No. NAVFAC DN-7 brought out by Naval Facilities Engineering Command, U.S. Navy, which may be seen.

3.2. Analysis I

Considering the failure surface to be passing through the weak clay stratum between 6 to 9 m depth below G.L., the essential steps in analysis are as below :

- i) Draw trial failure surface ABCDEFG to scale, Fig. H-4 (Actually, a graph paper may be used for this purpose and the scale chosen may be $10^\circ \tan = 2 \text{ m}$ or 5 m).

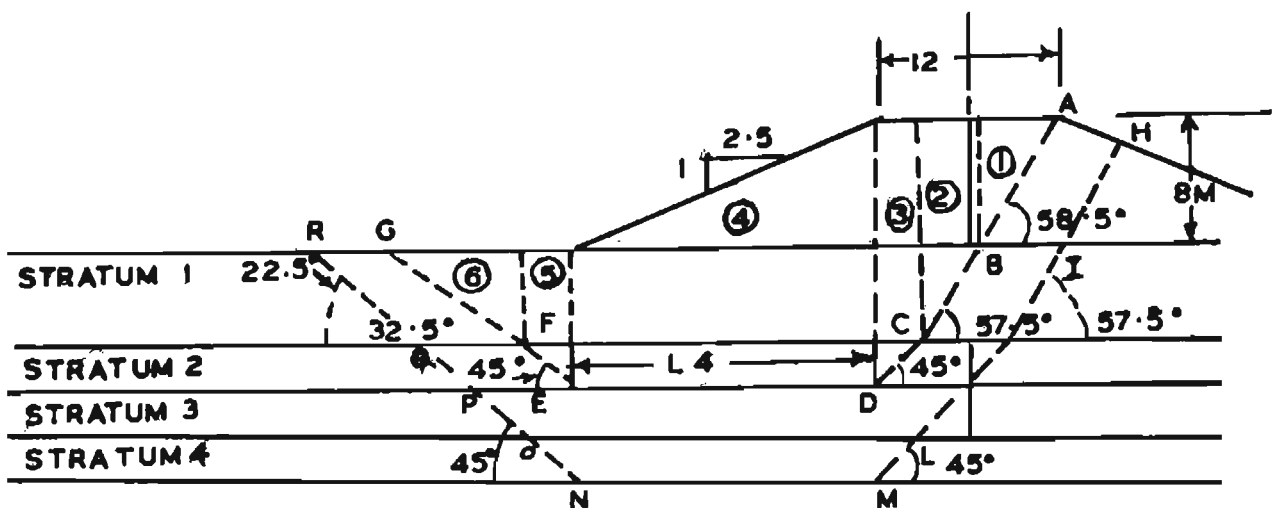


Fig. H.4

- ii) By drawing vertical lines through the points B,C,D,E & F, divide the soil mass lying above the failure surface into wedges as shown. Wedges 1, 2 and 3 will tend to slide down along ABCD and are called active wedges. Wedges 5 and 6 will tend to move up along EFG and are called passive wedges. Wedge 4 will tend to be moved out horizontally and is called neutral wedge.
- iii) Calculate the effective weights (W) of the individual wedges and measure their base lengths (L) by scaling.

Wedge No.	Weight of Wedge (W)	Base length (L)
1	31.96 ^T	8.8 m
2.	58.52 ^T	7.2 m
3.	54.3 ^T	4.2 m
4.	244 ^T	20 m
5.	13.5 ^T	4.2 m
6.	16.56 ^T	11.2 m

- iv) Calculate WAH, PA and RA for each active wedge and WPH, PP and RP for each passive wedge, where

WAH	=	$W \tan (45^\circ + \phi/2)$	for any active wedge
PA	=	$W \tan (45^\circ - \phi/2)$	
RP	=	$-2CL \cos (45^\circ - \phi/2)$	
		WAH - PA	
and WPH	=	$W \tan (45^\circ - \phi/2)$	for any passive wedge
PP	=	$W \tan (45^\circ + \phi/2) + 2CL \cos (45^\circ - \phi/2)$	
RP=PP-WPH			

Wedge 1

$$\begin{aligned} \text{WAH 1} &= 31.96 \tan 58.5^\circ = 52.14^T \\ \text{PA 1} &= 31.96 \tan 31.5^\circ = 19.58^T \\ \text{RA 1} &= 52.14 - 19.58 = 32.56^T \end{aligned}$$

Wedge 2

$$\begin{aligned} \text{WAH 2} &= 58.52 \tan 57.5^\circ = 91.86^T \\ \text{PA 2} &= 58.52 \tan 32.5^\circ = 37.28^T \\ \text{RA 2} &= 91.86 - 37.28 = 54.58^T \end{aligned}$$

Wedge 3

$$\begin{aligned} \text{WAH 3} &= 54.30 \tan 45^\circ = 54.30^T \\ \text{PA 3} &= 54.30 \tan 45^\circ - 2 \times 2.7 \times 4.2 \cos 45^\circ \\ &= 54.30 - 16.04 = 38.26^T \\ \text{RA 3} &= 54.30 - 38.26 = 16.04^T \end{aligned}$$

Wedge 5

$$\begin{aligned} \text{WPH 5} &= 13.50 \tan 45^\circ = 13.50^T \\ \text{PP 5} &= 13.50 \tan 45^\circ + 2 \times 2.7 \times 4.2 \cos 45^\circ \\ &= 13.50 + 16.04 = 29.50^T \\ \text{RP 5} &= 29.50 - 13.50 = 16.00^T \end{aligned}$$

Wedge 6

$$\begin{aligned} \text{WPH 6} &= 16.56 \tan 32.5^\circ = 10.55^T \\ \text{PP 6} &= 16.56 \tan 57.5^\circ + 0 = 26.00^T \\ \text{RP 6} &= 26.00 - 10.55 = 15.45^T \end{aligned}$$

$$\Sigma W_{AH} \text{ (for active wedges 1 to 3)} = 52.14 + 91.86 + 54.30 = 198.30^T$$

$$\Sigma R_A \text{ (for active wedges 1 to 3)} = 32.56 + 54.58 + 16.04 = 103.18^T$$

$$\Sigma W_{PH} \text{ (for passive wedges 5\&6)} = 13.50 + 10.55 = 24.05^T$$

$$\Sigma R_P \text{ (for passive wedges 5\&6)} = 16.00 + 15.45 = 41.45^T$$

- v) The neutral wedge (wedge 4) is taken to be acted on by forces as shown in Fig. H.5 and the factor of safety is defined as

$$F = \frac{\Sigma R_A + \Sigma R_P + C_4 L_4 + W_4 \tan \phi_4}{\Sigma W_{AH} - \Sigma W_{PH}}$$

Here, $W_4 \tan \phi_4 = 0$
 $C_4 L_4 = 2.7 \times 20 = 54^T$

$$\begin{aligned} \text{Therefore, } F &= \frac{103.18 + 31.45 + 54.00}{198.30 - 24.05} \\ &= \frac{188.63}{174.25} = 1.08 \end{aligned}$$

This indicates marginal stability (F slightly above 1) for the failure surface ABCDEFG.

(N.B. Steps (i) to (iv) as described above have also been followed for Analysis II to IV mentioned below, but the details of calculations have not been repeated to save space).

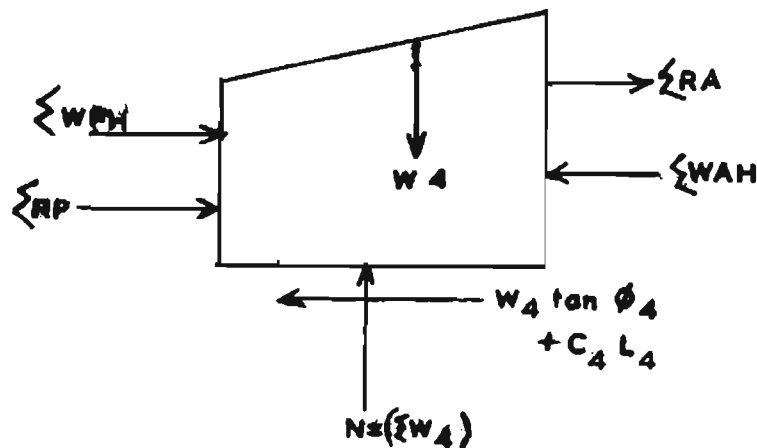


Fig. H.5

3.3 Analysis II

Next, the failure surface HIJKLMNQPQR is considered (Figs. H-4 & H.5) and proceeding with analysis in the same manner as for failure surface ABCDEFG, the factor of safety for failure surface HIJKLMNQPQR is derived as 1.01. Comparison of Analysis I and II shows that the failure surface passing through the lower clay layer (9-12 m depth) is more critical and this type of failure surface only is considered in Analysis III and IV that follow.

3.4 Analysis III

It is seen from previous analysis that the factor of safety available for the tentative cross-section shown in Fig. H.5 is far short of the required minimum 1.30. The factor of safety can be improved by adding stabilizing berms (Fig. H.6). For a trial, adopt $L = 25$ m, $h = 25$ m and carry out analysis of stability against sliding for failure surface HIJKLMN 'O'P'Q'R' (Fig. H.6). Following the same procedure is detailed under Analysis I, the factor of safety works out to 1.22. This is still inadequate.

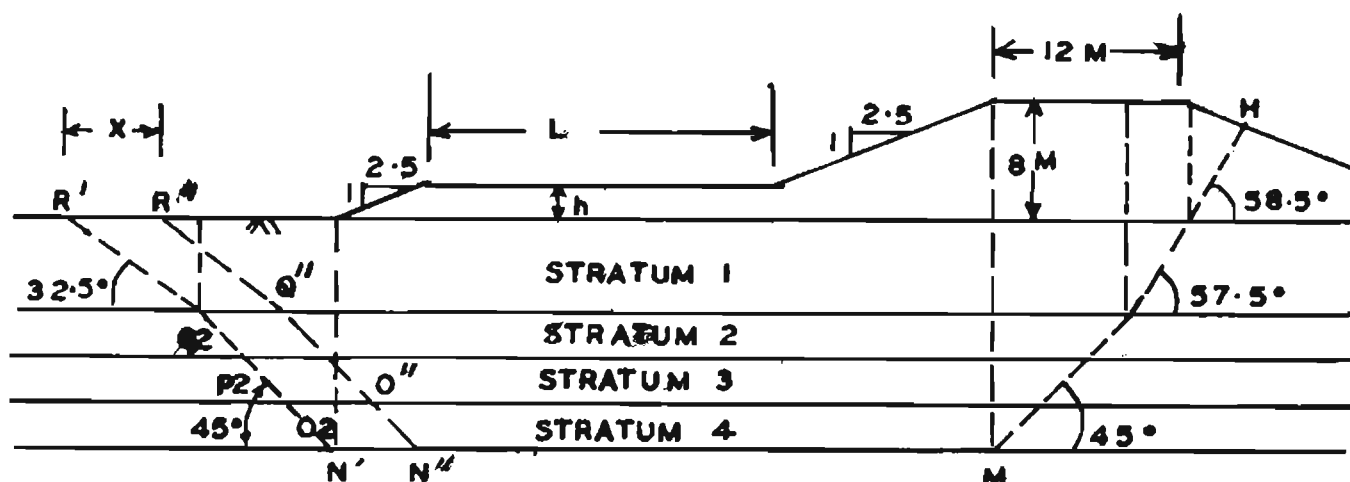


Fig. H.6

3.5 Analysis IV

With reference to Fig. H.6, adopt $L = 35$ m and $h = 2.5$ m. The factor of safety against sliding along failure surface HIJKLMN'O'P'Q'R' works out to 1.36. The factor of safety can be a little lower than derived above for a failure surface like HIJKLMN'O'P'Q'R', Fig. H.6. For $x = 4$ m (Fig. H.6), the factor of safety for failure surface HIJKLMN'O'P'Q'R' is found to be 1.34, which is about the lowest to be expected in this case for sliding block type of failure. This is still larger than the required minimum factor of safety of 1.30 and hence adequate.

4. Slip circle analysis

4.1 The embankment cross-section derived as per Analysis IV above will be now checked for safety against failure along circular slip surfaces. Ordinary method of slices (also known as Swedish circle method or Mellenius method) will be adopted for analysis. This procedure of analysis is fairly well-known and hence its basis will not be discussed herein. (A fairly detailed description of this method of analysis is available in Chapter 24 of "Soil Mechanics", by Lambe and Whitman, Wiley Eastern Reprint, 1971).

4.3.1 See Fig. H.7 for the trial slip circle No. 1 chosen and division of the trial failure mass into slices. The trial slip circles are sought to be so positioned, by judgement, that :

- (i) The driving moment (about the centre of the slip circle) due to the failure mass is kept relatively large and
- (ii) The resisting moment (about the centre of the slip circle) due to shear strength along the failure arc is kept relatively low. This will ordinarily require that a good part of the failure should pass through one or more of the weaker soil strata.

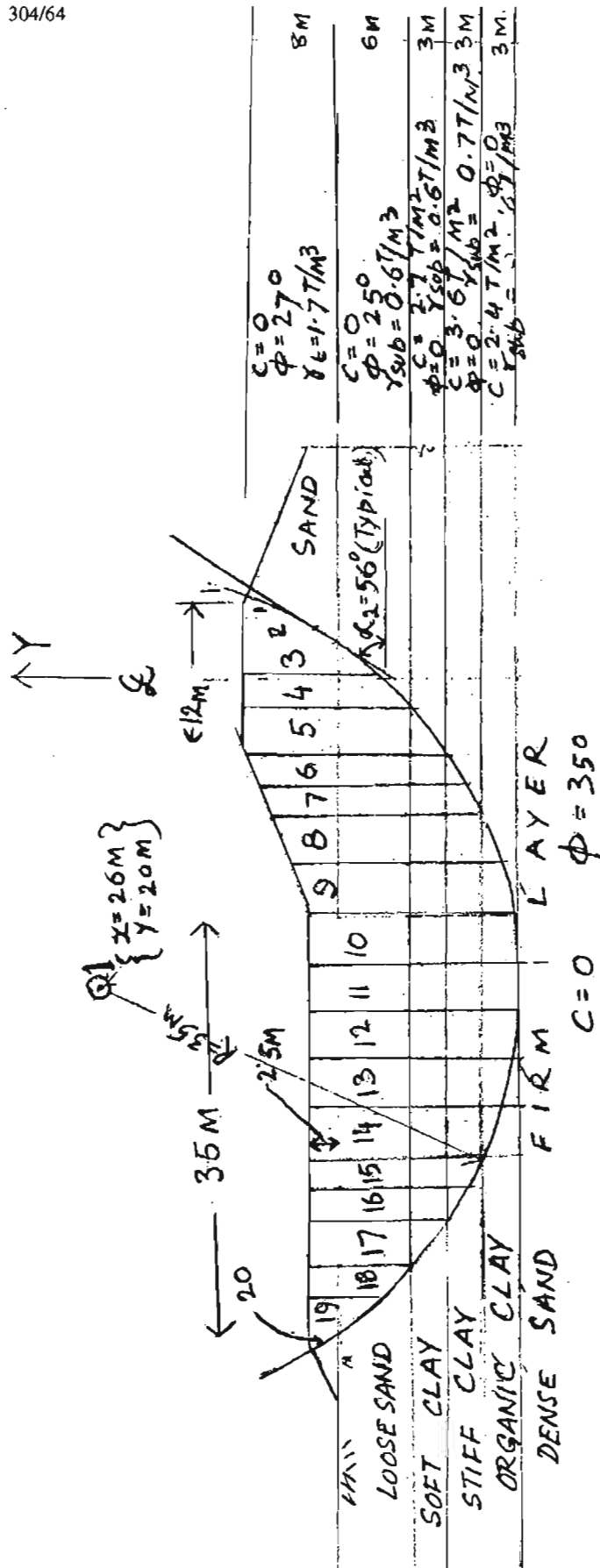


FIG H.7 SHOWING TRIAL SLIP CIRCLE NO. 1
AND DIVISION INTO SLICES OF
THE MASS LYING ABOVE SLIP CIRCLE
(SLICES NUMBERED 1 TO 20)

4.2.2 The soil mass lying above the sliding surface is divided into slices (20 in this case) by passing vertical lines through points of intersection between the chosen slip circle and the strata boundaries as well as through some intermediate points. Considering the moment equilibrium of the slices about the centre of the slip circle, the factor of safety (F) is derived as

$$F = \frac{\sum (C_i L_i + W_i \cos \alpha_i \tan \phi)}{\sum W_i \sin \alpha_i}$$

Where, for any individual slice numbered i (Fig. H.8)

C_i = Cohesion of soil at base of slice.

L_i = length of the base of the slice measured along the slip circle,

W_i = weight of the slice acting on the base,

α_i = angle maintained by the base of the slice with respect to the horizontal (For the segment of the slip circle lying on the embankment side of the centre may be taken as positive and as negative for the segment of the slip circle lying to the toe side of the centre,

ϕ_i = angle of internal friction of the soil at the base of the slice.

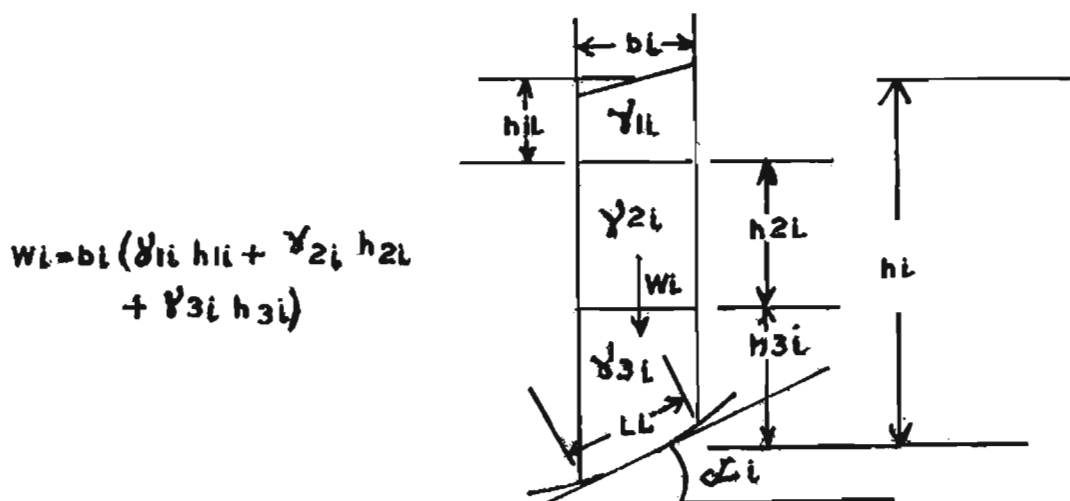


Fig. H 8

The calculations for factor of safety are conveniently carried out in a tabular form, as indicated in Tabel H.1 below. In this connection, it may be noted (with reference to Figs. H.7 and H.8).

C_i and ϕ_i , being soil properties, are given data.

α_i may be scaled from drawing (e.g. Fig. H.7) drawn to scale, on graph paper preferably,

L_i may be scaled (or, alternatively, b_i may be scaled and L_i computed as equal to $b_i / \sin \alpha_i$),

W_i may be typically computed

as $b_i (\gamma_{1i} h_{1i} + \gamma_{2i} h_{2i} + \gamma_{3i} h_{3i})$

Where γ_{1i} , γ_{2i} , γ_{3i} are given data (being effective unit weights of the various soil strata) and b_i as well as h_{1i} , h_{2i} , h_{3i} ... are scaled from drawing (vide Fig. H.8 for explanation of symbols).

It is thus seen that the procedure for calculating factor of safety is partly graphical and partly computational.

4.2.2 The soil mass lying above the sliding surface is divided into slices (20 in this case) by passing vertical lines through points of intersection between the chosen slip circle and the strata boundaries as well as through some intermediate points. Considering the moment equilibrium of the slices about the centre of the slip circle, the factor of safety (F) is derived as

$$F = \frac{\sum (C_i L_i + W_i \cos \alpha_i \tan \phi)}{\sum W_i \sin \alpha_i}$$

Where, for any individual slice numbered i (Fig. H.8)

- C_i = Cohesion of soil at base of slice.
- L_i = length of the base of the slice measured along the slip circle,
- W_i = weight of the slice acting on the base,
- α_i = angle maintained by the base of the slice with respect to the horizontal (For the segment of the slip circle lying on the embankment side of the centre may be taken as positive and as negative for the segment of the slip circle lying to the toe side of the centre,
- ϕ_i = angle of internal friction of the soil at the base of the slice.

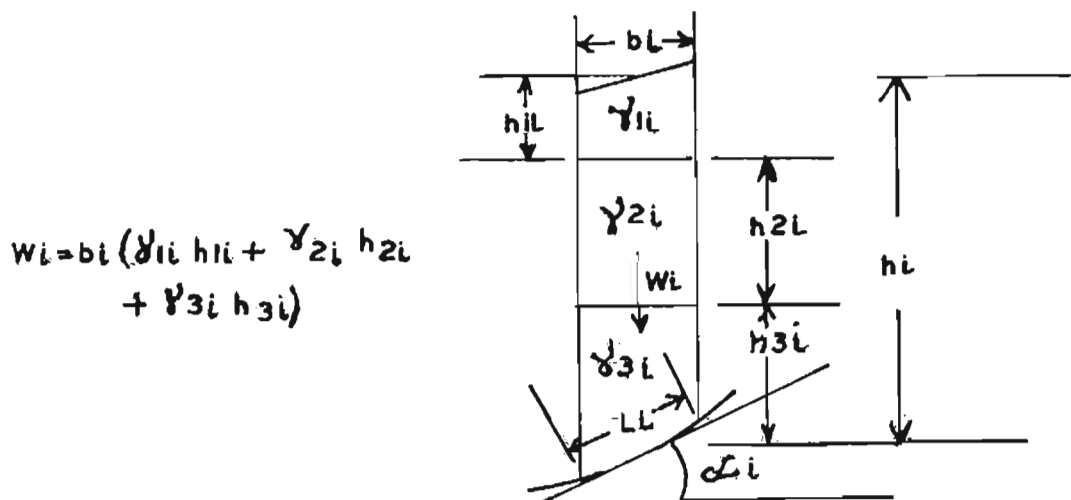


Fig. H 8

The calculations for factor of safety are conveniently carried out in a tabular form, as indicated in Tabel H.1 below. In this connection, it may be noted (with reference to Figs. H.7 and H.8).

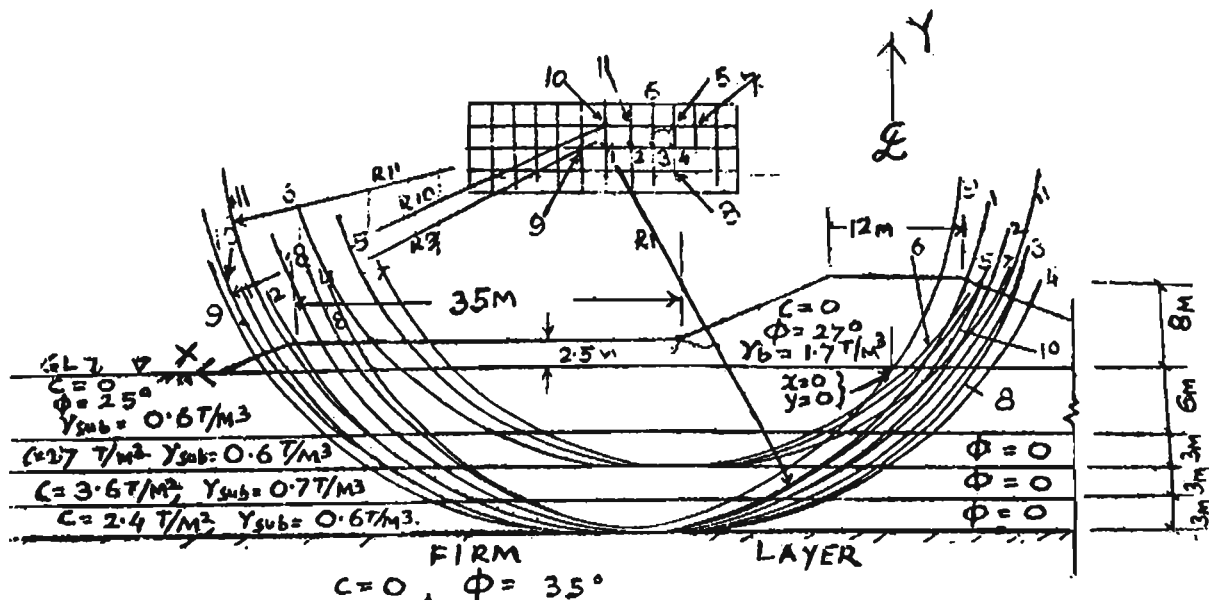
- C_i and ϕ_i , being soil properties, are given data.
- α_i may be scaled from drawing (e.g. Fig. H.7) drawn to scale, on graph paper preferably,
- L_i may be scaled (or, alternatively, b_i may be scaled and L_i computed as equal to $b_i / \sin \alpha_i$),
- W_i may be typically computed as $b_i (\gamma_{1i} h_{1i} + \gamma_{2i} h_{2i} + \gamma_{3i} h_{3i})$

Where γ_{1i} , γ_{2i} , γ_{3i} are given data (being effective unit weights of the various soil strata) and b_i as well as h_{1i} , h_{2i} , h_{3i} ... are scaled from drawing (vide Fig. H.8 for explanation of symbols).

It is thus seen that the procedure for calculating factor of safety is partly graphical and partly computational.

4.2.3 Other trial slip circles are chosen (Fig. H.9) and the corresponding factors of safety calculated in the same manner as for trial circle No. 1. it is seen from Table H-2 that the computed minimum factor of safety from slip circle analysis is 1.55 (circle No.5).

(N.B. It is possible that the computed minimum factor of safety may further get reduced if more slip circles are tried. For this purpose, the F values may be plotted against the respective centres of slip circles and from this, contours of F values varying in steps of say, 0.1 or less, drawn for locating the minimum F . However, for carrying out this procedure in an effective manner, it is necessary to adopt computer method of stability analysis. For hand calculation methods, judgement will have to be exercised for reducing computational labours. In this case, it is unlikely that F derived on the basis of slip circle analysis may come down to the level of 1.34 as already calculated by the sliding block method, vide analysis IV above).



CONTD TO P12

FIG H.9 SHOWING SLIP CIRCLES USED IN
ANALYSIS AND RESPECTIVE
FACTORS OF SAFETY(F)

Table H.1

Tabular form of computation for $F = \frac{\sum (C_i L_i W_i \cos \alpha_i \tan \phi_i)}{\sum W \sin \alpha_i}$

Slice No. (i)	C ton/m ²	ϕ degrees	l m	α degrees	W tonnes	cL tonnes	W, Cos α tan tonnes	W sin α tonnes	Remarks
1.	0	27°	5.0	64°	8.09	0	1.81	7.27	
2.	0	27°	4.1	56°	24.31	0	6.93	20.15	
3.	0	25°	4.4	51°	38.01	0	11.15	29.54	
4.	0	25°	3.7	46°	38.48	0	12.46	27.68	
5.	2.7	0	5.1	37°	64.52	13.77	0	38.83	
6.	2.8	0	3.2	31°	51.63	11.52	0	26.50	
7.	3.6	0	3.2	24°	78.84	11.52	0	32.00	
8.	2.4	0	4.2	20°	64.68	10.08	0	22.12	
9.	2.4	0	4.2	12°	57.00	10.08	8	11.85	
10.	2.4	0	4.2	7°	53.36	10.08	0	6.50	
11.	2.4	0	4.2	0°	54.08	10.08	0	0	$F = \frac{144.18+43.17}{113.38}$
12.	2.4	0	4.2	-7°	53.36	10.08	0	-6.50	≈ 1.65
13.	2.4	0	4.2	-12°	51.92	10.08	0	-10.79	
14.	2.4	0	4.2	-20°	49.04	10.08	0	-10.77	
15.	3.6	0	3.2	-24°	31.72	11.52	0	-12.90	
16.	3.6	0	3.2	-31°	28.78	11.52	0	-14.82	
17.	2.7	0	5.1	-37°	35.00	13.77	0	-21.06	
18.	0	25°	4.4	-46°	18.38	0	5.95	-13.22	
19.	0	25°	4.1	-51°	13.70	0	4.02	-10.65	
20.	0	27°	2.3	-56°	2.98	0	0.35	-2.50	
$\sum cL = 144.18$					$\sum W \cos \alpha \tan \phi = 43.17$	$\sum W \sin \alpha = 113.38$			

TABLE H.2

CO-ORD. OF CENTRE OF CIRCLE		CIRCLE NO.	RADIUS M	F
x*	y*			
m	m			
26	20	1	35	1.65
24	20	2	35	1.61
22	20	3	35	1.58
20	20	4	35	1.60
20	22	5	31	1.55
22	24	6	33	1.67
18	22	7	31	1.56
20	18	8	33	1.85
28	20	9	35	1.74
26	22	10	37	1.65
24	22	11	37	1.64

* x = 0 & y = 0 at intersection of C.L. and ground level line (vide sketch on pre-page)

5. Conclusion

The embankment cross-section shown in Fig. H.6 may be adopted as the final one, since the minimum factor of safety calculated for this cross-section is 1.34 which is slightly more than 1.30, which is the minimum specified.

TYPICAL WORKED OUT EXAMPLE OF FILTER DESIGN

1. Design problem statement

It is proposed to protect an embankment made up of silty fine sand against the effects of flood spill by covering the side slopes with 0.30 m thick pitching underlain by filter. Free board including allowance for wave height may be taken to be 1 m above H.F.L. The pitching will consist of more or less cubical shaped stones of size 280-350 mm and will be hand laid. The joints between the hand laid stones will be packed with spalls of sizes between 150 to 250 mm. It is required to design the thickness and composition of the filter underlying the pitching.

2. Design criteria

2.1. According to clause 2502 of Ministry of Shipping and Transport (Roads Wing) Specification for Road and Bridge Works (1978), the following requirements, inter alia should be satisfied in filter design:

- i) The filter material may consist of sound gravel, stone, brick ballast or coarse sand and more than 5% of the material should pass through 75 micron sieve.
- ii) The filter material should satisfy the following gradation requirements :

$$\begin{aligned} \text{a)} \quad & \frac{\text{D}_{15} \text{ of Filter material}}{\text{D}_{15} \text{ of base material}} = 5 \text{ to } 40; \\ \text{b)} \quad & \frac{\text{D}_{15} \text{ of filter material}}{\text{D}_{85} \text{ of base material}} = 5 \text{ or less} \end{aligned}$$

(N.B. In case of a multi-layer filter system made-up of progressively coarser components, the gradation criteria will also apply between the successive layers constituting the filter system).

- iii) The grain-size curve of the filter should be roughly parallel to that of the base material.
- iv) For single-layer filter, the filter thickness should not be less than 150 mm and for multi-layer filter, the thickness of each filter layer should not be less than 115 mm.

2.2. The following design criterion given in 'Design Manual: Soil Mechanics, Foundations and Earth Structures (a well-known reference publication brought out by Naval Facilities Engineering Command, U.S. Navy) may be found useful:

Maximum wave height	Minimum D ₈₅ size for filter*
0-1.2 m	25-38 mm
1.2-3 m	38-50 mm

*No filter is needed if the fill material itself meets the requirements regarding D₈₅ size mentioned above.

3. Gradation of fill and filter materials

3.1. On the basis of survey of borrow areas and quarries, the following information regarding available fill and filter materials have been compiled (Table I.1.).

Table I.1.

S.No.	Description of Material	Unit cost at site (per cum)
1.	Fill materials (silty fine sand of variable grading)	Rs.6/-
2.	Filter material No.F ₁ (medium coarse sand)	Rs.18/-
3.	Filter material No.F ₂ (well-graded coarse sand)	Rs.30/-
4.	Filter material No.F ₃ (gravel-sand)	Rs.45/-
5.	Filter material No.F ₄ (gravel)	Rs.62/-

3.2. The range of grain-size distribution for the fill material is indicated by the hatched band marked in Fig. I.1. The grain-size distributions for the available filter materials are indicated by the plotted curves marked F₁, F₂, F₃, and F₄ in Fig.I.1.

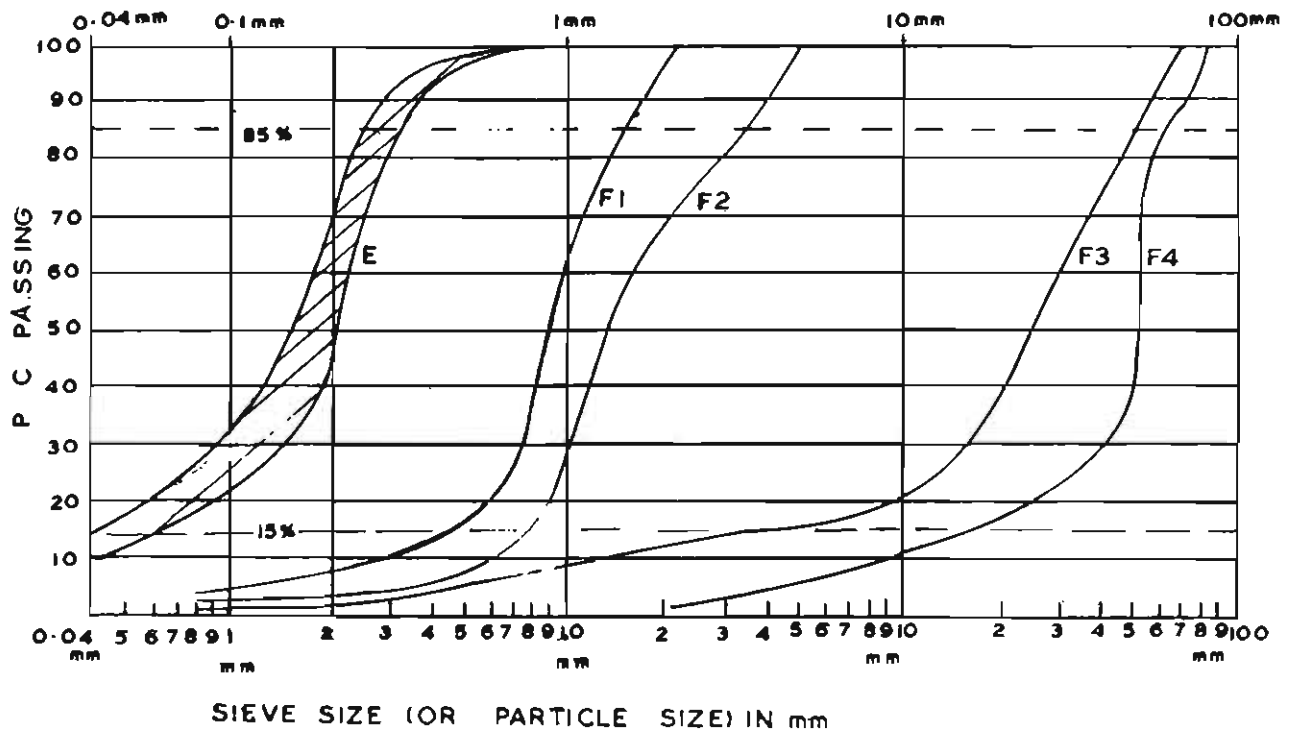


Fig. I.1

3.3. From the grain-size distribution curves plotted in Fig. I.1, D15 and D85 sizes of the fill and filter materials are to be found out. In this connection, it may be noted that D15 size means the largest particle size present in the smallest 15 p.c. fraction of the material. This can be easily determined from the grain-size distribution plot by the following procedure:

- i) Through the 15 p.c. point on the ordinate draw a line parallel to the abscissa.
- ii) Through the intersection point of the line drawn as per (i) above and the grain-size distribution curve under consideration, draw a line parallel to the ordinate.
- iii) The point at which the line drawn as per (ii) above meets the abscissa corresponds to D15 size.

(Substituting 85 p.c. for 15 p.c. steps (i) above and continuing with steps (ii) and (iii) the D85 size can be similarly determined).

3.4. Following the procedure outlined as above, the D15 and D85 sizes for the fill and filter materials are derived as below (Table I.2.):

Table I.2.

S.No.	Description of material	D15 size (mm)	D85 size (mm)
1.	Fill materials (variable grading)	0.04 to 0.065	0.25 to 0.32
2.	Filter material F ₁	0.5	1.5
3.	Filter material F ₂	0.8	3.5
4.	Filter material F ₃	3	50
5.	Filter material F ₄	16	60

4. Filter design

4.1. Four types of materials have been identified as the probable filter materials (Table I.1.). It is now to be found out which of these materials satisfy filter criteria from different considerations and whether a single-layer filter will do or a multi-layer filter (made up of progressively coarser components) is required to be provided.

4.2. It may be seen from the grain size distribution curves in Fig. I.1. that all the four types of filter materials satisfy the requirements (i) and (iii) given under para 2.1.

4.3. The D85 sizes of the materials F₁ and F₂ (vide Table I.2.) do not satisfy the criterion mentioned in Para 2.2. However, D85 sizes of materials F₃ and F₄ do satisfy this criterion. So, either F₃ or F₄ may be selected for being placed under the pitching, subject to the other requirements of filter design being satisfied, as further examined below.

4.4. It may now be examined to what extent materials F₁, F₂, F₃ and F₄ (Table I.1.) satisfy the filter gradation criteria (as given in (ii) under para 2.1.) among themselves and in relation to the fill material E. This is done in tabular form in Table I.2.

Table I.3.

Filter material	Base material	D15 filter	D15 base	D85 base	D15 filter/ D15 base	D15 filter/ D85 base	Whether filter gradation criteria are satisfied
		mm	mm	mm			
1.	2.	3.	4.	5.	6.	7.	8.
F3	E	3	0.04 to 0.065	0.25 to 0.32	75 to 46	12 to 9.4	No
F4	E	16	-do-	-do-	400 to 246	64 to 32	No
F1	E	0.5	-do-	-do-	12.5 to 7.7	2 to 1.61	Yes
F2	E	0.8	-do-	-do-	20 to 12.3	3.2 to 2.5	Yes
F3	F1	3	0.5	1.5	6	2	Yes
F3	F2	3	0.8	3.5	3.75	0.86	No
F4	F1	16	0.5	1.5	32	10.06	No
F4	F2	16	0.8	3.5	20	4.6	Yes

4.5. From the examination of gradations made in Table I.3, the following conclusions may be drawn:

- i) F3 and F4, any of which is suitable for being placed under the pitching (para 4.3.), do not satisfy filter gradation criteria with respect to the fill material and hence another layer of filter has to be interposed between F3 or F4 and the fill material. In other words, a two layer filter system has to be used.
- ii) Both F1 and F2 are suitable to serve as filter in relation to fill material;
- iii) In the two-layer filter system, F1 can be combined with either F3 or F4, but F2 can be combined only with F4 and not F3.

4.6. From cost consideration (Table I.1), F1 - F3 combination (vide (iii) under para 4.5) is the most economical and may be adopted. The compacted thickness of each filter layer may be 150 mm. The arrangement is illustrated in Fig.I.2.

Fig. 1.2

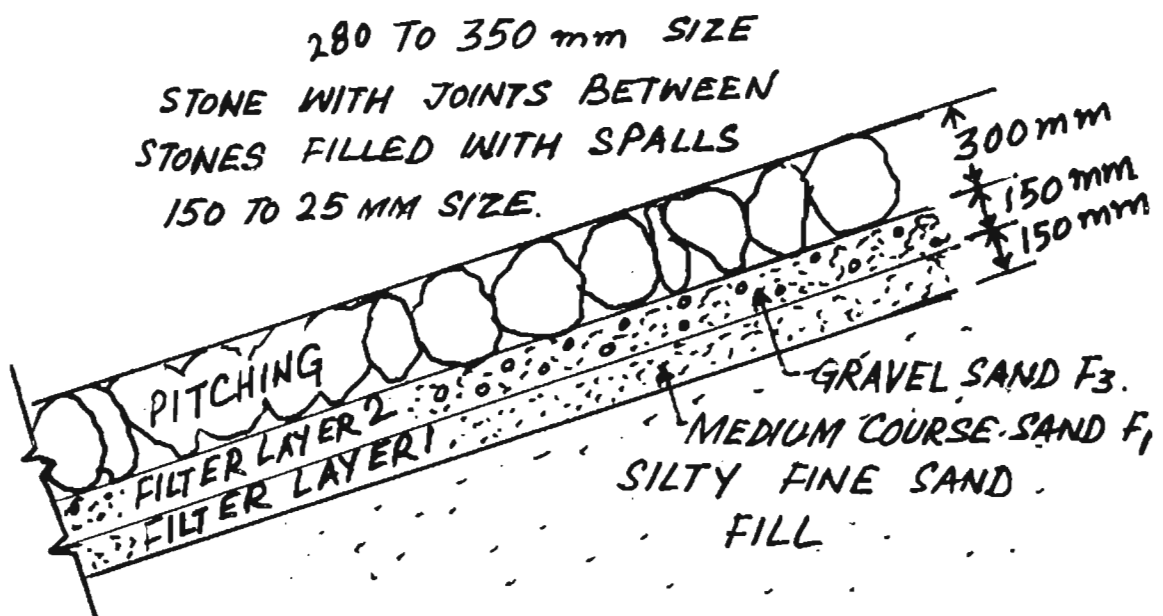


FIG 1.2 SKETCH SHOWING ARRANGE-
MENT OF PITCHING, FILTER
AND FILL.

TYPICAL WORKED OUT EXAMPLE OF SETTLEMENT ANALYSIS

1. Problem

For the embankment cross-section and sub-soil conditions shown in Fig.J.1, total expected settlement due to primary consolidation of sub-soil is to be estimated for the position corresponding to the centreline of the roadway. Settlements occurring at the end of 6 months, 1 year and 5 years are also to be estimated.

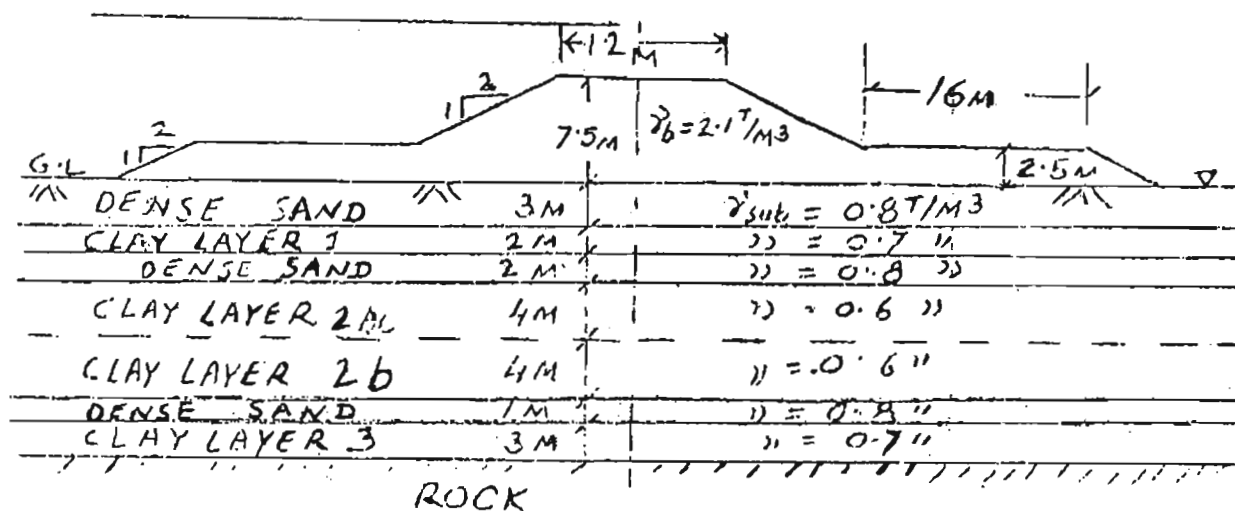


Fig. J.1 Embankment Cross Section, Sub-soil Stratification & Soil Properties

On the basis of given information about stratification, soil properties and construction programming, it may be taken

- The subsoil is normally consolidated and fully saturated, water table being at ground level;

- ii) The construction time is short;
- iii) Two way drainage occurs for the clay layers 1 and 2 (Fig.J.1) since these are bounded by permeable sandy strata at top and bottom and one-way drainage (in the upward direction only) occurs for clay layers), since drainage in the downward direction is obstructed by the rock stratum.

2. Steps in analysis

The settlement analysis given herein is in respect of clay layers 1,2 and 3 only, as indicated in Fig.J.1. The contribution to settlement in this case due to consolidation of the fill material itself, due to consolidation of the sand seams and due to elastic compression are likely to be minor. Besides, the settlements due to the last two factors will be instantaneous, i.e. occurring simultaneously with the placement of the fill material and hence will be made up as construction proceeds. The settlement due to consolidation of clay layers will, however, extend over a fairly long period of time. The basic steps in analysing are:

- i) Sub divide thicker clay strata (having thickness, say in excess of 5 m). Here, clay layer 2 is sub-divided into layers 2a and 2b, each 4 m thick.
- ii) Compute existing overburden pressures (p_z) at the mid-height of the clay layers.
- iii) Compute incremental vertical stresses (Δp_z), due to imposed embankment load, at the mid-height of the clay layers.
- iv) Compute total settlement for individual clay layers and total settlement for all the clay layers cumulatively;
- v) Compute periodic settlement for individual clay layers and for all the clay layers cumulatively.

3. Existing overburden pressures (p_z)

Clay Layer No.	Mid-layer depth Z (m)	P_z (t/sqm)
1.	4-----	$3 \times 0.8 + 0.7 = 3.1$
2a.	9-----	$3 \times 0.8 + 2 \times 0.7 + 2 \times 0.8 + 2 \times 0.6 = 6.6$
2b	13----	$6.6 + 4 \times 0.6 = 9.0$
3.	17.5----	$3 \times 0.8 + 2 \times 0.7 + 2 \times 0.8 + 8 \times 0.6 + 1 \times 0.8 + 1.5 \times 0.7 = 12.05$

4. Incremental vertical stresses (Δp_z) due to embankment load

The incremental vertical stresses (Δp_z) in the consolidating layers are generally calculated by using influence charts developed by Osterberg (Reference 1). Referring to Fig.J.2, the incremental vertical stress at depth Z below the ground level due to the load of half of the embankment cross section is derived as,

$$\Delta p_z = I_1, vH$$

Where I_1 , is the related to Z and embankment geometry and can be obtained from Osterberg's charts. The actual cross-section (minus berms) consists of two areas of the shape shown in Fig.J.2 and hence the actual incremental vertical stress at depth Z is

$$\Delta p_{z1} = 2.I_1, vH$$

The area of the berm on one side, Fig.J.3(i), may be taken to consist of the trapezium shown in Fig.J.3(ii) minus that shown in Fig.J.3(iii) and accordingly, incremental vertical stress due to berms on both sides may be derived as:

$$\Delta p_{z2} = 2 (I_2 - I_3) vH$$

Finally, total incremental vertical stress,

$$\Delta p_z = \Delta p_{z1} + \Delta p_{z2}$$

The calculations for Δp_{z1} and Δp_{z2} can be done in tabular form vide Table J.1 and J.2.

Table J.1. Calculations for Δp_{z1}

Layer No.	Mid-layer depth (Z) m	$\frac{a^*}{z}$	$\frac{b^*}{z}$	I_1^{**}	$\Delta P_{z1} = 2I_1 \text{ vH}$ t/sqm
1.	4	3.75	1.5	0.490	15.4
2a	9	1.67	0.67	0.445	14.0
2b	13	1.15	0.44	0.405	12.7
3	17.5	0.85	0.34	0.350	10.9

*vide Fig.J.2.

**From Reference 1.

Table J.2. Calculation for Δp_{z2}

Layer No.	Mid-layer depth(Z) m	I2			I3			p _{z2} = 2(I ₂ - I ₃) vH.
		$\frac{a^*}{z}$	$\frac{b^*}{z}$	I_2^{**}	$\frac{a@}{z}$	$\frac{b@}{z}$	I_3^{**}	
1.	4	1.25	8	0.5	1.25	4	0.5	0
2a	9	0.56	3.55	0.5	0.96	1.77	0.48	.2
2b	13	0.38	2.46	0.49	0.38	1.23	0.455	.4
3	17.5	0.28	1.83	0.48	0.28	0.91	0.415	.7

*Vide Fig.J.3(ii)

@Vide Fig.J.3(iii)

**From Reference 1.

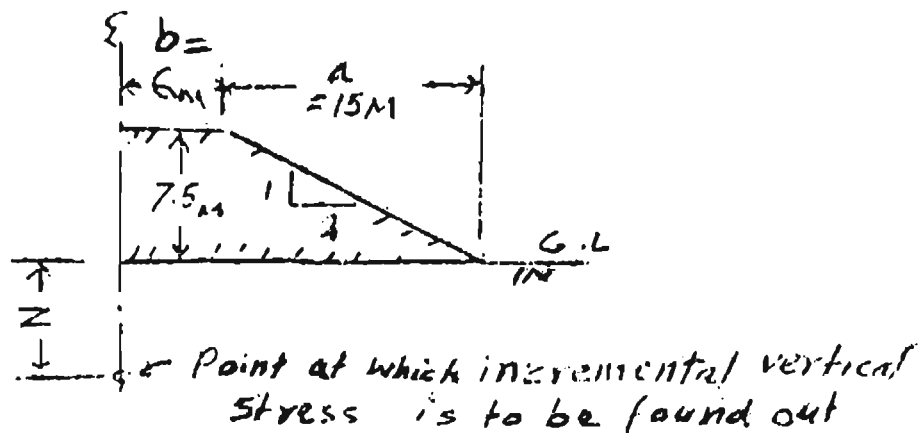


Fig. J.2

CONSOLIDATION PROPERTIES
OF CLAY LAYERS

CLAY LAYER NO	e_0	C_c	C_u $\text{cm}^2/\text{s} \times c$
1	0.7	0.3	8.5×10^{-4}
2a	1.0	0.5	3.2×10^{-4}
2b	Do	Do	Do
3	0.7	0.3	9×10^{-4}

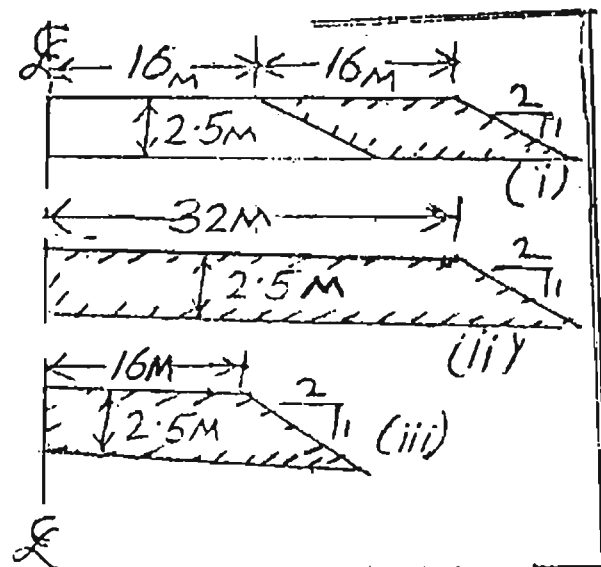


Fig. J.3(i), (ii) & (iii)

Total Settlement

Total settlement due to primary consolidation is commonly calculated according to the following formula:

$$S = H \frac{1 + C_c}{1 + e_0} \log \left(1 + \frac{\Delta p_z}{p_z} \right)$$

- Where
- S = total settlement due to primary consolidation
 - H = thickness of layer undergoing consolidation
 - C_c = compression index of soil undergoing consolidation
 - e_0 = initial void ratio of soil undergoing consolidation
 - p_z = existing overburden pressure
 - Δp_z = incremental vertical stress due to embankment load

In the present case, there are three distinct clay layers contributing to consolidation settlement and for this condition,

$$S = \sum H \frac{C_c}{1 + e_0} \log \left(1 + \frac{\Delta p_z}{p_z} \right) \quad \text{where the summation is carried out for all the clay layers.}$$

The calculations for total settlement may be carried out in tabular form, as shown in Table J.3.

Table J.3. Calculation for total settlement

Layer No.	Layer thickness H m'	Mid layer depth z m'	p_z T/sqm	Δp_z = $\Delta p_{z1} + \Delta p_{z2}$ T/sqm	e_0	C_c	Layer settlement = $\frac{C_c}{1+e} H \log \left(1 + \frac{\Delta p_z}{p_z} \right)$ m'
1	2	4	3.1	15.4	0.7	0.3	0.27
2a	4	9	6.6	14.2	1.0	0.5	0.50
2b	4	13	9	13.1	1.0	0.5	0.39
3	3	17.5	12.05	11.6	0.7	0.3	0.16
Total settlement							1.32 m

6. Rate of settlement

The total settlement calculated in para 5 above will occur over a period of time and it often becomes necessary to know what settlements might be expected at the end of designated periods. The p.c. consolidation (U.%-) undergone by a consolidating layer at the end of time have been correlated with a dimensionless factor T_v (Reference 2). For a consolidating clay layer between permeable sandy strata.

$$T_v = \frac{C_v t}{H^2}$$

Where C_v = coefficient of consolidation for the clay layer undergoing consolidation
 t = time elapsed
 H = half thickness of clay layer undergoing double drainage (layers 1 and 2) and full thickness of clay layer 3 undergoing single drainage.

(i) Settlement after 6 months

$$t = 6 \text{ months} \\ = (6 \times 30 \times 24 \times 60 \times 60) \text{ seconds.}$$

Clay layer 1

$$T_v = \frac{C_v t}{(H/2)^2} \\ = \frac{8.5 \times 10^{-4} \times (6 \times 30 \times 24 \times 60 \times 60)}{(200/2)^2} \\ = 1.32$$

From correlation between T_v and U (vide Reference 2)

$$U = 96\%$$

Clayer Layer 2 (i.e. 2a and 2b)

$$T_v = \frac{(6 \times 30 \times 24 \times 60 \times 60) \times 3.2 \times 10^{-4}}{(800/2)^2}$$

$$T = .0311$$

$$U = 20\%$$

Clay layer 3:

$$T_v = \frac{(6 \times 30 \times 24 \times 60 \times 60) \times 9 \times 10^{-4}}{(300)^2}$$

$$I = .15$$

$$U = 43\%$$

$$\begin{aligned} \text{Settlement after 6 months} &= .27 \times 96 + (.5 + .39) \times .20 + .16 \times .43 \\ &= .26 + .18 + .07 \\ &= .51 \text{ m} \end{aligned}$$

(ii) Settlement after 1 year

T_v after 1 year will be twice T_v after 6 months, as calculated under (i) above.

Clay layer 1

$$T_v = 1.32 \times 2 = 2.64$$

$$U = 100\% \text{ (theoretically } U = 100\% \text{ at } T_v = \infty \text{)}$$

Clay layer 2

$$T_v = .0311 \times 2 = 0.0622$$

$$U = 28\%$$

Clay layer 3

$$T_v = .15 \times 2 = 0.30$$

$$U = 58\%$$

$$\begin{aligned} \text{Settlement after 1 year} &= .27 \times 1.0 + (.50 + .39) \times .28 + .16 \times .58 \\ &= .27 + .25 + .09 \\ &= .61 \text{ m} \end{aligned}$$

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(iii) Settlement after 5 years

T_v after 5 year will be 10 times T_v after 6 months as calculated under (i) above

Clay layer 1

$$T_v = 1.32 \times 10 = 13.2$$

$$U = 100\%$$

Clayer layer 2

$$T_v = .0311 \times 10 = .311$$

$$U = 66\%$$

Clay layer 3

$$T_v = .15 \times 10 = 1.5$$

$$U = 98\%$$

$$\begin{aligned} \text{Settlement after 5 years} &= .27 \times 1.0 + (.50 + .40) \cdot 62 + .16 \times 98 \\ &= .27 + .56 + .16 \\ &= 0.99 \text{ m} \end{aligned}$$

References

1. Osterberg, J.O.(1957) 'Influence values for vertical stresses in a semi infinite mass due to embankment loading' Proc. 4th Int. Cong. Soil. Mech, London 1 pp393-394.
2. Taylor D.W. "Fundamentals of Soil Mechanic", Chap.10, Asia Publishing House, New Delhi.

304/80

(iii) Settlement after 5 years

T_v after 5 year will be 10 times T_v after 6 months as calculated under (i) above

Clay layer 1

$$T_v = 1.32 \times 10 = 13.2$$

$$U = 100\%$$

Clay layer 2

$$T_v = .0311 \times 10 = .311$$

$$U = 66\%$$

Clay layer 3

$$T_v = .15 \times 10 = 1.5$$

$$U = 98\%$$

$$\begin{aligned} \text{Settlement after 5 years} &= .27 \times 1.0 + (.50 + .40) \cdot .62 + .16 \times .98 \\ &= .27 + .56 + .16 \\ &= 0.99 \text{ m} \end{aligned}$$

References

1. Osterberg, J.O.(1957) 'Influence values for vertical stresses in a semi infinite mass due to embankment loading' Proc. 4th Int. Cong. Soil. Mech, London 1 pp393-394.
2. Taylor D.W. "Fundamentals of Soil Mechanic", Chap.10, Asia Publishing House, New Delhi.

ANNEXURE 'K'**PROCEDURE FOR INSTALLATION OF SETTLEMENT PLATES AND RECORDING OF OBSERVATIONS****1. Installation**

The following extract from the book 'Soil Mechanics in Engineering Practice', 2nd Edition by Karl Terzaghi and Ralph B. Peck will make clear the general purpose and procedure of installing settlement plates:

"In many instances it is necessary to determine the settlement of the base of a fill due to the compression of the underlying soil, whereas the compression of the fill itself is insignificant. Under these circumstances 'settlement plates' (Fig.66.4) are commonly installed on the ground surface before the fill is placed. The size of the plate depends on the compressibility and uniformity of the surficial materials underlying the fill. The plate supports a flange to which a section of the pipe, usually about 5 ft long, is attached. As the fill is built up, additional sections are coupled to the pipe. The elevation of the top of each section must be determined as soon as it is installed, and also just before the next section is added; in this manner the settlements produced by the increments of fill can be evaluated. Inasmuch as the riser pipe interferes with filling and compaction operations, the fill for a few feet around the pipe must be placed and compacted by hand. The accuracy of the results is of the order of 0.5 inch."

2. Spacing and location

For recording the maximum settlement under the embankment, the settlement plate (Fig.K.1) should be installed along the centre line of the embankment. Where raising/widening of an existing embankment is involved, the settlement plates may be placed at the toe of the existing embankment. The No. and spacing of settlement plates should be fixed after taking account of individual site conditions and design objectives. As a general guideline, a spacing of 30 to 100 metres for road embankments can be recommended. If differential settlements along the width of the embankment are desired to be known, settlement plates should be located on the centre line of the embankment and on either side of it (i.e. along a line perpendicular to the centre line) at intervals of 15 metres or so.

3. Taking readings

Taking the readings consists of recording the R.L. of the top of the pipe with reference to a secure bench mark located away from the zone of influence of the embankment. During construction, readings should be taken at initial installation and at weekly intervals thereafter or every time an extension piece is added to the riser pipe. After the construction is over, readings may be taken at monthly intervals during the first year and at quarterly intervals thereafter till the incremental settlement has been rendered negligible. In case, a fast rate of settlement is expected as in poor ground, the frequency of the settlement observations may be so regulated that the increment of settlement recorded between two successive observations does not exceed 20 mm. A convenient form for recording and reducing of readings is shown in Table K.1.

4. Precautions

The settlement plate should be carefully installed on a level patch of ground so that the verticality of the riser pipe is ensured. Some care is necessary to ensure that the riser pipe is not disturbed by construction machinery. For this purpose, an area of 2 m x 2 m to 3 m x 3 m around the riser pipe can be isolated with temporary light fencing or movable barriers (e.g. empty drums). Operation of construction machinery beyond 2 to 3 m of the riser pipe should not, in general, disturb the settlement plate. The soil in the area around the riser pipe should be compacted by using light power tampers. It should be possible to devise practical working procedures in these regards at each individual site after a little of working experience. Any unexpected or sudden changes in the rate of settlement should be promptly investigated to ascertain if there is any disturbance with the settlement plate or otherwise if the stability of the embankment is affected. The readings should be taken by an officer not below the rank of Assistant Engineer.

TABLE K.1
FOUNDATION SETTLEMENT READINGS

Project _____

B.M. REFERENCE _____

Location _____

CHAINAGE REF. _____

Division _____

Settle- ment Plate No.	Location		Design ht. of embankment above G.L. at location of settlement plate	Date of Obser- vation	R.L. on Top of riser pipe	Length of riser pipe (including thickness of base plate)	R.L. of base plate (Col. 6- Col. 7	Settlement or heave of base plate since last recording	Total settle- ment or heave of base plate recorded so far *	Current ht. of embank- ment above G.L.	Remarks	Initials of of observer
	Ch. on C.L.	Offset if any, from C.L.										
1	2	3	4	5	6	7	8	9	10	11	12	13

* | + | = | Settlement

| - | = | Heave

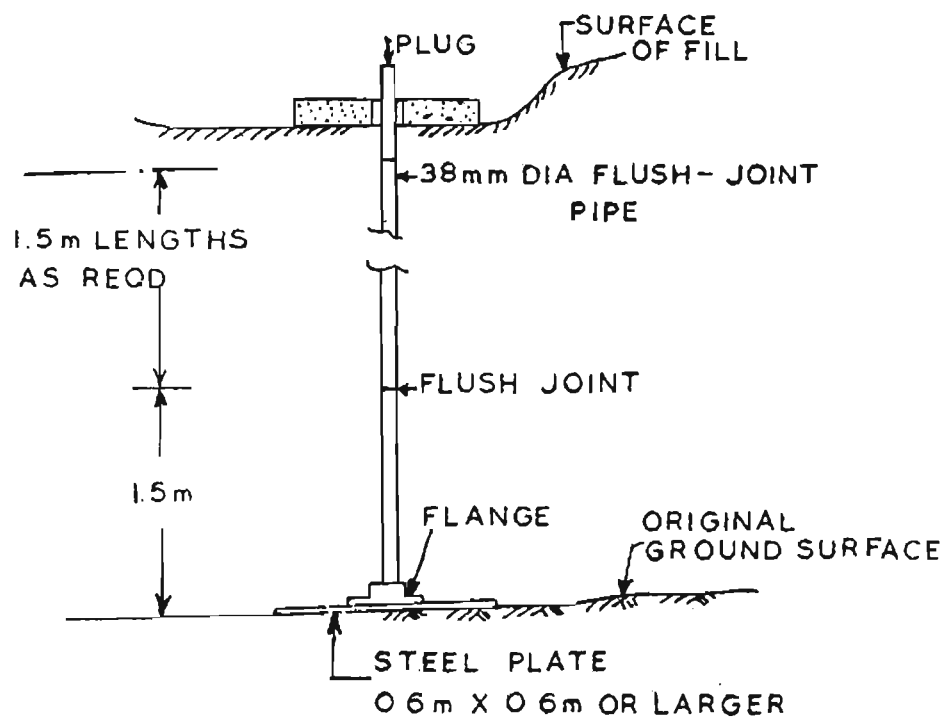


Fig. K-1

SETTLEMENT PLATE FOR DETERMINING SETTLEMENT
OF BASE OF FILL

(ADOPTED FROM FIG. 66.4 MENTIONED IN EXTRACT
 UNDER PARA 1 ANNEXURE K)

ANNEXURE 'L'

PROCEDURE FOR INSTALLATION OF TOE PEGS AND RECORDING OF OBSERVATIONS

1. Installation

Toe pegs are used for recording movements in the ground in the vicinity of the toe of the embankment. For this purpose, the toe pegs should be securely fixed to the ground. A suggested arrangement is shown in Fig.L.1. Further, the exact position of the toe peg at the time of installation and thereafter should be determinable. For this purpose, it is convenient to locate the toe pegs along theodoliter ranged straight lines, whose end points defined by permanent reference pillars. Where the alignment is on a curve it would be necessary to range a number of interconnected straight lines approximately following the curve of the alignment. The initial R.L.'s of the top of the toe pegs should also be recorded.

2. Location and Spacing

Two rows of toe pegs at offset distances of 2 m and 5 m from the average toe lines of the embankment (or of the stabilising berm, where one is provided) may be laid out along straight lines ranged with the help of a theodolite and the ends of the straight line should be defined by permanent reference pillars located away from the zone of influence of the embankment. The longitudinal spacing between the toe pegs may be ordinarily 10 m; a typical general lay out of the pegs (for straight alignment) is illustrated in Fig.L.2.

3. Taking Readings

Taking the reading consists of recording the lateral shift and changes in the R.L. of the top of the toe peg with reference to its initial position. This requires, firstly, that the theodolite is positioned to range the reference straight lines whose ends are by peg already defined and the offsets. If any from this straight line to the positions of the tops of the toe pegs are then read. Secondly, the inclination of the toe peg may be observed using a simple type of inclinometer or even a plum bob (for small inclinations, the tangent value may be taken to be equal to the angular value of the inclination). Thirdly, the R.L.'s of the tops of the toe pegs are read. In case, any change is noticed in the longitudinal spacing between the toe pegs, the same should also be recorded. Any apparent damage to toe peg or disturbance of their positions should be noted.

A convenient form of recording and reducing of readings is shown in Table L.1.

Table L.1. Toe Peg Reading

PROJECT _____ B.M. REFERENCE _____
 LOCATION _____ CHAINAGE REF. _____
 DIVISION _____

Toe Peg No.	Location		Date of observation	Offset to top of toe peg from the theodo-lite ranged ref. line += towards embankment away from the embankment	Inclination of toe peg with the ref. to the vertical + = towards embankment + = away from embankment	R.L. of the top of toe peg	Current height of embankment over GL at the position of toe peg	Remarks	Signatures of observer
	Chhainage on CL of embankment	Offset from CL of embankment (Mention U/S or D/S)							

4. Precautions

The soil supporting the base of the toe peg should be reasonably firm, so as not to settle or move on its own or under the weight of the base of the toe peg. Care should be taken to ensure the verticality of the toe peg at the time of installation. The alignment of the top of the toe pegs should be made to conform to a straight line, using a theodolite as already mentioned, while the concrete at its base is still grain, so that minor adjustments are possible. The disturbance of the toe pegs due to external causes, such as due to movement of machinery, men or animals, should be guarded against. Any unexpected or sudden changes in the position, inclination or level of the toe pegs should be promptly investigated to ascertain if this is due to external disturbance or due to ground movements. If the latter be the cause, early corrective measures such as suspending construction, flattening the slopes, providing stabilising berms, etc., should be instituted after the necessary design consultation. The readings should be taken by an officer not lower the rank of an Assistant Engineer.

ANNEXURE 'M'

**LIST OF BASIC FIELD EXPLORATION AND LABORATORY ITEMS OF SOIL INVESTIGATION FOR
HIGH EMBANKMENTS REQUIRED TO BE HANDLED BY A DEPARTMENTAL SOIL
INVESTIGATION UNIT**

I. Field exploration items

1. Boring 100 mm and 150 mm diameter holes with and without casing pipe in all kinds of soil:
 - a) Upto 10 M depth, using auger
 - b) Upto 30 M depth, using wash pipe and bailer with flap valve.
 - c) Upto 60 M depth using rotary drill.
2. Extending borehole into refusal strata (e.g. hard rock) by percussion or core drilling upto an additional depth of 3 m.
3. Collection of undisturbed samples in thin-walled tube samplers of 75 mm and 100 mm internal diameter.
4. Determination of water level in borehole by electrical sensing.
5. Field permeability test.
6. Standard penetration test.
7. In-situ vane shear test.
8. Static cone penetration test.
9. Dynamic cone penetration test.
10. Vane shear tests on undisturbed samples in the field using pocket vane shear apparatus.
11. Determination of density of soils in-place by the sand replacement method.
12. Determination of moisture content in the field.

II. Laboratory testing items

1. Grain size analysis (including for minus 75 micron fraction).
2. Water content determination.
3. Liquid limit and plastic limit tests
4. Specific gravity determination.
5. Chemical tests for determination of organic content pH value, total soluble solids and total soluble sulphates.
6. Determination of swelling index and swelling pressure.
7. Permeability test by constant head and falling head methods.
8. Determination of moisture content-dry density relationship using light compaction and heavy compaction.
9. Determination of relative density for cohesionless soils.
10. Laboratory vane shear test.
11. Unconfined compression test.

12. Direct shear test.

13. Triaxial shear tests of the following types:

- a) unconsolidated undrained test without and with measurement of pore pressure (UU and UU types).
- b) consolidated undrained test without and with measurement of pore pressure (CU and CU types).
- c) consolidated drained test (CD type).

(N.B. The triaxial test set-up should include facility for back pressure saturation and checking of the degree of saturation attained by measuring B-factor).

14. Consolidation test.

SUGGESTED LIST OF SPECIAL CONDITIONS TO BE INCLUDED IN TENDER/CONTRACT DOCUMENTS RELATING TO SOIL INVESTIGATIONS FOR HIGH EMBANKMENTS

1. Variations regarding number, locations and depth of boreholes

The number, locations and depths of boreholes indicated in the tender are tentative, being based on preliminary assessment and liable to deletions, additions and other changes at the discretion of the Engineer-in-charge prior to or during actual field exploration. No extra claim outside the tendered rates on account of such variations shall be entertained from the contractor.

2. Variations between tendered and executed quantities

The quantities shown against different items of work in the tender schedule are tentative, being based on preliminary assessment and liable to be increased, decreased or deleted at the discretion of the Engineer-in-charge prior to or during the progress of boring, field testing and laboratory testing. Any consequent variation in quantity in respect of any of the items of work shall not cause any variation from the rates quoted in the tender. The contractor shall be paid for the quantum of different items of work as actually executed as per directions of the Engineer-in-charge and on the basis of the rates quoted in the tender, without any extra claim being admitted on account of variation between tendered and executed quantities.

3. Rates quoted to be all-inclusive

The rates quoted in the tender for the different items of work shown in the tender schedule shall be treated as all-inclusive rates, that is, inclusive of charges for plant and equipment, accessories, materials, labour, storage, transportation, location levies and any other cost element.

4. List of plant and equipments

The tenderer shall submit along with his tender a list of plant and equipments with essential descriptions thereof proposed to be used by the tenderer for field exploration and laboratory testing. The authority competent to accept the tender may decide at his discretion whether the plant and equipments as per list submitted by the tenderer are adequate or not for the purpose of the soil investigations and laboratory testing envisaged as per the tender schedule. If the latter be the case, it shall be open to the authority competent to accept the tender either to reject the tender outright or to cause the tenderer to modify his list of plant and equipments suitably. If the tenderer may not modify his list of plant and equipments to the satisfaction of the authority competent to accept the tender, the tender shall stand to be rejected.

5. Work not provided in tender schedule

In respect of any item of work not included in the tender schedule, but requiring to be done as per directions of the Engineer-in-charge, the applicable rate shall be as mutually settled between the Engineer-in-charge and the contractor prior to the actual execution of the relevant item of work.

6. Alterations by tenderer in tender specifications, etc.

In case the tenderer proposes to make any alterations (including additions or deletions) in respect of specifications, conditions and other provisions contained in the tender document issued by the Department, he shall indicate the same clearly in his tender and it shall be open to the authority competent to accept the tender to decide at his discretion whether to accept the alterations proposed by the tenderer or to accept them with modifications mutually agreed to or to reject them altogether. In the last mentioned case, it shall be open to the authority competent to accept the tender to reject the tender outright.

7. Retention of thin-walled tube samplers by the Department

In case of thin-wall tube samples supplied by the contractor but deposited with the Department along with the undisturbed soil samples contained therein, the tube samples with samples shall be retainable by the Department free of charge for a period upto nine months from the date of handing over of the samplers by the contractor to the Engineer-in-charge or his representative. If beyond such period also the samplers are needed to be retained by the Department or the samplers are required to be cut up for recovering samples, the samplers shall not be returnable to the contractor and in lieu thereof, the contractor shall be reimbursed the actual cost of the samplers, which is to be indicated by the contractor while submitting the tender and to be accepted by the authority competent to accept the tender, subject to modifications at his discretion, before issuing the work order. In case there is no agreement between the tenderer and the authority competent to accept the tender regarding the reimbursement cost of sampler tubes not returnable by the Department, the concerned tender is liable to be rejected outright.

8. Obtaining familiarity with site conditions

Before submitting the tender, the tenderer shall familiarize and satisfy himself thoroughly with all aspects of the actual site conditions relevant to the tendered work. Any plea citing lack of familiarity with site conditions on part of the tenderer or the contractor shall not constitute a valid ground for claiming any payment outside the tendered rates or any relaxation of specifications or conditions forming part of the tender.

9. Programme of work

Subject to the target dates specified in the tender, the contractor shall submit to the Engineer-in-charge within two weeks of the issue of the work order a programme of work indicating the proposed dates for commencement/completion of the different phases of soil investigation including laboratory testing. The programme of work, as approved by the Engineer-in-charge and subject to modifications therein (if any) to be mutually settled between the contractor and the Engineer-in-charge, shall not be deviated from except with the prior consent of the Engineer-in-charge.

10. Consultation with Engineer-in-charge during field investigation

All operations in respect of boring, sampling and field tests shall be carried out in the presence of and in consultation with the Engineer-in-charge or his authorized representative. Boring, sampling and field tests shall be done at locations and levels indicated by the Engineer-in-charge or his authorized representative.

11. Employment of Specialist Geotechnical Engineer by the contractor

All aspects of the soil investigation work in the field and laboratory shall be carried out under the supervision of a qualified and experienced Specialist Geotechnical Engineer in the employ of the contractor, with authority to receive and execute instructions from the Engineer-in-charge.

12. Subcontracting

The contractor shall not subcontract any item of soil investigation in the field or the laboratory, except where there is prior agreement in this respect for any specific item of work between the contractor and the Engineer-in-charge. The Engineer-in-charge shall reserve the right to reject any proposal on part of the contractor for subcontracting of work and for laying down conditions to regulate subcontracting, where this has been agreed to.

13. Underground installations

The contractor shall satisfy himself about the locations of all underground installations in consultation with the owners of such installations and take all necessary precautions for not causing damage to such installations in course of the work performed by the contractor or his agents. The liability for any damage caused to such installations shall be borne by the contractor and not by the Department.

14. Use of proper and appropriate plant and equipments

The contractor shall make use of proper and appropriate plant and equipments in good working order for boring, field testing and laboratory testing in accordance with sound engineering practice and conforming to the requirements of relevant Indian Standard Codes/Specifications/Methods of Test, wherever applicable. The contractor shall also remain bound to make full use of the plant and equipments as per list submitted by him along with his tender, also taking into account modifications agreed to prior to the issue of the work order.

15. Procedure for field investigations and reporting of results

Boring, sampling and field tests shall be carried out by the contractor in accordance with sound engineering practice and conforming to the requirements of relevant Indian Standard Codes/Specifications/Methods of Test, wherever applicable. Before shifting the boring rig from any borehole location the contractor shall submit to the Engineer-in-charge (or his authorised representative) the borelog concerning that borehole, containing pertinent observations and full records made during boring, sampling and field testing and get the same approved by the Engineer-in-charge.

16. Observation of ground water level

The ground water level in boreholes shall be determined by the contractor at the start and end of each working shift at site and at such other times, including outside normal working hours, as directed by the Engineer-in-charge. Observation of ground water level in boreholes shall be treated as an integral part of boring work and no separate payment for such observations shall be claimed by the contractor. Ground water observation data shall be reported to the Engineer-in-charge along with other borehole data. If directed by the Engineer-in-charge, the contractor shall be required to leave the casing in place for a period upto 72 hours after the completion of boring for proper observation of the ground water level.

17. Completion of boring to the specified depth

Borings along with associated sampling and field tests shall be made at the locations and to the depths specified in the tender or as directed by the Engineer-in-charge through all types of material encountered including fills, boulders, rock or any other type of obstruction. The contractor shall not abandon or discontinue any boring or remove any casing or equipment from the site of boring without first obtaining the approval of the Engineer-in-charge. No payment shall be made to the contractor in respect of borings which are abandoned before reaching the specified depth or wherein the specified sequence of sampling and field tests have not been carried out. However, if the Engineer-in-charge is satisfied that the contractor is unable to complete any boring or associated field operations upto the specified depth due to having encountered underground utilities or other obstructions of unusual or previously unknown nature, and the failure to penetrate these is not due to the fault of the contractor, the Engineer-in-charge may allow at his discretion payment to contractor based on the actual work done prior to encountering the obstructions.

18. Ownership and preservation of samples recovered from boreholes

All samples of soil or any other material recovered from the boreholes shall become the sole property of the Department as soon as they are recovered and the contractor shall not refuse or delay handing over the same to the Engineer-in-charge, whenever so required by the Engineer-in-charge, on any pretext whatsoever. The Engineer-in-charge may, however, allow the custody of the samples to remain with the contractor for purposes of testing and/or storage.

In respect of samples allowed to remain with the contractor for laboratory testing, a residual portion of each sample tested shall be preserved by the contractor in a sealed airtight container clearly identified for subsequent reference. All sample materials is left over after laboratory testing, including samples not tested, shall also be carefully preserved by the contractor as residual samples in their original containers and in airtight condition. The aforementioned categories of residual samples shall continue to be stored by the contractor in their original sealed condition till instructions are given by the Engineer-in-charge for returning the same to the Department or their disposal otherwise.

19. Back filling borehole

On completion of work at any borehole location, the contractor shall backfill the borehole upto the ground level and restore the site otherwise to its original condition to the satisfaction of the Engineer-in-charge, unless otherwise directed by the Engineer-in-charge.

20. Sequence of testing

The order in which the undisturbed soil samples are to be tested in the laboratory shall ordinarily be the same in which the samples have been recovered in the field unless otherwise directed by the Engineer-in-charge. It shall be opened to the Engineer-in-charge to require that the undisturbed samples collected from a borehole shall not be tested for strength and consolidation properties until the related classification tests have been made and the data therefrom analysed for determining the quantum and nature of the other tests to be performed on the undisturbed samples. The contractor shall not carry out laboratory tests not required to be done as per directions of the Engineer-in-charge and no payment shall be made to the contractor for laboratory tests carried out contrary to the directions of the Engineer-in-charge.

21. Inspection of contractor's laboratory

The Engineer-in-charge or his representatives shall have the right to inspect the contractor's laboratory and the records of all tests done while laboratory testing of soil samples are in progress and also to have the samples of soil tested in their presence or repeated tests done.

22. Procedure for laboratory investigations and reporting of results

All laboratory tests shall be carried out by the contractor in accordance with sound engineering practice and conforming to the relevant Indian Standard Codes/Specifications/Methods of Test, wherever applicable. The contractor shall submit to the Engineer-in-charge abstracts of test data in the prescribed form, alongwith supporting laboratory records of measured and derived values, particle size distribution curves, stress-strain in curves, Mohr circle plots, e-log P curves, moisture density relationship curves etc. Further, if so directed by the Engineer-in-charge, the contractor shall make available the original laboratory data sheets for consultation by the Engineer-in-charge or his representatives.

23. Repeat tests

In respect of results of laboratory tests considered doubtful by the Engineer-in-charge, the contractor shall be required to perform repeat tests in his laboratory in presence of the Engineer-in-charge or his representative and if such repeat tests do not corroborate the results of the earlier tests, no payment shall be made to the contractor for the earlier tests done.

24. Penalty for failure to comply with special conditions

The failure to comply with any of the special conditions at Serial Nos. 9 to 23 above by the contractor shall constitute a breach of contract on part of the contractor for which the contractor shall be liable to incur penalties, which may include inter alia, forfeiture of security deposit and termination of contract.

**LIST OF COMMON FIELD EXPLORATION AND LABORATORY TESTING ITEMS FOR USE IN
FRAMING SOIL INVESTIGATION ESTIMATE**

(N.B. The selection of the items to be included in any particular soil exploration estimate will depend upon site conditions, project features and design objectives. It is likely that a particular soil exploration estimate may not include all the items listed below, while it might include special items not listed below.)

I. Field Exploration

	Item		Unit
1.	Setting up at site including transportation of all necessary plant, equipment and materials for boring, field tests and sampling to the site and withdrawing the same after completion of field work, including restoring the site to its original condition.	..	L.S.
2.	(a) Setting up boring rig at each borehole location, including providing and carrying all necessary plant, equipment and materials for boring, field tests and collection of samples, at each borehole location.	..	Per borehole
	(b) Extra over item 2(a) for borehole locations involving standing water or slush of more than 1 m depth.	..	Per borehole
3.	(a) Boring 150 mm dia. holes including providing casing where necessary in all kinds of soil including gravel, sand, silt and clay or mixtures thereof in strata at depth		
	(i) not exceeding 5 m below G.L.	..	Per metre
	(ii) exceeding 5 m, but not exceeding 30 m below G.L.	..	Per metre
	(iii) exceeding 30 m below G.L.	..	Per metre
	(b) Extra over item 3(a) above for drilling in hard rock or similar refusal strata at any depth.	..	Per metre
4.	(a) Recovering undisturbed soil sample using thin-walled tube sampler of 100 mm internal dia. and min. 600 mm length conforming to IS 2132-1972 at any required depth, including cleaning the borehole before collection of sample, retention of the sampler before testing, waxing, labelling and packing, storage and safe transshipment of the sample to the testing laboratory or any other location as directed by the Engineer-in-Charge.	..	Each sample recovered
	(b) Extra over item 4(a) for collection of undisturbed sample using thin-walled piston sampler, if so directed by the Engineer-in-Charge.	..	Each sample recovered
5.	Conducting in-situ vane shear test in borehole as per IS 4334-1978 at any depth as directed by the Engineer-in-Charge, including cleaning the borehole before conducting the test.	..	Each test
6.	(a) Conducting standard penetration test in borehole as per IS 2132-1963 at any depth as directed by the Engineer-in-Charge including cleaning the borehole before conducting the test.	..	Each test

Item		Unit
(b)	Recovering the sample contained in the split-spoon sampler and preserving the same in air-tight sample container including waxing, labelling, packing, storage, transshipment and cost of non-returnable sample container.	.. Each sample recovered
7.	Conducting static cone penetration test as per IS 4968 (Part I)-1977 upto any depth, as directed by the Engineer-in-Charge.	.. Per metre
II. Laboratory testing		
1.	(a) Carrying out grain size analysis using 100 mm, 80 mm, 20 mm, 4.75 mm, 2 mm, 425 micron and 75 micron IS sieves as per IS 2720 (Part IV)-1975.	.. Each sample
	(b) Extra over item 1(a) for carrying out grain size analysis of the fraction passing 75 micron sieve as per IS 2720 (Part IV)-1975.	.. Each sample
2.	Determination of natural moisture content as per IS 2720 (Part II)-1973	.. Each sample
3.	Determination of liquid limit and plastic limit (on samples other than purely cohesionless sand or gravel) as per IS 2720 (Part V)-1970.	.. Each sample
4.	Determination of specific gravity as per IS 2720 (Part III)-1964.	.. Each sample
5.	Determination of organic matter content of soil as per IS 2720 (Part XXII)-1972.	.. Each sample
6.	Determination of moisture content - dry density relationship using light compaction as per IS 2720 (Part VII)-1974.	.. Each sample
7.	Determination of unconfined compression strength as per IS 2720 (Part X)-1973.	.. Each sample
8.	Determination of shear strength parameters from direct shear test as per IS 2720 (Part XIII)-1972 including determination of bulk density natural moisture content and void ratio (by testing a set of minimum three specimens from the same sample at different normal stresses)	
	(a) on undisturbed sample	.. Each sample
	(b) on remoulded sample	.. Each sample
9.	Determination of shear strength parameters from unconsolidated undrained triaxial test as per IS 2720 (Part XI)-1970 including determination of bulk density natural moisture content and void ratio (by testing a set of minimum three specimens from the same sample at different cell pressures)	
	(a) on undisturbed sample	.. Each sample
	(b) on remoulded sample	.. Each sample
10.	Determination of shear strength parameters from consolidated undrained test with measurement of pore pressure as per IS 2720 (Part XII)-1975 including determination of bulk density, natural moisture content, A-factor and B-factor (by testing a set of minimum three specimens from the same sample at different consolidation pressures)	
	(a) on undisturbed sample	.. Each sample
	(b) on remoulded sample	.. Each sample

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Item		Unit
11.	Determination of C_c and C_v from consolidation test as per IS 2720 (Part XV)-1965	.. Each sample
III.	Others	
12.	(a) Compiling and presentation of consolidated report (in quadruplicate) on soil investigation including borelogs, subsoil profiles, results and records of field tests, results and records of laboratory tests and other pertinent information.	.. L.S.
	(b) Extra over item 11(a) for supplying extra copies of consolidated report on soil investigations.	.. Per copy

304/95

Item		Unit
11.	Determination of C_c and C_v from consolidation test as per IS 2720 (Part XV)-1965	.. Each sample
III.	Others	
12.	(a) Compiling and presentation of consolidated report (in quadruplicate) on soil investigation including borelogs, subsoil profiles, results and records of field tests, results and records of laboratory tests and other pertinent information.	.. L.S.
	(b) Extra over item 11(a) for supplying extra copies of consolidated report on soil investigations.	.. Per copy

ANNEXURE 'P'

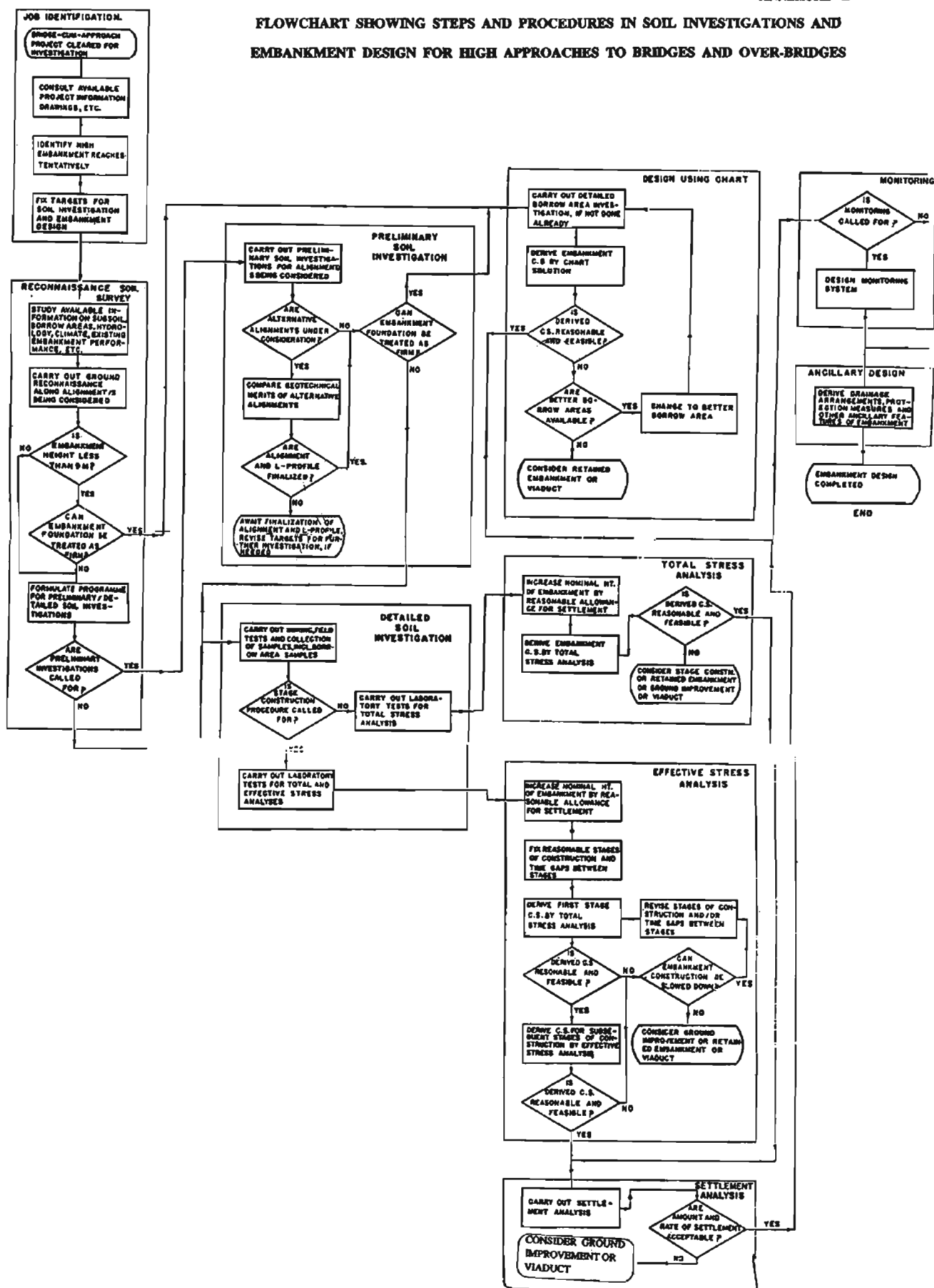
**LIST OF ISI CODES/SPECIFICATIONS RELATING TO SOIL EXPLORATION AND TESTING
(AS IN FEB. 1979, LIABLE TO CHANGE FROM TIME TO TIME)**

1.	IS: 1498-1970	Classification and identification of soil for general engineering purposes (first revision)
2.	IS:2131-1963	Method for standard penetration test of soils.
3.	IS:2132-1972	Code of practice for thin-walled tube sampling of soils (first revision)
4.	IS:2720	Methods of test for soils:
	Part I-1972	Preparation of dry soil samples for various tests (first revision)
	Part II-1973	Determination of water content (second revision)
	Part III-1964	Determination of specific gravity
	Part IV-1975	Grain size analysis (first revision)
	Part V-1970	Determination of liquid and plastic limits (first revision)
	Part VI-1972	Determination of shrinkage factors (first revision)
	Part VII-1974	Determination of water content dry density relation using light compaction (first revision)
	Part VIII-1974	Determination of water content dry density relation using heavy compaction (first revision)
	Part X-1973	Determination of unconfined compressive strength (first revision)
	Part XI-1970	Determination of shear strength parameters of a specimen tested in unconsolidated undrained triaxial compression without the measurement of pore water pressure.
	Part XII-1975	Determination of shear strength parameters of soil from consolidated undrained triaxial compression test with measurement of pore water pressure.
	Part XIII-1972	Direct shear test (first revision)
	Part XIV-1964	Determination of density index (relative density) of cohesionless soils.
	Part XV-1965	Determination of consolidation properties.
	Part XXI-1978	Determination of total soluble solids (first revision)
	Part XXII-1972	Determination of organic matter (first revision)
	Part XXVI-1973	Determination of pH value (first revision)
	Part XXVII-1978	Determination of total soluble sulphates (first revision)
	Part XXVIII-1974	Determination of dry density of soils, in place, by the sand replacement method (first revision)

	Part XXIX-1975	Determination of dry density of soils, in place, by the core cutter method (first revision)
	Part XXX-1968	Laboratory vane shear test
	Part XXXIII-1967	Determination of the density in place by ring and water replacement method.
	Part XXXIV-1972	Determination of density of soil in-place by rubber balloon method.
	Part XXXV-1974	Measurement of negative pore water pressure
	Part XXXVI-1975	Laboratory determination of permeability of granular soils (constant head)
	Part XXXVII-1976	Determination of sand equivalent values of soils and fine aggregates
	Part XXXVIII-1976	Compaction central test (Half method)
	Part XXXIX-1977	Direct shear test for soils containing gravels Sectional Laboratory test
	Part XL-1978	Determination of swelling potential of soils
	Part XLI-1978	Determination of swelling pressure of soils
5	IS:2809-1972	Glossary of terms and symbols relating to soil engineering (first revision)
6	IS:4434-1978	Code of practice for in-situ vane shear test for soils (first revision)
7	IS:4968	Method for subsurface sounding for soils
	Part I-1977	Dynamic method using 50 mm cone without bentonite slurry (first revision)
	Part II-1977	Dynamic method using cone and bentonite slurry (first revision)
	Part III-1977	Static cone penetration test (first revision)
8	IS:8763-1978	Code of Practice for undisturbed sampling of sands
9	IS:1892-1962	Code of practice for silt investigation for foundations.

N.B. Since ISI Codes/Specifications are liable to revisions/additions/deletion from time to time, the currently applicable ISI Codes/Specifications should be ascertained and made use of.

FLOWCHART SHOWING STEPS AND PROCEDURES IN SOIL INVESTIGATIONS AND EMBANKMENT DESIGN FOR HIGH APPROACHES TO BRIDGES AND OVER-BRIDGES



**407 SPECIFICATIONS-SEE MINISTRY OF SURFACE TRANSPORT (ROADS WING)
SPECIFICATIONS FOR ROAD AND BRIDGE WORKS (SECOND REVISION) 1988**

<i>Code No.</i>	<i>Circular No. & Date</i>	<i>Brief Subject</i>	<i>Page No.</i>
407.14	RW/33035/2/93/S&R dated 9.8.95	Ministry of Surface Transport (Roads Wing's) Specifications for Road and Bridge Works (Third Revision 1995) - Adoption thereof on all National Highways and Centrally Aided Woks	407/30
407.15	RW/NH-33035/2/93/S&R dated 16.11.95	Ministry of Surface Transport (Roads Wing's) Specifications for Road and Bridge Works (Third Revision 1994) - Adoption thereof on all National Highways and Centrally Aided Woks - Corrigendum to Clause No. 408.5.1 and 408.5.3	407/30

No.RW/33035/2/93/S&R**Dated, the 9th August, 1995**

To

The Chief Engineers (dealing with National Highways and other Centrally aided works), Public Works Department of all States and Union Territories, Director General (Works), Central Public Works Department, Director General Border Road

Subject: Ministry of Surface Transport (Roads Wing's) Specifications for Road and Bridge Works (Third Revision 1995) - Adoption thereof on all National Highways and Centrally Aided Works

Ministry has revised (Third Revision) the "Specifications for Road & Bridge Works" which is now available for sale from the Indian Roads Congress, New Delhi. This has been priced at Rs.400/- per copy.

2. The third revised edition of the "Specifications" includes specification for a number of new items such as erosion control, slurry seal and recycling of bituminous pavements etc. A full section has been devoted to concrete pavements, geosynthetics. In bridges, a section has also been added for expansion joints and wearing coat and appurtenances etc. Overall, attempt has been to ensure through these specification high quality standards in execution of highway and bridge works.

3. It has been decided that all NITs and Tender Documents should henceforth be issued based on the third revision and all future projects and estimates pertaining to National Highway works should be framed in accordance with these provisions.

In order to ensure this, it is requested that necessary copies of the specifications may be obtained directly from the Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi immediately and all officers working in your organisation directed for taking suitable action accordingly.

Kindly acknowledge this letter.

No.RW/NH-33035/2/93/S&R**Dated, the 16th November, 1995**

To

The Chief Engineers (dealing with National Highways and other Centrally aided works), Public Works Department of all States and Union Territories, Director General (Works), Central Public Works Department, Director General Border Road, Chairman, National Highways Authority of India

Subject: Ministry of Surface (Roads Wing's) Specifications for Road and Bridge Works (Third Revision 1994) - Adoption thereof on all National Highways and Centrally Aided Works - Corrigendum to Clause No. 408.5.1 and 408.5.3

Please refer to the correspondence resting with letter of even number dated 9th August, 1995 vide which it was intimated that henceforth all NITs and Tender Documents need to be based on the third revision. The paras 408.5.1 and 408.5.3 under Clause 408 "cement concrete kerb and kerb with channel" have been reviewed and amended. The amended paras as under shall be applicable.

- 408.5.1 Kerb shall be laid on firm foundation of minimum 150 mm thickness of cement concrete of M10 grade cast in situ or on extended width of pavement. The foundation shall have a projection of 50 mm beyond the kerb stone. Before laying the foundation of lean concrete, the base shall be levelled and slightly watered to make it damp.
- 408.5.3 After laying the kerbs and just prior to hardening of the concrete, saw cut grooves shall be provided at 5 m intervals or as specified by the Engineer.

602 ROAD SIGNS AND MARKINGS

Code No.	Circular No. & Date	Brief Subject	Page No.
602.22	RW/NH-33023/31/88-DO III dated 4.12.95	Policy regarding installation of Road Signs using Retro-reflective Sheetings on National Highways	602/26 to 33
602.23	RW/NH-33023/31/88-DO III dated 15.1.96	Use of Sheet Moulding Compound (SMC) Plates for Road Traffic Signs	602/33
602.24	RW/NH-11047/1/87-DO I 8.2.96	-do-	602/33 & 34
602.25	RW/NH-33023/31/88-DO III dated 5.2.96	Policy regarding installation of road signs using retro-reflective sheetings on National Highways	602/34
602.26	RW/NH-33023/31/88-DO III dated 5/15.2.96	Installation of Road Signs Using Retro- reflective Sheetings on National Highways - Feedback regarding Field Performance	602/34 & 35
602.27	RW/NH-33023/31/88-DO III dated 22.3.96	Policy regarding private participation in provision of Retro-reflective road signs on National Highways	602/35 & 36
602.28	RW/NH-33023/31/88-DO III dated 26.8.96/9.9.96	Road signs on National Highways using Retro-reflective sheeting	602/36 & 37
602.29	RW/NH-33023/31/88-DO III dated 19.3.97	Policy regarding Private Participation in provision of retro-reflective road signs on National Highways - Model draft agreement	602/37 to 40
602.30	RW/NH-33023/10/97-DO III dated 11.6.97	Tentative Specifications for Reflective Pavement Markers (Roads Studs)	602/40 to 44
602.31	RW/NH-33023/31/88-DO III dated 9.2.98	Private participation in provision of retro- reflective road signs on National Highways	602/44

604 HIGHWAY SAFETY-RAILS, BARRIERS, SPEED BREAKERS

604.16	RW/NH-11064/1/91-DO I dated 1.11.94	Provision of Safety Measures at Approaches to Railway Level Crossings	604/29
604.17	RW/NH-11064/1/91-DO I dated 28.6.96	Construction of Speed Breakers : Policy regarding	604/29 to 31
604.18	RW/NH-33044/11/96-S&R dated 20.12.96	Safety precautions on 2-lane National Highways with paved shoulders	604/32 & 33

No.RW/NH-33023/31/88-DO III**Dated, the 4th December, 1995**

To

The Secretaries, PWD of all States/UTs, Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States and Union Territories, Director General, (Border Road), Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Policy regarding installation of Road Signs using Retro-reflective Sheetings on National Highways

The Ministry vide its Circular No. RW/NH-33023/31/88-DO III dated 2.5.94 had brought out guidelines for use of retro-reflective sheetings for road signs with two types of materials namely 'High Intensity Grade' and 'Engineering Grade' (Annex-I). While encapsulated lens type retro-reflective sheetings signs only were specified earlier for high intensity grade, it has now been decided to include micro-prismatic type materials also, for providing high intensity grade road signs. The guidelines earlier circulated have accordingly been modified to facilitate use of these materials for road signs along National Highways (Annex-II).

2. A typical warranty supplied by the known manufacturers of micro-prismatic materials for road signs is enclosed at Annex-III. It is suggested that a feedback regarding their performance at site may be sent to this Ministry wherever these are installed.

Enclosure with letter No.RW/NH-33023/31/88-DO III dated, the 4th December, 1995

Annex I

801.3. Traffic Signs having retro-reflective sheeting:

801.3.1. General Requirements:

The retro-reflective sheetings used on the sign shall consist of white or coloured sheeting having a smooth outer surface which has the property of retro-reflection over its entire surface. It shall be weather-resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained from a reputed laboratory by the manufacturer of the sheeting. The reflective sheeting shall be either of engineering grade material with enclosed lens or of high intensity grade with encapsulated lens/micro prismatic type. The type of sheeting to be used would depend upon the type, functional hierarchy and importance of the road.

801.3.2. High Intensity Grade Sheeting:

801.3.2.1. Encapsulated Lens Type:

This sheeting shall be of encapsulated lens type consisting of spherical glass lens elements, adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard E:810) as indicated in Table 800-1 (a).

Table 800-1 (a)

**ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE
(ENCAPSULATED LENS TYPE) SHEETING (CANDELAS PER LUX SQUARE METRE)**

Observation angle (in degrees)	Entrance Angle (in degrees)	White	Yellow	Orange	Green/ Red	Blue
0.2	-4	250	170	100	45	20
0.2	+30	150	100	60	25	11
0.5	-4	95	62	30	15	7.5
0.5	+30	65	45	25	10	5.0

801.3.2.2. Micro-prismatic Type:

These sheetings shall be of unmetallised micro-prismatic material with high density of microscopic prism elements coated with pressure sensitive adhesive. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection determined in accordance with ASTM standard E:810 as indicated in Table 800-1 (b)

Table 800-1 (b)

**ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE
(MICRO-PRISMATIC) SHEETING (CANDELAS PER LUX SQUARE METRE)**

Observation angle (in degrees)	Entrance Angle (in degrees)	White	Yellow	Orange	Green/ Red	Blue
0.1	-4	400	270	160	56	32
0.2	-4	250	170	100	35	20
0.2	+30	80	64	34	9	5
0.5	-4	135	100	64	17	10
0.5	+30	55	37	24	6.5	3.5

801.3.2.3. When totally wet, the sheeting shall not show less than 90% of the values of retro-reflectance indicated in Table 800-1(a) and 800-1(b) respectively. At the end of 7 years, the sheeting shall retain at least 80% of its original retro-reflectance except for orange colour.

801.3.3. Engineering Grade Sheeting:

This sheeting shall be of enclosed lens type consisting of microscopic lens elements embedded beneath the surface of a smooth, flexible, transparent, water-proof plastic, resulting in a non-exposed lens optical reflecting system. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard : E-810) as indicated in Table 800-2.

Table 800-2

ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR ENGINEERING GRADE SHEETING (CANDELAS PER LUX PER SQUARE METRE)

Observation Angle in degree	Entrance angle in degree	White	Yellow	Orange	Green	Red	Blue
0.2	-4	70	50	25	9.0	14.5	4.0
0.2	+30	30	22	7.0	3.5	6.0	1.7
0.5	-4	30	25	13.5	4.5	7.5	2.0
0.5	+30	15	13	4.0	2.2	3.0	0.8

When totally wet, the sheeting shall not show less than 90% of the values, of retro-reflection indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at least 50% of its original retro-reflectance.

801.3.4. Messages/Borders:

The messages (legends, letters, numerals etc.) and borders shall either be screen-printed or of cut-outs. Screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. Cut-outs shall be of materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer.

801.3.5. For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50% of the values of corresponding colour in Tables 800-1(a), 800-1(b) and 800-2 as applicable.

801.3.6. Cut-out messages and borders, wherever used, shall be made out of retro-reflective sheeting (as per Clause 801.3.2 or 801.3.3 as applicable) except those in black which shall be of non-reflective sheeting.

801.3.7. Colour:

Unless otherwise specified, the general colour scheme shall be as stipulated in IS: 5 "Colour for Ready Mixed Paints".

Blue	IS	Colour No. 166 : French Blue
Red	IS	Colour No. 537 : Signal Red
Green	IS	Colour No. 284 : India Green
Orange	IS	Colour No. 591 : Deep Orange

The colours shall be durable and uniform in acceptable hue when viewed in day light or under normal headlights at night.

801.3.8. Adhesives:

The sheeting shall either have a pressure sensitive adhesive of the aggressive-tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack free adhesive activated by heat, applied in a heat-vacuum applicator, in a manner recommended by the sheeting manufacturer. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure-sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's specifications. Sheeting with adhesives requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

801.3.9. Refurbishment:

Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminium backing precoated with aggressive-tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the sign and should thoroughly bond with that material.

Alternatively, the aluminium blank shall be re-cycled to a finished condition and new sheetings put on, in an approved manner.

801.3.10. Fabrication:

801.3.10.1. Surface to be reflectorised shall be effectively prepared to receive the retro-reflective sheeting. The aluminium sheeting shall be de-greased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting.

801.3.10.2. Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure sensitive adhesives shall be overlapped not less than 5 mm. Sheeting with heat-activated adhesives may be spliced with an overlap not less than 5 mm or butted with a gap not exceeding 0.75 mm. Where screen printing with transparent colours is proposed, only butt jointing shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

801.3.11. Warranty and Durability:

For each lot of sheetings procured, the contractor shall obtain from the manufacturer a 7 years warranty for satisfactory field performance including stipulated retro-reflectance of the sheetings of high intensity grade and a 5 years warranty for the engineering grade and submit the same to the Engineer. In addition, a 7 years and a five years warranty for satisfactory in-field performance of the finished sign with retro-reflective sheeting of high intensity grade and engineering grade respectively, inclusive of the screen printed or cut-out letters/legends and their bonding to the retro-reflective sheeting shall be obtained from the contractor/supplier and passed on to the Engineer. The contractor/supplier shall also furnish a certification that the signs and materials supplied against the assigned work meet all the stipulated requirements and carry the stipulated warranty. All signs shall be dated during fabrication with indelible markings to indicate the start of warranty. The warranty shall also cover the replacement obligation by the sheeting manufacturer as well as contractor for replacement/repair/restoration of the retro-reflective efficiency.

801.4. Installation:

801.4.1. Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally signs with an area upto 0.9 sq.m. shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanised iron (G.I.). Post-end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant specifications as specified.

801.4.2. All components of signs and supports, other than the reflective portion and G.I. posts shall be thoroughly descaled, cleaned, primed and painted with two coats of epoxy paint. Any part of mild steel (M.S.) post below ground shall be painted with three coats of red lead paint.

801.4.3.

The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size in the case of reinforced concrete or G.I. Posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

801.5. Measurements for Payment:

The measurement for standard cautionary, mandatory and information signs shall be in numbers of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by area in square metres.

801.6. The contract unit rate shall be payment in full for the cost of making the road sign, including all materials, installing it at the site and incidentals to complete the work in accordance with the specifications.

Annex II

GUIDELINES ON THE USE OF RETRO-REFLECTIVE SHEETINGS FOR ROAD SIGNS ON 2-LANE AND 4-LANE NATIONAL HIGHWAY SECTIONS

1. Retro-reflective sheetings of "High Intensity Grade" shall be used for -
 - (i) All Road Signs (viz. regulatory/mandatory, cautionary/warning and informatory) on 4-lane National Highway (NH) sections;
 - (ii) Mandatory/regulatory and cautionary/warning signs on 2-lane NH sections;
 - (iii) Mandatory/regulatory, cautionary/warning and informatory signs on the existing 2-lane NH stretches which are to be widened to 4-lane carriageway in the next 2-3 years;
 - (iv) All overhead signs.
2. Retro-reflective sheeting of "Engineering Grade" shall be used for informatory signs for 2-lane NH sections.
3. **COLOUR SCHEME :**
 - (i) Colour Scheme for mandatory/regulatory and cautionary/warning signs shall conform to IRC:67-1977 "Code of Practice for Road Signs".
 - (ii) Direction, destination and place identification signs shall have green background, white messages (legends, letters, numerals, etc.) and borders instead of white background, black messages and borders.
 - (iii) Colour Scheme for facility information signs, other useful information signs and parking signs shall continue to conform to the provisions contained in IRC:67-1977 "Code of Practice for Road Signs".
4. In respect of informatory signs, the messages/borders shall either be screen-printed or of cut-out, while for warning and regulatory signs, these shall be screen-printed.
5. Clustering and proliferation of road signs shall be avoided for enhancing their effectiveness.
6. **PRIORITY FOR REPLACEMENT :**

Existing road signs with retro-reflective sheetings shall be replaced with signs adopting the above criteria only if they are damaged, worn out or have outlived their useful service life.
7. **TRANSPORTATION & STORAGE :**
 - (i) While transporting the road signs for field installation, they should be secured vertically in racks to prevent them from rubbing against one another.
 - (ii) All signs should be kept dry at all times and should not normally be stored in the open.
 - (iii) The finished signs, if required, shall be stored in an upright position with space in between for air circulation.

8. INSPECTION & UPKEEP :

- (i) Periodic inspection of road signs shall be carried out on a regular basis. During inspection, the following aspects shall be checked in particular and appropriate corrective measures adopted :
 - (a) Condition of sign face - major cracking, blistering, missing message, etc.
 - (b) Orientation and structural stability of the post(s).
 - (c) Discolouration, streaking or fading of the sign.
 - (d) Visibility of sign, roadside plantation or a structure may be hiding the sign.
 - (e) Dirt or other substance on sign.
 - (f) Damages/removal of the sign due to accident or vandalism.
 - (g) Retro-reflectance properties.
- (ii) Sometimes, dirt, fungus or mildew can cause the signs to lose their retro-reflective properties. In case the dirt accumulation is severe and/or signs are in heavy industrial areas, washing of signs with a mild non-abrasive detergent free of solvents or alcohols should be carried out periodically.
- (iii) Sometimes, paper posters are pasted on the face of the road signs making them invisible. These should be immediately removed, apart from taking preventive action to avoid their recurrence.

Annex-III

WARRANTY FOR INDIA

STIMSONITE HIGH PERFORMANCE GRADE RETRO-REFLECTIVE SHEETING Series # 4200

1. STIMSONITE Corporation (USA) warrants that the STIMASONITE High Performance Grade retro-reflective sheeting (STIMSONITE Sheeting) as supplied new, meets the values set forth in the India Ministry of Surface Transportation Specification for Traffic Sign Retro-Reflective Sheeting, Table 800-0.
2. STIMSONITE warrants that subject to conditions stated herein, for a period of at least seven years from the documented date of sign fabrication, the STIMSONITE Sheeting will retain its effectiveness as a component of traffic control and guidance signs, that it will continue to adhere to the sign substrate, that it will retain effective daytime colour, that it will continue to provide effective nighttime retro-reflectivity and that it will meet the minimum retro-reflectivity values set forth in Table 1 below.

**Table 1 Minimum Retained Retro-reflectivity
(Candela/Lux/Meter²)
@ Observation Angle = 0.2°**

	@ 5-Year	@ 7-Years
White	212	200
Red	29	28
Yellow	144	136
Blue	17	16
Green	29	28
Brown	6	5.5

Orange*

75 *NOTE : Warranty period for Orange is 3-years

All values tested at -4 degrees Entrance Angle.

STIMSONITE WARRANTY - INDIA

3. Signs made with STIMSONITE Sheeting which is screen printed using approved STIMSONITE Transparent Colours are covered under this WARRANTY. Such signs shall have reflectivity values not less than 75% of the above values for the same colour. Signs made using inks of other manufacturers are not covered by this WARRANTY unless a written, signed and dated ADDENDUM to this WARRANTY is obtained from STIMSONITE which expressly extends the STIMSONITE sheeting WARRANTY to include the use of that brand of colour (ink) and in the specifically stated colour(s). The ADDENDUM will not extend the STIMSONITE sheeting WARRANTY to the adhesion or durability of the other brand of colour itself over which STIMSONITE has no control.

4. Signs made with STIMSONITE Sheeting which is overlaid with STIMSONITE Coloured Overlay Films or Opaque Black Lettering Film are covered by this WARRANTY. Signs using overlay films of other manufacturers are not covered by this WARRANTY unless a written, signed and dated ADDENDUM to this WARRANTY is obtained from STIMSONITE which expressly extends the STIMSONITE sheeting WARRANTY to include the use of that specific brand and colour of overlay film. The ADDENDUM will not extend the STIMSONITE sheeting WARRANTY to the adhesion or durability of the other overlay film itself over which STIMSONITE has no control.

5. Signs made with STIMSONITE Sheeting which is direct-applied as copy (legend) over another brand of reflective sheeting or which is mounted as the sign background over which is direct-applied another brand of reflective sheeting as copy (legend) are not covered by this WARRANTY unless a written, signed and dated ADDENDUM to this WARRANTY is obtained from STIMSONITE which expressly extends the STIMSONITE sheeting WARRANTY to include the use of that specific brand of reflective sheeting in combination with STIMSONITE sheeting and only if applied by a method approved by STIMSONITE. The ADDENDUM will not extend the STIMSONITE sheeting WARRANTY to the adhesion, performance, or durability of the other reflective sheeting itself over which STIMSONITE has no control.

6. The user-agency agrees to require that all signs be dated at time of sign fabrication and that reliable records be kept of the fabrication date for each warranted sign. Such records shall be available for review and verification by Stimsonite. If within 7 years of the verified date of sign fabrication, the sign becomes ineffective for its intended purpose when viewed from a moving vehicle, or its retro-reflectivity values fail to meet the minimum average values as given in Table 1, the sign contractor and STIMSONITE shall jointly and severally agree to replace or repair the sign (at their option) restoring its surface to the guaranteed retro-reflective efficiency, according to the following schedule :

a.	For years 1 through 5:	AT NO COST to the user.
b.	For years 6 and 7:	(If the user is prepared to pay the balance of the cost as indicated).
	Cost of Sign Replacement or Repair Paid by STIMSONITE and the Contractor	Cost of Take-down Old and Erect New Paid by STIMSONITE and the Contractor
Year 6:	75%	20%
Year 7:	50%	15%

The new sign which replaced a prior sign under these warranty conditions is covered under the same terms and conditions of the original sign, but only for the remaining balance of the warranty period applicable to the original sign. Both markings on replacement signs and the supporting documentation shall clearly establish original fabrication date (Warranty base date) of the sign which was replaced.

8. The sign repair or replacement shall take place within a reasonable period of time after receipt of written notice.

9. This warranty shall NOT extend to signs to which any of the following applies :

9.1 If the mounting of the STIMSONITE sheeting to the sign substrate was not according to STIMSONITE's written recommendations, if the STIMSONITE sheeting was mounted on a substrate material which is not approved, or if the sign surface was not properly and thoroughly cleaned.

602/33

9.2 If the fabrication, storage, screening, handling, or cleaning of the sheeting or sign have not been in conformance with STIMSONITE's written recommendations.

9.3 If the sign or sheeting have been exposed to extreme climatic or environmental conditions, (i.e. heavy hail, volcanic eruption, industrial pollutants, splashed solvent) or vandalism, which can reasonably be expected to have affected sign or sheeting performance.

9.4 Any failure of or damage to the sign substrate.

November 1995

AUTHORISED PRESENTATIVE/SUPPLIERS OF STIMSONITE :

M/s. Arrow Coated Products Ltd.,
159, Mittal Industrial Estate,
SANJAY, Building NO. 5-B,
Marol Naka,
Andheri-Kurla Road, Andheri (E),
BOMBAY-400059

602.23

No.RW/NH.33023/31/88-DO.III

Dated, the 15th January, 1996

To

Chief Engineers of all States and Union Territories dealing with Roads

Subject: Use of Sheet Moulding Compound (SMC) Plates for Road Traffic Signs

M/s. Sintex Industries Limited, Kalol, Gujarat have approached this Ministry for introduction of Sheet Moulding Compound (SMC) plates being manufactured by them for road and traffic signs. These plates manufactured by the method of hot processed compression moulding are claimed to have many advantages like light weight thus easy in handling and installation, economised due to low maintenance cost, and free from theft or pilferage on account of zero resale value etc. These plates can be fixed in the same way as mild steel (MS) or Aluminium sign plates on MS angles. The plates are reported to have comparable strength parameters not affected over a temperature range of -65°F to 212°F. The firm claims to supply the complete road and traffic signs as per IRC specifications. This material is reported to be in use in USA and middle east countries. Though this material appears to have promising potential, its merits, suitability, economics and other performance characteristics are required to be examined in Indian conditions before considering for general adoption. For this purpose you may consider using this material on experimental basis, whenever a new sign is to be put up and its performance be monitored. The normal procedure of procurement should be followed.

2. For any further information and details regarding this material i.e. its specification, mode of application, availability, price etc. Mr. K.R. Ananthanarayanan, Marketing Manager, Sintex Industries Limited, Kalol, Gujarat-382721 may be contacted.

602.24

No.RW/NH-11047/1/87-DO.I

New Delhi, the 8th February, 1996

To

The Secretaries (dealing with National Highways) Public Works Departments of all States and Union Territories

I am directed to refer to this Ministry's letters of even number dated 8.9.88 and 7.7.89 regarding the guidelines for installation of distance informatory/destination sign boards along National Highways and the languages to be used on the sign boards. The Hindi Salahakar Samity of Ministry of Parliamentary Affairs, in its meeting held on 15.9.95 has desired that the sign boards of roads and bridges should be in Hindi.

2. It is presumed that the State Governments must have followed the same guidelines in respect of the languages to be used for the name boards of bridges on the National Highways. However, it is requested that the name boards of bridges on National Highways may please be written in Hindi and English (with Hindi inscription at the top and English below) and where Hindi is not the regional language, the regional language of the State may also be inscribed below English language on the name boards of the bridges in future.

3. These instructions may strictly be complied with henceforth.

602.25

No.RW/NH-33023/31/88-DO.III

Dated the 5th February, 96

To

The Chief Engineers of all States/U.Ts., P.W.D. (dealing with National Highways and other centrally sponsored schemes), Director General (Border Roads), Director General (Works), Central Public Works Department

Subject: Policy regarding installation of road signs using retro-reflective sheetings on National Highways

The policy and guidelines regarding installation of retro-reflective road signs on National Highways have been circulated by this Ministry from time to time. Accordingly, retro-reflective materials of requisite grade, quality and warranty only are to be used for installation through authorised agencies.

2. As against the above requirements, it has been brought to the notice of this Ministry that sheetings of inadequate and inferior quality are made use of resulting in reduced efficacy and life of the signs installed. In order to obviate such instances, it is essential that materials of the requisite quality and warranty only are used and their performance tested at the required time intervals.

3. Identification of sign boards installed under various contracts are to be ensured through proper documentation and markings on the sign boards. In this connection, Para 801.3.11 of this Ministry's Circular of even number dated 4.12.95 may also be referred to. It is requested that all signs boards using retro-reflective sheetings be marked at the back of the sign boards, to indicate (a) names of manufacturers of sign boards and sheetings (b) type and grade of retro-reflective sheetings used and (c) the date of start of warranty, to facilitate timely performance evaluations to ensure proper quality of signs.

602.26

No.RW/NH-33023/31/88-DO.III

Dated the 5th/15th February, 96

To

The Chief Engineers of all States/U.Ts., P.W.D. (dealing with National Highways and other centrally sponsored schemes), Director General (Border Roads), Director General (Works), Central Public Works Department

Subject: Installation of Road Signs Using Retro-reflective Sheetings on National Highways - Feedback regarding Field Performance

The Ministry has been recommending installation of road signs using retro-reflective sheetings on National Highways since quite some time in the past. Detailed policy and guidelines for the use of these sheetings were circulated from time to time and in this connection, Ministry's letter Nos. NH-11047/1/87-DO.I dated 8th September, 1988, 21st December, 1988, 7th July, 1980, 11th March, 1993 and No. RW/NH-33023/31/88-DO.III dated 2.5.94 and 4.12.95 may be referred to. Since the guidelines as well as Ministry's specifications clearly stipulate the warranty requirements for different grades of retro-reflective sheetings, it is necessary that the field performance levels warranted by the sign manufacturers are tested on all signs installed from time to time before the expiry of the warranty period (seven years for high intensity grade and five years for engineering grade).

2. It is presumed that the State Governments must have followed the same guidelines in respect of the languages to be used for the name boards of bridges on the National Highways. However, it is requested that the name boards of bridges on National Highways may please be written in Hindi and English (with Hindi inscription at the top and English below) and where Hindi is not the regional language, the regional language of the State may also be inscribed below English language on the name boards of the bridges in future.

3. These instructions may strictly be complied with henceforth.

602.25

No.RW/NH-33023/31/88-DO.III

Dated the 5th February, 96

To

The Chief Engineers of all States/U.Ts., P.W.D. (dealing with National Highways and other centrally sponsored schemes), Director General (Border Roads), Director General (Works), Central Public Works Department

Subject: Policy regarding installation of road signs using retro-reflective sheetings on National Highways

The policy and guidelines regarding installation of retro-reflective road signs on National Highways have been circulated by this Ministry from time to time. Accordingly, retro-reflective materials of requisite grade, quality and warranty only are to be used for installation through authorised agencies.

2. As against the above requirements, it has been brought to the notice of this Ministry that sheetings of inadequate and inferior quality are made use of resulting in reduced efficacy and life of the signs installed. In order to obviate such instances, it is essential that materials of the requisite quality and warranty only are used and their performance tested at the required time intervals.

3. Identification of sign boards installed under various contracts are to be ensured through proper documentation and markings on the sign boards. In this connection, Para 801.3.11 of this Ministry's Circular of even number dated 4.12.95 may also be referred to. It is requested that all signs boards using retro-reflective sheetings be marked at the back of the sign boards, to indicate (a) names of manufacturers of sign boards and sheetings (b) type and grade of retro-reflective sheetings used and (c) the date of start of warranty, to facilitate timely performance evaluations to ensure proper quality of signs.

602.26

No.RW/NH-33023/31/88-DO.III

Dated the 5th/15th February, 96

To

The Chief Engineers of all States/U.Ts., P.W.D. (dealing with National Highways and other centrally sponsored schemes), Director General (Border Roads), Director General (Works), Central Public Works Department

Subject: Installation of Road Signs Using Retro-reflective Sheetings on National Highways - Feedback regarding Field Performance

The Ministry has been recommending installation of road signs using retro-reflective sheetings on National Highways since quite some time in the past. Detailed policy and guidelines for the use of these sheetings were circulated from time to time and in this connection, Ministry's letter Nos. NH-11047/1/87-DO.I dated 8th September, 1988, 21st December, 1988, 7th July, 1980, 11th March, 1993 and No. RW/NH-33023/31/88-DO.III dated 2.5.94 and 4.12.95 may be referred to. Since the guidelines as well as Ministry's specifications clearly stipulate the warranty requirements for different grades of retro-reflective sheetings, it is necessary that the field performance levels warranted by the sign manufacturers are tested on all signs installed from time to time before the expiry of the warranty period (seven years for high intensity grade and five years for engineering grade).

2. Since a considerable number of signs installed in the initial stages may be nearing their terminal period of warranty, it is requested that a detailed stock of signs installed in your State be taken and performance measurements carried out through recognised laboratories/research or academic institutions equipped with such facilities. An inventory of such records may be maintained at the field units and cases where performance deficiencies are observed may be taken up with the concerned sign manufacturer for invoking the replacement obligations.

3. It is also requested that division-wise summary reports on the status indicating number of signs installed, tested and found complying with field performance requirements, be supplied to this Ministry for information and necessary action.

602.27

No.RW/NH-33023/31/88-DO.III

Dated the 22nd March, 1996

To

The Secretaries, PWD of all States/UTs, Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States and Union Territories, Director General Border Road, Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Policy regarding private participation in provision of Retro-reflective road signs on National Highways

As per the existing policy of the Ministry, advertisements are not allowed within the right of way of National Highways, as they might distract the attention of the drivers. Policy in this regard is contained in IRC:46-1976 "A policy of roadside advertisements". As per this policy, some relaxation can be allowed in public interest for informative advertisements (such as Hospital, Name of town), advertisements relating to premises on which these are displayed (such as property of XYZ) and advertisements of temporary nature such as Diwali Mela etc.

2. Road signs on our National Highways are inadequate. Due to lack of resources, it has not been possible to augment these to the desired extent. In the recent past the Govt. have been actively considering involvement of Private entrepreneurs in the development of National Highways. This Ministry has also received some proposals/suggestions for the involvement of private entrepreneurs to augment the Govt.'s effort for provision of road signs in urban and rural areas. Such signs have already been tried in metropolitan cities like Bombay, Madras, Bangalore, etc. without any reported adverse impact by the local bodies.

3. After duly considering the merits and demerits of such private participation, it has now been decided by the Ministry that privately sponsored retro-reflective traffic signs could be allowed in selected locations, provided that the advertisement display is regulated by restricting it to the name or logo only of the firms and without unduly affecting the aesthetics of the highway and attention of the drivers.

4. General guidelines and technical specifications to be followed for such privately sponsored road signs are enclosed at Annex-I for introducing the same on trial basis. All such proposals should be submitted to the Ministry along with the recommendations of the State PWDs. for prior approval. The performance of the scheme may please be monitored and feedback sent to this Ministry.

Enclosure to letter No.RW/NH-33023/31/88-DO.III, dated the 22nd March, 1996

Annex-I

Providing retro-reflective traffic signs on National Highways under private participation

1. All traffic signs proposed under private sponsorship shall conform to IRC:67-1977 "Code of practice for road signs" and Ministry's Circular No. NH.11047/1/87-DO.I dated 8.9.1988 (Guidelines for installation of distance informative/destination signs along National Highways) and No.RW/NH.33023/31/88-DO.III dated 4.12.1995 (Policy

regarding installation of road signs using retro-reflective sheetings on National Highways). The specifications for the advertisements of different categories of signs shall be as under :

(i) **Gantry mounted signs**

For Gantry mounted signs, the vertical clearance available under the sign/display panel as also the lateral clearance shall be in accordance with IRC:54-1974 "Lateral and Vertical Clearances at underpasses for vehicular traffic". The height of the sign panel shall be 2.1 metre. The structural stability of the gantry mounted sign shall be checked for safety against wind and other forces. The material and colour scheme for gantry mounted signs shall be in accordance with the Ministry's circular No. RW/NH-33023/31/88-DO.III dated 4.12.95. The plate displaying sponsoring firm's logo/name shall be hung underneath the sign panel in the central portion after ensuring the vertical clearance in accordance with IRC:54-1974. The length of this plate shall be restricted to the length of the central panel and shall not exceed 4.5 metres. The width of the advertisement panel shall be restricted to 0.3 metre. For cantilevered gantry mounted signs, the plate displaying sponsors name/logo would also be hung below the sign panel after ensuring the prescribed vertical clearance. The length of the plate shall be restricted to that of sign panel and width shall not exceed 0.3 metre. The advertisement shall contain only logo and/or the name of the sponsor and the colour scheme for the same shall be only black and white.

(ii) **Kerb mounted signs**

The kerb mounted informatory signs would conform to Ministry's circular No. NH.11047/1/87-DO.I dated 8th September, 1988 and IRC:67-1977 for its dimensions, height, placement etc. The colour scheme for road signs shall be, as given in the Ministry's circular No. RW/NH.33023/31/88-DO.III dated the 4th December, 1995. The advertisement plate containing the sponsor firm's logo/name shall be 0.15 metre wide and would span between the support posts at 0.10 metre below the sign panel. In case of kerb mounted cautionary signs, advertisement plate shall be put on the supporting posts at 0.10 metre below the sign panel with the advertisement panel dimension not exceeding 0.50 m x 0.15 m. The colour scheme of the advertisement panel shall be only in black and white.

2. **Procedural requirements**

The State PWDs shall invite proposals from private entrepreneurs through open advertisement indicating the likely locations or stretches of the road within their jurisdiction for such scheme. In exceptional cases the entrepreneurs can also suggest locations and stretches under this scheme. The final selection will rest with the competent road authorities. The entrepreneurs will have to enter into an agreement with the State PWDs for provision, installation maintenance and up-keep of these road signs to the entire satisfaction of the road authorities. The initial contract period for the schemes shall be a maximum of 5 years. The agreement shall provide for removal of these signs, as and when required by the road authorities.

602.28

No. RW/NH-33023/31/88-DO.III

Dated 26.8. 96/9.9.96

To

The Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all State and Union Territories, Director General (Border Roads), Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Road signs on National Highways using Retro-reflective sheeting

In continuation of this Ministry's Circular No. NH-11047/1/87-DO.I dated 11th March, 1993, it is to state that M/s. KIWA CHEMICAL INDUSTRIES CO. LTD. have intimated that Shimnit Machine Tools and Equipment Ltd. having their Head Office at :

Office No. 4/A, 6/A Floor, New Excelsior Cinema Building, A.K. Nayak Marg, Fort,
MUMBAI-400001

with postal address - P.B. No. 1766 (GPO), MUMBAI-400001

Phone : 91 22 2073435, 2071852

Fax : 91 22 3646624, 2075337

Telex : 011 81138 and 84091 SNEH IN

Cable : BEST SAFETY, MUMBAI - 400001

are their exclusive authorised agents for "KIWALITE" Retro-reflective Sheetings for Indian Sub-continent and will render the following services :

- a) Necessary approvals of samples of "KIWALITE" Retro-reflective Sheetings.
- b) Technical clarification/support, commercial negotiations and issue of guarantee/warranty certificates on their behalf
- c) To participate in all Government tenders by themselves or through their authorised convertors.

2. M/s. Shimnit Machine Tools & Equipment Ltd. have appointed the following firms as their authorised convertors :

- a) M/s. Safety Sign Technologies,
181, 4th Main, B.E.M.L. Layout, Ist Stage,
Basaveshwaranagar, BANGALORE-560079
Tel. 080 3354754, 3387352, 3380013
Fax 080 3324848, 3324338
- b) M/s. Indiana Hitek Signs,
Near Old Octroi Post, Sultanwind Road,
AMRITSAR - 143 006 (PUNJAB)
Tel. 0183 230803, 230850, 231208
Fax 0183 226463, 225564

3. This is for your information.

602.29

No.RW/NH-33023/31/88-DO III

Dated, the 19th March, 1997

To

The Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States and Union Territories, Director General (Works), Central Public Works Department, Director General Border Road, Chairman, National Highways Authority of India

Subject: Policy regarding Private Participation in provision of retro-reflective road signs on National Highways - Model draft agreement

Please refer to this Ministry's letter of even number dated 22.3.96 forwarding therewith the details of the above mentioned policy. As per the guidelines already circulated, the entrepreneurs are required to enter into an agreement with the State PWD for provision, installation, maintenance and upkeep of the road signs to the entire satisfaction of the road authorities. In this connection, a model draft agreement is enclosed herewith for adoption by the State PWD.

Enclosure to letter No.RW/NH-33023/31/88-DO.III, dated the 19th March, 1997

**LICENCE DEED FOR ERECTION OF TRAFFIC SIGN BOARDS BY SPONSOR
ON NATIONAL HIGHWAY**

1. Agreement with Sponsor to erect Traffic Sign Boards on National Highway No. _____ between km _____ and km _____ in _____ State.

2. An agreement made this day _____ of _____ (Month) of _____ (year) between the President of India (hereinafter called the Government which expression shall, unless excluded by or repugnant context, include his successors in office and assigns) of the ONE PART and SPONSOR _____ (hereinafter called the Licensee which expression shall, unless excluded by or repugnant to the context, includes their successor and assigns) of the OTHER PART.

3. WHEREAS THE LICENSEE has applied to erect Traffic Sign Boards on National Highway No. _____ between km _____ and in _____ State, more particularly described in the Schedule annexed hereto and as shown in the drawings attached hereto AND WHEREAS THE Government has agreed to grant such permission on the terms and conditions hereinafter mentioned.

4. Now this agreement witnesseth that, in consideration of the conditions hereinafter contained and on the part of the Licensee to be observed and performed, the Government hereby grants to the Licensee permission to erect Traffic Sign Boards as per the norms of Indian Roads Congress/Ministry of Surface Transport subject to the following conditions, namely :

- (i) That the Licensee shall within six months from the date hereby, without interfering with the road traffic, complete the erection of Traffic Sign Boards to the satisfaction of the Divisional/Executive Engineer incharge of the National Highway Division.
- (ii) The work of erection of Traffic Sign Board shall be carried out as per specifications and other conditions given in Annexure-I.
- (iii) That the Licensee shall be solely responsible for structural stability of the Sign Boards.
- (iv) That the Licensee shall be responsible for restoring the road at their own cost, to the original condition after erection of Traffic Sign Boards or if any damage is caused due to inadequate maintenance/operation of it.
- (v) That the Licensee shall not, without the prior permission in writing of the Divisional/Executive Engineer undertake any work of shifting, repairs or alterations to the said Traffic Sign Boards.
- (vi) That the Licensee shall at all times permit any duly authorised official of the Government to inspect the said Traffic Sign Boards.
- (vii) That the Licensee shall be liable for any loss or damage caused to the Government by drainage/traffic obstructions or any other like causes due to the said erection of Traffic Sign Boards.
- (viii) That the Licensee, within two months of a notice duly given to them in this behalf by the Divisional/Executive Engineer shall at their own cost remove the Traffic Sign Boards and restore the road land to the original condition when required to do so by the Government or by any person authorised on its behalf. The Licensee shall not be entitled to any compensation on account of such removal.
- (ix) That if the Licensee fails to execute any work which they have agreed to execute under this agreement to the entire satisfaction of the Divisional/Executive Engineer, the work shall be executed by the Divisional/Executive Engineer at the cost of Licensee and the amount shall be recoverable from the Licensee as the penalty/fine/arrears of land revenue without prejudice to any other remedies which may be open to the Government in this behalf.
- (x) That the Licensee shall not sell, transfer or otherwise dispose of the Boards space to other sponsor or advertiser without obtaining the prior consent of the Government in writing.
- (xi) That the agreement will remain in force for a maximum period of five years in the first instance and the same may be renewed only with the approval of the Government.

- (xii) That the permission granted by this License shall not be deemed to convey to the Licensee any right for or over any interest in Government land other than what is herein expressly granted.
- (xiii) That during the subsistence of this Licence, the Traffic Sign Boards located on the road shall be deemed to have been erected and continued only with the consent and permission of the Government so that the right of the Licensee to the use thereof shall not become absolute and indefensible by lapse of time.
- (xiv) That Licensee shall bear the legal stamp duty charges on this agreement.

5. The Traffic Sign Boards shall not be brought to use by Licensee unless a completion Certificate to the effect that the erection of Traffic Sign Boards have been done in accordance with the approved specifications and drawings has been obtained from Divisional/Executive Engineer.

6. Notwithstanding anything contained in Clause 4(viii) the Licence may be cancelled at any time by the Government for breach of any condition of the Licence and the Licensee shall not be entitled to any compensation for any damage caused to it for such cancellation nor shall it be absolved of any liability already incurred under this agreement.

SCHEDULE

(here type the Schedule referred to in Clause 3)

IN WITNESS WHEREOF this Agreement is executed in duplicate the parties hereto on the dates mentioned below their signatures.

Signed by Shri _____ (Name in full) the Licensee or the constituted attorney of the Licensee,

For and on behalf of the
President of India
Under Secretary to the Govt. of India
Ministry of Surface Transport (Roads Wing)

IN THE PRESENCE OF :

1. Signature & name in full with designation

1. Signature & Name in full with designation

2. Signature & Name in full with designation

2. Signature & Name in full with designation

N.B. Wherever alternatives such as at/from, his/their, licensee/Licensees, Divisional/Executive Engineer has/have etc. are given, only applicable portion should be typed in the fair licence deed.

ANNEXURE I

1. All traffic signs proposed under private sponsorship shall conform to IRC: 67-1977 "Code of Practice for Road Signs" and Ministry's Circular NO. NH.11047/1/87-DO. I dated 8.9. 1988 (Guidelines for installation of distance informatory/destination signs along National Highways) and No. RW/NH.33023/31/88-DO.III dated 4.12. 1995 (Policy regarding installation of road signs using retro-reflective sheetings on National Highways). The specifications for the advertisements of different categories of signs shall be as under :

(i) Gantry Mounted Signs

For Gantry mounted signs, the vertical clearance available under the sign/display panel as also the lateral clearance shall be in accordance with IRC:54-1974, "Lateral and vertical clearances at underpass for vehicular traffic". The height of the sign panel shall be 2.1 metre. The structural stability of the gantry mounted sign shall be checked for safety against wind and other forces. The material and other stipulations for gantry mounted signs shall be in accordance with the Ministry's Circular No.RW/NH-33023/31/88-DO.III dated 4.12.1995. The plate displaying sponsoring firm's logo/name shall be hung underneath the sign panel in the central portion after ensuring the vertical clearance in accordance with IRC:54-1974. The length of this plate shall be restricted to the length of the central panel and shall not exceed 4.5 metres. The width of the advertisement panel shall be restricted to 0.3 metre. For cantilevered gantry mounted signs, the plate displaying sponsor's name/logo would also be hung below the sign panel

after ensuring the prescribed vertical clearance. The length of the plate shall be restricted to that of sign panel and width shall not exceed 0.3 metre. The advertisement shall contain only logo and/or the name of the sponsor and the colour scheme for the same shall be only black and white.

(ii) **Kerb mounted signs**

The kerb mounted informative signs would conform to Ministry's Circular No.11047/1/87-DO.I dated 8th September, 1988 and IRC:67-1977 for its dimensions, height, placement etc. The material and other stipulations shall be as per Ministry's Circular letter No.RW/NH.33023/31/88-DO.III dated the 4th December, 1995. The advertisement plate containing the sponsoring firm's logo/name shall be 0.15 metre wide and would span between the support posts at 0.10 metre below the sign panel. In case of kerb mounted cautionary signs, advertisement plate shall be put on the supporting posts at 0.10 metre below the sign panel with advertisement panel dimension not exceeding 0.50 m x 0.15 m. The colour scheme of the advertisement panel shall be only in black and white.

2. Colour scheme

- (i) Colour scheme for mandatory/regulatory cautionary/warning signs shall conform to IRC:67-1977 "Code of Practice for Road Signs".
- (ii) Direction, destination and place identification signs shall have green background, white messages (legend, letters, numerals, etc.) and borders instead of white background, black messages and borders.
- (iii) Colour scheme for facility information signs, other useful information signs and parking signs shall continue to conform to the provisions contained in IRC:67-1977 "Code of Practice for Road Signs".

3. Internally illuminated signs/neon signs shall not be permitted.

4. The sponsor shall be fully responsible for the upkeep and maintenance of the signs in perfect condition and shall be liable for responding to any complaints from the road users for misguidance and hazards etc.

5. The Traffic Sign Boards shall be erected at the approved locations only.

6. The Traffic Sign Boards shall be installed without interference with the maintenance of National Highways and cable lines.

7. The licensee shall ensure that there is no damage to the road or any other structure while carrying out the installation work. The damage, if any, shall be made good by the licensee at his own cost.

8. If it is necessary to shift these Traffic Sign Boards for any work such as road improvement etc. in future, the licensee shall have to carry out such shifting work at his own cost within a reasonable period (not exceeding 15 days) from the date of intimation to that effect.

602.30

No.RW/NH-33023/10/97-DO III

Dated, the 11th June, 1997

To

The Chief Engineers, PWD of all States/UTs, (dealing with National Highways and other Centrally Sponsored Schemes), Director General Border Roads, Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Tentative Specifications for Reflective Pavement Markers (Roads Studs)

Reflective pavement markers or Road Studs are being increasingly used on the roads for lane marking and delineation for night time visibility. At present there are no prescribed specifications for this product issued either by the Ministry or the IRC. Markers available in the market are of varying quality and their performance also varies widely. In order to regulate the quality of pavement markers, tentative specifications for this have been prepared and are enclosed (Annexure). Most of the provisions in the specifications have been based on BS 873 Part-4: 1973 and ASTM D 4280.

2. As per para 7 of the tentative specifications, the Contractor shall obtain from the manufacturer a two year warranty for satisfactory performance including stipulated retro-reflectance of the reflecting panel and submit the same to the Engineer. In addition, a two year warranty for satisfactory infield performance of the finished road marker shall also be given by the contractor who carries out the work of fixing of reflective road markers. In case the markers are displaced, damaged, get worn out or lose their reflectivity compared to stipulated standards, the contractor would be required to replace all such markers within 15 days of the intimation from the Engineer at his own cost and with no extra remuneration to be paid for such works.
3. The specifications prescribe different values of coefficient of luminous intensity for category 'A' and category 'B' Road studs. It would be desirable to use category 'A' road studs on arterial roads like National Highways, State Highways etc. Category 'B' road studs may be used on minor roads.
4. White reflective road markers may be used for lane markings at locations where lane marking in white colour has been prescribed in IRC-35. Amber colour reflective markers may be used at locations where lane markings in yellow colour have been prescribed in IRC-35 and red colour markers could be used to indicate no entry roads.
5. It is requested that these tentative specifications may be used for works on National Highways. Any suggestions based on field performance of these specifications may please be forwarded to the Ministry for improvement/augmentation of the specifications.

Enclosure to letter No.RW/NH-33023/10/97-DO.III, dated the 11th June, 1997

Annexure

Tentative Specifications for Reflective Pavement Markers (Road Studs)

1. General

Reflective pavement marker (RPM) or road stud is a device which is bonded to or anchored within the road surface for lane marking and delineation for night-time visibility. It reflects incident light in directions close to the direction from which it came.

2. Definitions

2.1. Description of Terms Specific to this standard

- 2.1.1. **Coefficient of luminous intensity (CIL) or specific intensity** - the ratio of luminous intensity of the retro-reflector in the direction of observation to illuminance at the retro-reflector on a plane perpendicular to the direction of the incident light expressed in terms of millicandelas per incident lux (mcd/lx).
- 2.1.2. **Horizontal entrance angle** - the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.
- 2.1.3. **Observation angle** - the angle at the reflector between the illumination axis and the observation axis.
- 2.1.4. **Retro-reflection** - reflection in which the radiation is returned in direction close to the directions from which it came. This property being maintained over wide variations of the direction of incident radiation.
- 2.1.5. **Head** - that part of a road stud which is above the road surface when the road stud is fixed in position in the road.
- 2.1.6. **Upper surface** - that part of the external surface of road stud which is visible when the road stud is fixed in position in the road.
- 2.1.7. **Anchorage** - that part of a road stud which is below the road surface when the road stud is fixed in position in the road.

3. Material

3.1. Plastic body of RPM/road stud shall be moulded from ASA (Acrylic Strene Acrylonitrite) or HIPS (Hi-impact Polystyrene) or ABS or any other suitable material approved by the Engineer-in-Charge. The markers shall support a load of 13635 kg tested in accordance with ASTM D4280.

3.2. Reflective panels shall consist of number of lenses containing single or dual prismatic cubes capable of providing total internal reflection of the light entering the lens face. Lenses shall be moulded of methyl methacrylate conforming to ASTM D 788 or equivalent.

4. Design

4.1. The slope or retro-reflecting surface shall preferably be 35 ± 5 degree to base.

4.2. The area of each retro-reflecting surface shall not be less than 13.0 sqcm.

5. Optical Performance

5.1. Unidirectional and bi-directional studs

5.1.1. Each reflector or combination of reflectors on each face of the stud shall have a C.I.L. not less than that given in Table 1 or 2 as appropriate.

Table 1 Minimum C.I.L. Values for Category 'A' studs

Entrance angle	Observation angle	C.I.L. in mcd/lx		
		White	Amber	Red
0°U 5° L&R	0.3°	220	110	44
0°U 10° L&R	0.5°	120	60	24

Table 2 Minimum C.I.L. Values for Category 'B' studs

Entrance angle	Observation angle	C.I.L. in mcd/lx		
		White	Amber	Red
0°U 6° L&R	0.3°	20	10	4
0°U 10° L&R	0.5°	15	7.5	3

Note: The entrance angle of 0°U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.

5.1.2. A stud that incorporates one or more corner cube reflectors shall be considered to be included in category 'A'. A stud that incorporates one or more bi-convex reflectors shall be considered to be included in category 'B'.

5.2. Omni-directional studs

Each omni-directional stud shall have a minimum C.I.L. of not less than 2 mcd/lx.

5.3. Tests

5.3.1. Coefficient of luminance intensity can be measured by procedure described in ASTM E 809 "Practice for Measuring Photometric Characteristics" or as recommended in BS: 873 - Part 4:1973.

5.3.2. Under test conditions, a stud shall not be considered to fail the photometric requirements if the measured C.I.L. at any one position of measurement is less than the values specified in Table 1 or 2 provided that

- (i) the value is not less than 80% of the specified minimum, and
- (ii) the average of the left and right measurements for the specific angle is greater than the specified minimum.

6. Fixing of Reflective Markers

6.1. Requirements

- 6.1.1. The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic.
- 6.1.2. The reflecting portions of the studs shall be free from crevice or ledges where dirt might accumulate.
- 6.1.3. All road studs shall be legibly marked with the name, trade mark or other means of identification of the manufacturer.
- 6.1.4. Marker height shall not exceed 20 mm.
- 6.1.5. Marker width shall not exceed 130 mm.
- 6.1.6. The base of the marker shall be flat within 1.3 mm. If the bottom of the marker is configurated, the outermost faces of the configurations shall not deviate more than 1.3 mm from a flat surface.

6.2. Placement

- 6.2.1. The reflective marker shall be fixed to the road surface using the adhesives and the procedure recommended by the manufacturer. No nails shall be used to affix the marker as nails are hazardous for the roads.
- 6.2.2. Regardless of the type of adhesive used, the markers shall not be fixed if the pavement is not surface dry and on new asphalt concrete surfacing until the surfacing has been opened to traffic for a period of not less than 14 hours.
- 6.2.3. The portions of the highway surface, to which the marker is to be bonded by the adhesive, shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive.
- 6.2.4. Use a wire brush, if necessary to loosen and remove dirt, then brush or blow clean.
- 6.2.5. The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the marker in a quantity sufficient to result in complete coverage of the area of contact of the marker with no voids present and with a slight excess after the marker has been lightly pressed in place.
- 6.2.6. For epoxy installations, excess adhesive around the edge of the marker, excess adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed. Soft rags moistened with mineral spirits or kerosene may be used, if necessary to remove adhesive from exposed faces of pavement markers.

7. Warranty and durability

The contractor shall obtain from the manufacturer a two year warranty for satisfactory field performance including stipulated retro-reflectance of the reflecting panel and submit the same to the Engineer. In addition, a two year warranty for satisfactory infield performance of the finished road marker shall also be given by the contractor who carries out the work of fixing of reflective road markers. In case the markers are displaced, damaged, get worn out or lose their reflectivity compared to stipulated standards, the contractor would be required to replace all such markers within 15 days of the intimation from the Engineer at his own cost and with no extra remuneration to be paid for such works.

8. **Measurement for Payment**

The measurement of reflective road markers shall be in numbers of different types of markers supplied and fixed.

9. **Rate**

The contract unit rate for reflective road markers shall be payment in full compensation for furnishing all labour, material, tools, equipment including incidental costs necessary for carrying out the work at site conforming to the specifications complete as per approved drawings or as directed by the Engineer.

602.31

No.RW/NH-33023/31/88-DO III

Dated, the 9th February, 1998

To

The Secretaries, PWD of all States/UTs, Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States and Union Territories, Director General Border Roads, Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Private participation in provision of retro-reflective road signs on National Highways

Please refer to this Ministry's letter of even number dated 22nd March, 1996 forwarding therewith the details of the above mentioned policy. Subsequently, a draft model agreement which the entrepreneurs are required to enter into with the State PWD for provision/installation, maintenance and upkeep of road signs was circulated vide this Ministry's letter of even number dated 19th March, 1997.

2. The above policy guidelines have been reviewed on the basis of feedback received from States and discussion in the Traffic Engineering Committee of IRC. It has been decided to make the following modifications in the policy :-

- (i) All proposals for private sponsorship for road signs which are strictly in conformity with Ministry's policy may be finalised by the State Chief Engineers in association with this Ministry's Regional Officer. However, in cases where there is any deviation from the policy or any relaxation are required, the proposals may continue to be forwarded to the Ministry.
- (ii) The sponsorer may be allowed to depict the name and/or logo in the advertisement space in the colour scheme used by them for their normal advertisement.
- (iii) As per policy, the initial contract period for provision of signs to private sector shall be a maximum of 5 years. While inviting the bids, the entrepreneurs may be asked to quote the amount they would be prepared to pay to the Government in advance in the beginning of each year of the 5 year period. The work could be awarded to the entrepreneur whose financial package offers maximum net present value to the Government.

3. The contents of the circular may be brought to the notice of all the concerned officers in the State PWD for information and adoption.

No.RW/NH-11064/1/91-DO I**Dated, the 1st November, 1994**

To

The Secretaries, PWD of all States/UTs, (dealing with National Highways)

Subject: Provision of Safety Measures at Approaches to Railway Level Crossings

I am directed to say that this Ministry has been issuing instructions, from time to time, regarding provision of safety measures at railway level crossings falling on National Highways including specifications for provision of rumble strips on the approaches. The recommended measures therein are :

- (i) Installation of IRC Road Signs (Specified in IRC:67-1977 "Code of Practice for Road Signs") whether the railway crossing is manned or unmanned;
- (ii) Imposition of speed limits for approaching traffic and installation of relevant road signs, and
- (iii) Provision of rumble strips on both sides of the railway crossings. Speed breakers of hump type shall not, however, be permitted.

2. Specifications for rumble strips were circulated among all State Governments vide this Ministry's letter No. PL-50(8)/72 dated 4th June, 1976. It was also reiterated that rumble strips as per the design and locational details communicated to the State Chief Engineers, vide this Ministry's letter dated 9th January, 1987 may be provided on approaches to railway level crossings. It was also mentioned therein that the speed breakers already provided by the Railways as a temporary measure at these locations should be removed concurrently with the provision of rumble strips.

3. In a recent communication to the Transport Secretaries of all States/Union Territory Administrations, this Ministry vide letter No.RT-25035/40/94-RSC dated 23rd September, 1994, has suggested, among other safety measures, that State PWD authorities should ensure complete road warning signs on approaches of the level crossings as per IRC Code and at prescribed distance.

4. It is requested that urgent instructions may be issued to all concerned in your Department, engaged in National Highways and other Centrally financed road works for implementing the above mentioned safety measures on a priority and time bound basis.

5. It is also requested that from public safety angle, similar instruction may be issued for providing these safety measures at approaches to railway level crossings falling on State roads.

6. This Ministry may please be informed of the action taken in the matter.

No.RW/NH-11064/1/91-DO I**Dated, the 28th June, 1996**

To

The Secretaries, PWD of all States/UTs, (dealing with National Highways), Director General Border Roads, Director General (Works), Central Public Works Department,

Subject: Construction of Speed Breakers : Policy regarding

Reference is invited to this Ministry's Circular NO. RW/NH-11064/1/87-NH.III/DI dated 23rd September, 1987 on the above mentioned subject. This circular reiterates Ministry's policy that speed breakers should not be constructed on National Highways as these defeat the basic objective of providing an obstruction-free high speed facility.

The circular recommended provision of properly designed rumble strips at places like approaches to sharp curves or level crossings, congested or accident prone sections etc. where control of speed on National Highways is unavoidable.

2. It has come to the notice of the Ministry that speed breakers continue to be provided on National Highways despite contrary advice from the engineers and planners. At most of the places, these are of poor design. The width of the speed breaker along the direction of traffic flow is kept very often far below the recommended width of 5 m. Similarly, the height of the crown of the bump of speed breaker over the carriageway is usually kept far greater than the recommended height of 100 mm. Consequently, the speed breakers actually put into use on the road become a safety hazard.

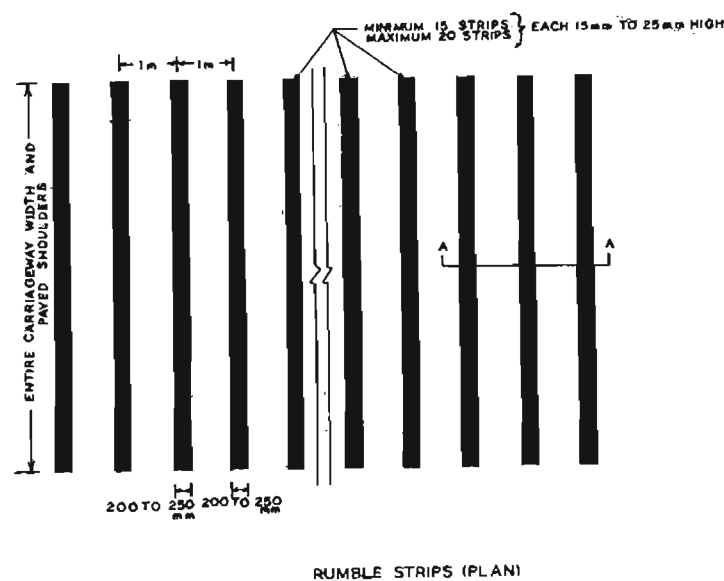
3. The locations where speed breakers have been constructed should be reviewed and other safety measures such as removal of encroachments, provision of speed limit signs, construction of parallel service roads etc. may please be considered. The existing policy of providing only rumble strips at places where speed control is unavoidable may be continued. However, proper care should be exercised to ensure that these strips conform to the design given in the above mentioned circular. Precast cement rumble strips, or strips covered with premixed bitumen carpet (coarse-textured treatment) may be provided across the entire width of carriageway and paved shoulders. The raised section should be 15-25 mm high, 200-300 mm wide and spaced about one metre centre to centre in a series of roughly 15 to 20 at the one location which should not be reduced. A drawing showing design of rumble strips is enclosed for ready reference (Annex-I).

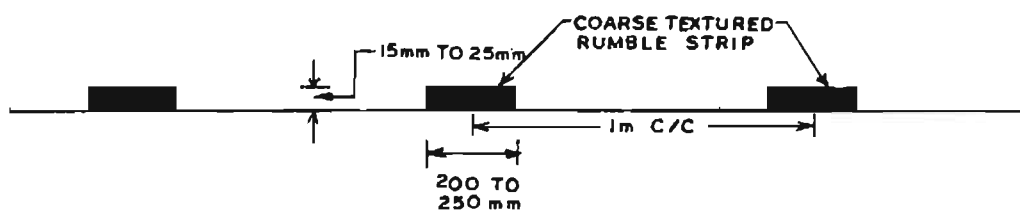
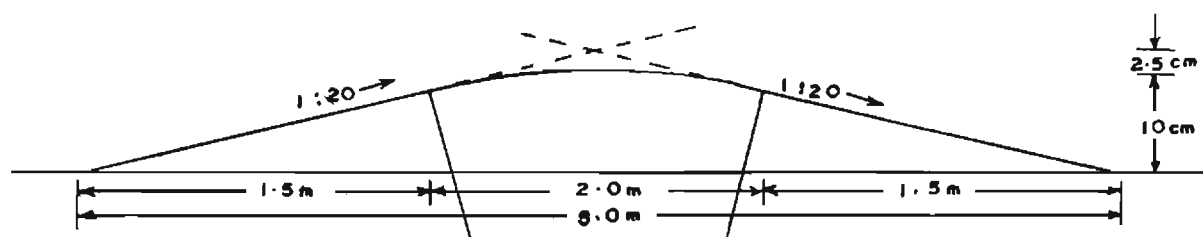
4. On minor roads (other than National Highways), speed breakers may be provided at locations where there is need to control speed of traffic to ensure safety. But careful attention must be paid to the design of the same. Type design for the speed breaker is given in IRC:99-1988. Enlarged cross section of a speed breaker recommended for roads carrying truck and bus traffic is enclosed at Annex-II. No changes in the design are permitted.

5. All speed breakers must be marked with chequered square pattern indicated in IRC:99-1988. This marking should be maintained properly so that the speed breaker is clearly visible to the drivers all the time. Cautionary signs must be provided in both the directions before the rumble strips/speed breakers. These signs should be so located that they are prominently visible to the drivers. The distance between the speed breaker and the signs should be slightly more than the safe stopping distance.

6. Contents of this letter may please be circulated among concerned officers of your Department.

ANNEX - I
(SHEET 1/2)



CROSS SECTION AT "AA"(NOT TO SCALE)CROSS SECTION OF A SPEED BREAKER FOR ROADS
CARRYING HEAVY TRUCK AND BUS TRAFFIC(NOT TO SCALE)

- NOTE :-
1. SPEED BREAKER SHOULD BE PROVIDED ACROSS THE ENTIRE CARRIAGEWAY AND PAVED SHOULDERS.
 2. SIGN POSTING AND MARKING SHOULD BE PROVIDED IN ACCORDANCE WITH IRC ; 99-1988.
 3. PROPER DRAINAGE SHOULD BE ENSURED.

No.RW/NH-33044/11/96-S&R***Dated, the 20th December, 1996***

To

The Chief Engineers (dealing with National Highways and other Centrally Financed Schemes), Public Works Department of all States and Union Territories, Director General (Works), Central Public Works Department, Director General Border Roads

Subject: Safety precautions on 2-lane National Highways with paved shoulders.

Detailed guidelines for construction of paved shoulders on both sides of two-lane carriageway had been issued vide this Ministry's Circular No. RW/NH-33054/20/88-DO II, dated 10.5.89. These guidelines had provided 1.5 m paved shoulders flanked by 1 m wide earthen/granular berm. Wherever paved shoulders are constructed on the sides of two-lane carriageway provision of the said circular should invariably be followed and berms in 1 m width should be maintained to proper cross sectional levels and slopes at all times.

2. It has come to Ministry's notice that at some locations, the above standards have been relaxed and the entire 2.5 m shoulder upto edge of the embankment has been paved. This has increased risks of accidents and drivers are not able to judge easily and accurately the edges of embankment particularly in the condition of poor visibility such as rain, fog or darkness. It has, therefore, been decided that on exceptional cases wherever shoulders have been paved upto the edge of the embankment, roadway indicator type delineators should be provided as per enclosed sketch at the edges of embankment.

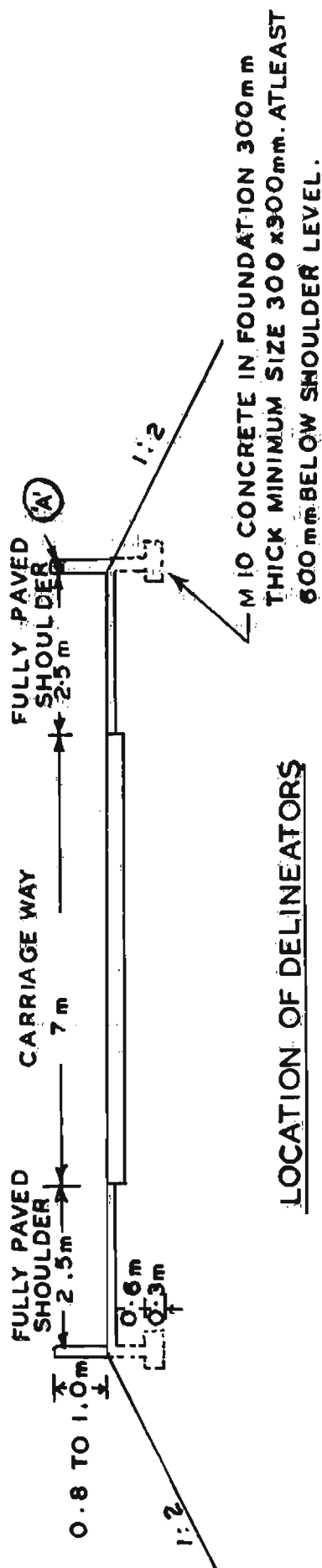
3. The above delineators can also be provided at the edges of high embankment in the accident-prone locations in cases where roadside safety barriers/railings are not provided.

4. The delineators referred to above shall be made of pipes, posts of metal, concrete, timber, cut stone or plastic. Plastic posts damage the vehicles less while concrete pipes could be less prone to vandalism or theft. The delineator posts should be 80-100 cms high and painted alternatively in black and white bands each 150 mm wide. This should be fitted with white coloured rectangular (80 x 100 mm) or circular (75 mm dia), retro-reflective panels at the top. Detailed guidelines for such delineators are given in IRC:79-1981. The delineators should be installed according to nature and stiffness of the ground and local practice. The installation should ensure that the post does not change its orientation and the reflectorised face remaining perpendicular to the direction of travel. A foundation slab of M-10 concrete 300 mm thick and having sides equal to 3 times the dimension of posts (Minimum 30 cm) shall meet these objectives.

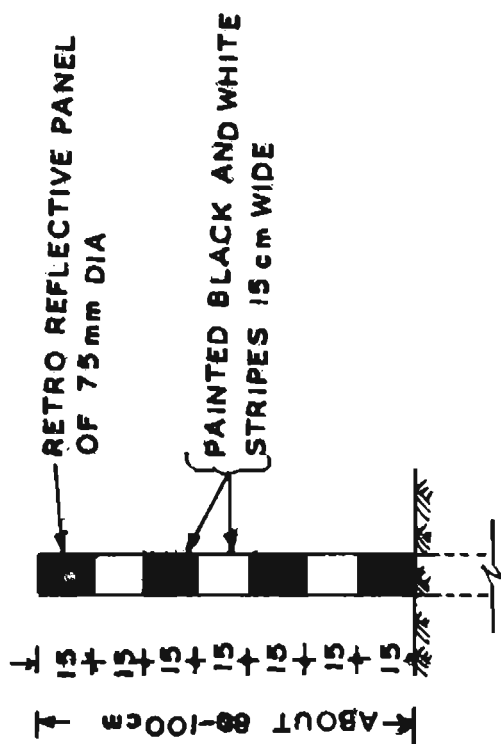
5. The specific cases where entire shoulder upto the edge of the embankment has been paved and the edges are failing due to slippage in the upper portion of the side slopes, shall be referred separately to Ministry after site inspection with the suggestions for remedial measures.

6. It is hoped that the implementation of the above suggestions will be useful particularly at night time in guiding a driver to drive his vehicle away from the edges.

7. The contents of this letter may please be brought to the notice of your field staff for information and necessary action.



LOCATION OF DELINEATORS



DETAIL AT 'A'
(NOT TO SCALE)

RADIUS OF CURVE (METRES)	SPACING OF DELINEATORS (METRES)
30	6
50	8
100	12
200	20
300	25
400	30
500	35
600	38
700	40
900	45
1000	50

NOTE - SPACING OF DELINEATORS ON STRAIGHT REACHES SHOULD BE 50-70M AND ON CURVES AS SHOWN ABOVE.

701 WAYSIDE AMENITIES

<i>Code No.</i>	<i>Circular No. & Date</i>	<i>Brief Subject</i>	<i>Page No.</i>
701.10	RW/NH-11052/3/97-DO I dated 31.12.97	Passenger Oriented Wayside Amenities Along National Highways	701/23
702. LANDSCAPING AND TREE PLANTATION			
702.14	RW/NH-11052/5/95-DO I dated 26.11.96	Greening of National Highway land for beautification through reputed organisations	702/1 to 4
702.15	RW/NH-11052/3/97-DO I dated 31.12.97	Plantation and Maintenance of Shrubs and Flowering Plants in Medians of Highways	702/5
702.16	RW/NH-11052/1/97-DO I dated 6.3.98	Revised Guidelines for Applicability of Forest (Conservation) Act, 1980 on linear plantations for widening/modernisation	702/5 & 6
703. ENVIRONMENTAL PROTECTION AND SOIL CONSERVATION			
703.2	RW/NH-11052/6/95-DO I dated 5.2.96	Implementation of stipulated environmental safeguards and conditions for major Highway Projects	703/2 & 3
703.3	RW/NH-11052/1/97-DO I dated 24.4.97	Exemption from environmental clearance for road projects along the existing alignment - Reg.	703/2 & 3

No.RW/NH-11052/3/97-DO I***Dated, the 31st December, 1997***

To

The Chief Secretaries/Secretaries, (Roads) PWD of all States/UTs, Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States and Union Territories, Director General Border Roads, Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Passenger Oriented Wayside Amenities Along National Highways

Provision of passenger oriented wayside amenities along highways is necessary since both the passengers and drivers need certain minimum, wayside facilities to make their travel safe, comfortable and convenient in order to reduce fatigue in a long distance journey. Such wayside facilities to a reasonable extent are operational in some states like Haryana and Rajasthan under patronage of State Tourism Departments. For facilitating long distance travel by road and enhancing road safety along National Highways, the Ministry had launched schemes for provision of basic wayside amenities both by Government Sector financing and by private sector financing. Under this scheme, basic facilities like parking areas for cars and buses, drinking water, toilet, snack bar/restaurants, rest rooms, dormitory etc. have been envisaged.

2. Under Government Sector, the scheme was launched in 1986 in association with Central Ministry of Tourism in which, Ministry of Surface Transport bears the cost of land and development of infrastructural facilities while Ministry of Tourism bears the cost of construction of building and services. Operation of the facilities rests with the State Department of Tourism. As a first priority, 17 locations in different States were identified and work on some of the facilities is in progress.

3. In order to supplement the Government effort, the Ministry had in 1987 invited the private entrepreneurs to finance and manage such facilities at selected locations. As an incentive to private entrepreneurs, allocation of fuel retail outlet was made an integral part of the scheme with the consent of Ministry of Petroleum. A few complexes under this scheme have already become operational and work on some others are in progress. Ministry of Petroleum had withdrawn from this Scheme in August, 1994 and thus the retail outlet is no longer a part of the scheme. Revival of this scheme is now being considered.

4. It would be seen that considering our vast road network, concerted efforts are required to develop more such facilities along National and State Highways. It has, therefore, been decided that henceforth in all National Highway Projects being funded through the aid from the multilateral agencies i.e. World Bank, ADB, OECF etc. or being developed through the private sector, provision must be made for passenger oriented wayside amenities at every 50 km of National Highways. Broad guidelines for selection of suitable sites for this purpose are given in Ministry's letter No. RW/34032/1/86-NHVI dated 7th August, 1986. For indicative arrangements of facilities, reference may be made to drawings circulated vide Ministry's letter No. RW/34032/1/86-NH Stds. dated the 23rd December, 1987.

5. It is requested that the contents of this circular may be brought to the notice of all concerned officers in your department for implementation.

No.RW/NH-11052/5/95-DO.I**Dated the 26th November, 1996**

To

The Secretaries, PWD of all States/UTs (dealing with National Highways, Director General (Border Roads), Director General (Works), Central Public Works Department,

Subject: Greening of National Highway land for beautification through reputed organisations

I am directed to refer to this Ministry's letter No.I-41(34)/69 dated 6th December, 1969 intimating the State Governments not to allow firms and individuals (private bodies) to develop and maintain gardens on traffic rotaries and/or road margin on National Highways and to say that this Ministry has been receiving requests from reputed companies/institutions/organisations for granting permission to develop and maintain gardens/tree plantation/landscaping on National Highway Land.

2. In view of the constraints of resources for developing and maintaining arboriculture on National Highway land, it has now been decided in supersession of this Ministry's letter dated 6.12.69, mentioned above to permit public sector corporations/reputed private companies/voluntary organisations to develop and maintain gardens/tree plantations/landscaping in vacant National Highway land on either side of the road/central verges/rotaries for beautification and prevention of encroachments. For this purpose a strip of National Highway land can be allotted to reputed organisations under a Memorandum of Understanding. The salient features of the scheme shall be :

- i) The Memorandum of Understanding will generally be valid for 5 years unless terminated earlier; renewal beyond 5 years will be considered taking into account the performance of the Agency, and the needs of National Highway development.
- ii) The entire cost of developing and maintaining gardens/tree plantation/landscaping shall be borne by the concerned agency.
- iii) No Construction of any kind will be permitted on the National Highway land.
- iv) No commercial usage of any kind from the land by way of sale of plants, setting up of Nursery, etc. shall be permitted.
- v) The Agency shall be allowed to publicise the free service on hoarding of approved size, which should not distract the attention of vehicle drivers. Such hoardings should be got approved from the State PWD/NHAI.
- vi) The garden/tree plantation/landscaping will be developed and maintained to the satisfaction of the Engineer-in-Charge and the National Highway land will be vacated if so desired for the development of the road or any other public purpose in a clean condition within one month of the notice from the Engineer-in-Charge. The Engineer-in-Charge for the purpose shall be the Executive Engineer/Divisional Engineer of the State PWD/NHAI under whose jurisdiction the said section of National Highway falls.
- vii) The ownership of the said NH land shall continue to vest with Ministry of Surface Transport at all times.
- viii) On expiry of the Memorandum of Understanding, all fencing material/tree guards, trees, shrubs, tubewell if any provided shall automatically become the property of the Ministry of Surface Transport.

3. In this connection, a copy of the Memorandum of Understanding which the agency has to execute with the Government is enclosed.

4. The State Governments are requested to forward such proposals received by them, in this connection, for the permission of the Ministry, along with their recommendations/comments.

MEMORANDUM OF UNDERSTANDING *

THIS MEMORANDUM OF UNDERSTANDING MADE THIS DAY OF BETWEEN, the President of India acting through Director General (Road Development), Ministry of Surface Transport, New Delhi or his authorised representative (Hereinafter called the MOST which expression shall where the context so admits include its successors in Office and assigns) of the one part AND (Name of Company/Organisation/Voluntary Body) (address) hereinafter called the Agency which expression shall where the context so admits, include his successors and assigns) of the other part. WHEREAS THE MOST IS THE ABSOLUTE owner of land, situated alongside the National Highways, hereinafter called the "said land" and more particularly described in the schedule and whereas the Agency has agreed to undertake development and maintenance of tree plantation/Gardens/Landscaping purely on voluntary basis, on the terms and conditions contained hereinafter :-

NOW THIS MEMORANDUM OF UNDERSTANDING WITNESSES AS UNDER :

1. The Agency shall from the (date) undertake the work pertaining to development and maintenance of gardens/tree plantation/landscaping on the said land alongwith protection of estate and land on behalf of Ministry of Surface Transport, Demarcation of existing encroachments shall also be done jointly and the agency shall be responsible to ensure that further encroachments do not occur. The Memorandum of Understanding shall remain in force until terminated by either party after giving one month notice, or for a period of 5 years (five years) from the date of its signing whichever is earlier. In case the Agency fails to take up the work of development and maintenance of gardens/tree plantation/landscaping within a period of 90 days from the above date (i.e. the date of signing of the MOU), the same shall automatically stand terminated without issue of notice.
2. The exact demarcation of the said land/area shall be done by the Public Works Department, Govt. of The Agency shall ensure that shrubs/trees only of acceptable variety are planted. A proposal in this regard will be got approved from Ministry of Surface Transport. The inventory of existing tree plantation shall be jointly taken by the Ministry of Surface Transport or its agent (State PWD/NHAI) and the Agency, and it will continue to be the property of the Ministry of Surface Transport. All sale proceeds, if any, on account of timber, grass and other forest produce on the said land taken for development of garden by the Agency shall be credited to the PWD, Govt. of
3. The Agency shall be responsible for maintenance of the entire existing and the newly planted trees/shrubs on the portion of the land (on both side as well as central verge of the road/rotary) handed over to them for the purpose of intensive plantation.
4. All costs of formation, protection, tree plantation, maintenance and providing tree guards etc. shall be borne by the Agency.
5. The Agency shall not be permitted to construct/erect any building or structure etc. on the land allotted for tree plantation under the Memorandum of Understanding.
6. The Agency shall not be permitted to undertake commercial usage of any kind from the land by way of sale of plants, setting up of nursery etc.
7. The Ministry of Surface Transport shall be entitled to authorise the PWD to utilise earth for repairs to formation and cut branches of trees and also to execute works required for normal functioning of the PWD. The decision of Ministry of Surface Transport in this regard shall be final and binding. No compensation shall be paid by MOST/PWD if any damage is caused to the plantation done by the Agency in the course of execution of such works.
8. The PWD shall be at liberty to carry out their normal work in connection with the maintenance of roads, traffic signals etc. and the employees of the PWD shall not be challenged or obstructed while moving around, in performance of their duties.
9. All the instructions/restrictions of the MOST/PWD relating to road visibility and traffic, plantation of tree, measures for the safety of the roads, underground cables, choice of species shall be followed.

(On a Non Judicial Stamp Paper of Rs.10/-)

10. In case of accidents due to over grown branches of trees and any other emergencies etc., the PWD Government of has the liberty to order cutting of trees/branches for works required in connection with restoration or transportation without giving any notice. The decision of the PWD in this regard shall be final and binding. No compensation shall be payable to the agency in such a case.

11. The ownership of the said land shall continue to vest with the Ministry of Surface Transport. The area/land selected for garden/tree plantation/landscaping will be handed over to the Agency for garden/tree plantation/landscaping without interference to traffic operation or to any PWD operations.

12. The PWD officers are authorised to enter the said land at any time without assigning any reason and without any compensation being payable to the Agency.

13. The Agency shall be allowed to display the boards of the maximum size of 75 cm x 60 cm and at locations as may be approved by Ministry of Surface Transport. The spacing of the display boards shall generally be 60 m apart. No display boards shall be allowed to be executed in the central verge of the road. The display board shall carry the message in Hindi or English like

"KEEP GREEN
(Name of the State)

OR
GROW MORE PLANTS TO KEEP AWAY POLLUTION"

The name/logo of the Agency shall be at the bottom of the display board and shall not occupy more than 50% of the area of the board. The message, location, height etc. of each board shall be got approved from State PWD/NHAI by submitting a drawing and the approved drawing shall form part of Memorandum of Understanding.

14. The Agency shall be permitted to display its name and or logo on the fence or treeguards erected for the protection of plants. There should be no advertisement of product. The size of such display board shall not exceed 1000 sq.cm.

15. The team of officers nominated by Ministry of Surface Transport will inspect the performance of the Agency at regular intervals. Necessary action as per recommendations of the said committee shall immediately be initiated against the agencies who are found to be violating the conditions of the Memorandum of Understanding and whose performance is not found satisfactory.

16. It shall be the responsibility of the Agency to arrange for the water required for the purpose at their cost. Ministry of Surface Transport shall however, allow drawing water from a tube well at the cost of agency. MOST/PWD may help the Agency in getting electric connection, but payment will have to be made by the Agency.

17. On expiry of this Memorandum of Understanding, all fencing material/treeguards, tubewells, provided by the Agency and the tree/shrubs planted by them shall become the property of the Ministry of Surface Transport.

18. All disputes and differences arising out of, or in any way touching or concerning this Memorandum of Understanding shall be decided by the Director General (Road Development) or his nominee and his decision shall be final and binding on the agency.

IN WITNESS WHERE OF THE parties to these presents have set and subscribed their hands and seals on the day, month and the year above written.

702/4

SCHEDULE

Particulars of land

FOR AND ON BEHALF OF THE
DIRECTOR GENERAL (ROAD DEVELOPMENT)

Witnesses :

1.

2.

Witnesses :

1.

2.

FOR AND ON BEHALF OF THE AGENCY

No.RW/NH-11052/3/97-DO I

Dated, the 31st December, 1997

To

The Chief Secretaries/Secretaries, (Roads) PWD of all States/UTs, Chief Engineers (dealing with National Highways and other Centrally Sponsored Schemes), Public Works Department of all States and Union Territories, Director General Border Roads, Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Plantation and Maintenance of Shrubs and Flowering Plants in the Medians of Highways

It has been observed that adequate attention is not being paid to plantation on medians of Highways. The essential purpose of planting in medians is to cut off headlight glare from traffic in the opposite direction. Flowering plants and shrubs are eminently suited for the purpose. These could be planted in a variety of ways, but a very effective method is in the form of baffles (shrubs planted across the median at an angle at 15 m interval as shown in Fig. 5 of IRC:SP:21-1979 "Manual on Landscaping of Roads"). This method ensures a penetration of view for the drivers. However, if the median width is less than about 3 m, baffle plantation will not be effective and a continuous line of shrubs should instead be thought of. Shrubs in medians should not exceed 1-1.5 m in height, otherwise visibility of the second carriageway will be affected. Further, in the vicinity of road inter-sections and median opening, no plantation should be done for a length of 10-15 m to ensure adequate visibility. Also no plantation should be done where the median is tapered to provide for a turning lane.

2. It has been decided that henceforth in all National Highway projects being funded through multilateral agencies like World Bank, ADB, OECF etc. or taken up through private sector financing, provision must be made for plantation in the median of Highways.

3. It is requested that the contents of this circular may be brought to the notice of all concerned officers in your department for implementation.

No.RW/NH-11052/1/97-DO.I

Dated, the 6th March, 1998

To

The Secretaries, PWD of all States/UTs, (dealing with National Highways), Director General Border Roads, Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Revised guidelines for applicability of Forest (Conservation) Act, 1980 on linear plantations for widening/modernisation

I am directed to send herewith a copy of letter No.4-1/97-FC dated 18th February, 1998 from the Ministry of Environment & Forests, New Delhi on the subject mentioned above alongwith its enclosures for your information and necessary action.

Enclosure to letter No.RW/NH-11052/1/97-DO.I dated the 6th March, 1998

Copy of letter No.4-1/97-FC dated 18.2.1998 from the Ministry of Environment & Forests, New Delhi addressed to Secretary, Ministry of Surface Transport

I am directed to refer to your D.O. No. RW/NH-11052/1/97-DO(I) dated 29.1.98 regarding Item No. 4.1 of the record of discussions of the meeting taken by Prime Minister on 15.12.97 to review the performance of the Ministry of Surface Transport. The necessary instructions have been issued regarding widening/modernisation of the national highways, etc. to all the State Govts. and the Regional Offices of this Ministry for immediate implementation. A copy of the instructions issued is enclosed for your kind information.

Copy of letter No. 4-1/97-FC dated 18.2.98 from the Ministry of Environment & Forests, New Delhi addressed to Secretary (Forests) of all All States/UTs regarding revised guidelines for applicability of Forest (Conservation) Act, 1980 on linear plantations for widening/modernisation.

I am directed to refer to Para 2.5 of the existing guidelines issued under the Forest (Conservation) Act, 1980 for diversion of forest land widening/expansion of roads, rail lines and canals. After careful consideration, and taking into account the difficulty faced by the concerned departments for undertaking widening/modernisation on lands primarily acquired by these departments for these purposes, the Ministry has decided to substitute the existing Para 2.5 with the new guideline as enclosed.

Applicability of Forest (Conservation) Act, 1980 on linear plantations for widening/modernisation.

This Ministry has been receiving large number of proposals under Forest (Conservation) Act, 1980 which pertains to widening/expansion of roadsides/railsides/canalsides. Large scale plantations along these linear strips have been taken up by different state governments under social forestry and other programmes. In order to have a better control and management of these linear patches, in many places these have been notified as protected forests. Recently, the Union Cabinet has taken a decision that in case of widening/modernisation of existing roads, forest and environmental clearance should not be required.

The main spirit behind Forest (Conservation) Act, 1980 is conservation of natural forests whereas most of the linear plantations have been done on the land belonging to either Road or Irrigation or to the Railway Department using ornamental and shade bearing trees. According to the definition of "forests" by the Hon'ble Supreme Court, these plantations could come under the purview of Forest (Conservation) Act, 1980. There are certain statutory provisions under the Rules and Guidelines which have to be followed for granting approval under the Forest (Conservation) Act, 1980. Of late there has been a spurt of activity in improving infrastructure. A delay in granting clearance/approval under Forest (Conservation) Act, 1980 would lead to time and cost escalation.

Keeping this preamble in view the following guidelines are, therefore, promulgated with immediate effect which will substitute the existing provision in para 2.5 of the guidelines as under :-

Para 2.5

- (i) Such lands which had been acquired by Government Departments like Railway, Irrigation, PWD, etc., for specific purposes like laying of roads, railway lines and canals and the vacant area was planted up with trees and these lands are not yet notified as protected forests will not attract the provisions of Forest (Conservation) Act, 1980 for the purposes of widening or expansion or re-alignment. However, the concerned agency will seek permission under local laws, if any, from appropriate authority.
 - (ii) Such lands which were acquired by the above departments and the vacant areas were subsequently planted and notified as protected forests for management purposes will need approval from the Central Government under Forest (Conservation) Act, 1980. The user agency will submit the proposal in the prescribed format through the State Forest Department to the concerned Regional Office of the Ministry. The Regional Offices shall be competent to finally dispose of all such proposals irrespective of the area, preferably within 30 days from the date of receipt of the proposal. While issuing the approval, in place of normal provision for compensatory afforestation, the Regional Offices will stipulate a condition that for every tree cut at least two trees should be planted.
 - (iii) However, if the decision is not accorded by the concerned Regional Office within 30 days of the receipt of fully completed application, the Central Government/State may proceed with the widening/expansion under intimation to the local State Forest Department and Central Government.
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No.RW/NH-11052/6/95-DO.I**Dated the 5th February, 1996**

To

Chief Engineers, Public Works Departments of all States Govts./Union Territories (dealing with National Highways)

Subject: Implementation of stipulated environmental safeguards and conditions for major Highway Projects

As you are aware all major highway projects costing more than Rs.5 crore require clearance by the Ministry of Environment & Forests (MOE&F). Such a clearance is given subject to the implementation of stipulated safeguards and conditions. The project authorities are required to report every six months on the progress of implementation of these conditions/safeguards stipulated to the concerned Regional Officer of MOE&F to monitor the same for effective implementation.

2. It has been brought to the notice of this Ministry that the conditions/safeguards stipulated are not being properly implemented by the project authorities and requisite information/progress reports are also not being sent to the Regional Offices of the MOE&F. This has resulted in issuing notices for stopping the work on the projects in certain cases by the MOE&F. It is, therefore, desirable that the State Chief Engineers/Project Directors who are handling major National Highways projects including those externally aided ones, should ensure that conditions/safeguards stipulated by MOE&F are properly implemented at site and necessary information/progress reports are sent to the concerned Regional Offices of MOE&F as well as Regional Officer of the Ministry. Any difficulties encountered in this regard should be sorted out by discussing the problems at appropriate levels.

3. Necessary instructions in this regard may please be issued to the field officers in your Department under intimation to this Ministry.

No.RW/NH-11052/1/97-DO.I**Dated, the 24th April, 1997**

To

The Secretaries, PWD of all States/UTs, (dealing with National Highways), Director General Border Roads, Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India

Subject: Exemption from environmental clearance for Road projects along the existing alignment - Reg.

I am directed to send herewith a copy of letter No. J-21012/15/96-IA-III dated 12th March 1997 from the Ministry of Environment & Forests, New Delhi on the subject mentioned above for information and necessary action.

Enclosure to letter No.RW/NH-11052/1/97-DO.I, dated the 24th April, 1997

Copy of letter No. J-21012/15/96-IA-III dated 12th March, 1997 from the Ministry of Environments & Forests, New Delhi addressed to the Secretary, Ministry of Surface Transport, New Delhi regarding exemption from Environmental clearance for Roads Projects along the existing alignment.

Reference is invited to D.O. letter of even number dated 29th November, 1996 from Shri R.H. Khwaja, Joint Secretary in this Ministry on the subject mentioned above. As mentioned in the afore-mentioned letter, a Group was constituted to consider the issues relating to exemption from environmental clearance for road projects along the existing alignments. The recommendations made by the Group are as under :

1. The projects relating to improvement works including widening and strengthening with marginal land acquisition of roads along the existing alignments irrespective of the cost component may be exempted from obtaining environmental clearance from this Ministry. The Committee also took note of the decision taken by the cabinet during its meeting

on 15.1.97 that the road projects on existing alignments which are in the nature of improvement by way of widening the existing roads are to be exempted from clearance from environmental and forestry angles. The amendments in this regard are being made in the EIA Notification.

2. In relating to the acquisition of marginal land for improvement of roads along the existing alignment, the proposal would need to be examined by the concerned Ministry on case to case basis and approved at their end keeping in view the following :
 - a) Where the Department has already got the land under its ownership, and no additional acquisition of land is involved, no problems are envisaged.
 - b) Where extra barren land is to be acquired by the side of existing right of way, no problems are envisaged.
 - c) Where acquisition of additional land involves cutting of trees on non-forest land, adequate compensatory plantation would be necessary.
 - d) Where acquisition of additional land involves displacement of population, rehabilitation for the displaced persons would be necessary.
3. For diversion of forest land, if any, required for road improvement projects, necessary clearance under the Forest (Conservation) Act, 1980 would be required under the existing procedure.
4. If the existing road passes through ecologically sensitive areas such as sanctuaries, tiger reserve, reserved forests etc. it shall be necessary to obtain environmental clearance even if the proposal is for strengthening and widening of road along the existing alignments.
5. Even in those cases where environmental clearance from this Ministry is not being obtained for road projects, the project proponents would need to carry out a detailed EIA study and provide necessary mitigative measures to ensure that the adverse environmental impacts are minimised. Ministry of Environment & Forests shall be kept apprised of any such developmental projects being implemented.

As the implementation of the above recommendations would require amendment in the EIA Notification, 1994, further necessary action in the matter is being taken and we will keep you informed of the developments in this regard.

1720 EXPANSION JOINTS

<i>Code No.</i>	<i>Circular No. & Date</i>	<i>Brief Subject</i>	<i>Page No.</i>
1720.5	RW/NH-34059/1/96-S&R dated 31.3.97	Modified Interim Specifications for Expansion Joints	1720/4 to 26

No. RW/NH-34059/1/96-S&R

Dated, the 31st March, 1997

To

The Chief Engineers, PWD of all States/UTs, (dealing with National Highways and other Centrally Financed Schemes), Director General, Border Roads, Director General (Works), Central Public Works Department, Chairman, National Highways Authority of India, The Engineer-in-Chief, Municipal Corporation of Delhi

Subject: Modified Interim Specifications for Expansion Joints

In supersession of this Ministry's Circular letter of even number dated 28th June, 1996 on above subject, please find herewith enclosed modified interim specifications for expansion joints for adoption on all National Highway and other centrally sponsored bridge projects. The provisions in these specifications will prevail whenever they are at variance with the existing specifications. Salient points of modified interim specifications are mentioned below :

- 1.1. Component of various types of expansion joints which are mentioned in Annexure-II shall be imported to ensure quality and performance.
- 1.2. Details of type, profile and major dimensions of edge beams and central beams of Strip Seal Joints and Modular Strip/Box Seal Joints shall conform to those indicated in the sketches enclosed herewith in Annexure-III.
- 1.3. Special type of modular expansion joint should be provided for bridges having span length more than 120 m and/or involving complex movements/rotations in different directions/planes, with prior approval of the Ministry.
- 1.4. Criteria for adoption of different types of expansion joints has been modified as indicated in Annexure-I.
- 1.5. Specification for strip seal joints contained in Clause 2607 of this Ministry's "Specifications for Roads & Bridge Works" stands substituted by those given herein.
2. List of Indian Suppliers of various types of expansion joints including their foreign manufacturer/collaborator is given in Annexure-II. Supply of expansion joints may be obtained on the basis of competitive bidding from amongst the manufacturers/suppliers of expansion joints mentioned therein, subject to their satisfying the requirements of the specifications.
3. While arranging supply of expansion joints, a warranty of trouble free performance for atleast ten years and free rectification of defects/replacement, if any, during this period may be insisted upon from the contractor/suppliers for all types of joints except for buried joints and filler joints.
4. It is requested that the contents of this circular be brought to the notice of all officers in your department concerned with National Highways and other Centrally sponsored schemes.
5. You are also requested to send your comments/suggestions, if any, for further improvements of the interim specifications.
6. Please acknowledge receipt of this letter.

**GOVERNMENT OF INDIA
MINISTRY OF SURFACE TRANSPORT
(ROADS WING)**

**MODIFIED INTERIM SPECIFICATIONS
FOR
EXPANSION JOINTS**

I. BURIED JOINT

Clause 2604 of MOST Specification for Road & Bridge Works (Third Revision) may be deemed modified as under :

1. This joint shall consist of continuously laid bituminous/asphaltic surfacing over the joint gap bridged by a steel plate resting freely over the top surface of the deck concrete.
2. The width of the joint gap shall be kept as 20 mm.
3. The steel plate shall conform to weldable structural steel as per IS: 2062. The plate shall be 12mm thick and 200mm wide. The plate shall be made of minimum number of pieces (not exceeding two pieces per traffic lane width) welded together to form the required length.
4. 8mm dia, 100mm long nails, spaced at 300mm centres along the centre line of the plate shall be welded to the bottom surface of the steel plate to protrude vertically into the joint gap in order to prevent dislodging of the plate.
5. The plate and the nails shall be protected against corrosion by galvanising or any other approved anti-corrosive coating with a minimum thickness of 100 micron. These shall be completely free of oil, rust, loose paint or other similar material before application of anti-corrosive coating.
6. The concrete surface shall be free from any loose material and cleared of any grease, oil, paint, etc. and the surface shall be sand blasted, clean of all laitence and level true, prior to placement of the steel plate.
7. The plate shall be placed symmetrical to the centre line of the joint and it shall be ensured that the plate does not get displaced from its position while laying the wearing course.

II. ASPHALTIC PLUG JOINT

1. Asphaltic plug joint shall consist of a polymer modified bitumen binder, carefully selected single size aggregate, closure/bridging metallic plate and heat resistant foam caulking/backer rod.

2. General Requirements :

2.1. The joint shall extend to the full depth of the wearing course down to structural concrete. Where needed, a recess may be cut into the deck slab concrete to accommodate the minimum required depth of the joints.

2.2. The Joint shall be provided in the entire width of the structure including kerb and/or footpath. A recess in the kerb and/or footpath shall be made to allow the joint to pass beneath them. The expansion gap in the adjoining kerbs and/or footpaths shall be sealed with a suitable sealant such as polysulphide sealant.

2.3. Expansion joint shall cater for a horizontal movement of 25mm and vertical movement of 2mm. This shall be certified by the manufacturer/supplier of the joint.

2.4. The minimum width (in traffic direction) of the joint shall be 500mm and maximum width shall be 750mm.

2.5. Minimum depth of joint shall be 75mm and maximum depth shall not exceed 100mm.

2.6. The joint shall be capable of performing satisfactorily, within the temperature (ambient) range of -5 to +50 degree C.

3. Material :

3.1. **Binder:** The polymer modified bitumen binder shall have the capacity to fill the gaps and voids between single size aggregate and to impart flexibility to accommodate various design movements. It shall be a patented blend of bitumen, synthetic polymer, fillers and surface active agent and shall be so formulated as to combine necessary fluidity for the installation process, low temperature flexibility and flow resistance at high ambient temperatures. The binder shall satisfy following requirement :

Softening point	:	100 deg. C minimum
Core penetration at 25 deg. C 0.1mm (BS 2499)	:	100mm max.
Flow resistance at 70 deg. C, 5 hours (BS 2499)	:	3mm max.
Extension Test	:	5 cycle of extension to
(blocks prepared to ASTM D1190		50 per cent at a rate of
and tested to limits BS 2499)		3.2 mm/h at 25 deg.
Safe heating temperature	:	210 deg. C.

3.2. **Aggregates:** The aggregate shall be single size aggregate chosen from basalt granite, grit stone or gabbro group. The nominal size of aggregate shall be 12.5mm for depths of joints upto 75mm and 20mm for joints of more depths of joint. The aggregate shall not be flaky and the Flakiness Index shall not be more than 25 per cent. The aggregate shall satisfy following grading requirements :

IS Sieve Designation	Nominal size of aggregate	
	20mm	12.5mm
	per cent by weight passing the sieve	
26.5mm	100	---
19.0mm	85 - 100	100
13.2mm	0 - 35	85 - 100
09.5mm	0 - 7	0 - 35
06.3mm	---	0 - 7
02.3mm	0 - 2	0 - 2
600 micron	---	---
75 micron	0 - 1	0 - 1

The aggregate should have good (i) Polished Stone Value (PSV), (ii) Aggregate Abrasion Value (AAV), Aggregate Impact Value (AIV) and (iv) Aggregate Crush Value (ACV). In addition surface characteristics should promote proper adhesion. The following are the required values :

PSV > 60
AAV < 05
AIV < 18
ACV = 10-25

3.3. **Closure Plate:** The closure plate shall be weldable structural steel conforming to IS 2062. The minimum thickness of steel plate shall be 6mm and the width shall not be less than 200mm. Closure plate shall be provided with as large length as possible and welded together to form the required length. The number of pieces shall not be more than two per traffic lane width. It shall be provided with equi-distant holes at a maximum spacing of 300mm centres for anchorage to the caulking/backer rod along the longitudinal centre line of the plate. The plate shall be protected against corrosion by galvanising or any other approved anti-corrosive coating paint with a minimum thickness of 100 micron.

3.4. **Foam caulking/Backer Rod:** A closed-cell polyolefine or open cell polyurethane foam cylindrical caulking or backer rod having diameter equal to 150 per cent of the joint opening shall be provided. It shall be heat resistant and possess good flexibility and recovery characteristics with density of 25 to 30 Kg/Cu.m.

4. **Installation :**

4.1. The Expansion joint shall be installed by the manufacturer/Supplier.

4.2. The block out for the joint shall be marked and constructed to the dimensions as indicated in the drawing or recommended by manufacturer/supplier.

4.3. The recess for the block out shall be thoroughly cleaned of any loose or foreign material by wire brushing and air blowing and dried with hot compressed air.

4.4. The recess in the deck slab, if required, shall be repaired with epoxy mortar and cleaned and dried again.

4.5. The foam caulking/backing rod shall be placed about 25mm down into the joint opening.

4.6. The aggregate shall be washed, cleaned and heated to a temperature between 120 - 180 deg. C. prior to placement.

4.7. The binder shall be preheated to temperature of 170 - 190 deg. C. before application.

4.8. While sealing the joint opening with preheated binder, care shall be taken that the binder does not spill on to the joint surface of the deck.

4.9. The joint shall not be installed when the ambient temperature goes below +5 deg. C. or above +35 deg. C. or while it is raining/snowing. (Planning for installation must take into account the weather condition).

4.10. When clement weather resumes, the joint installation may be continued after the upper layer and/or exposed surface of the partially completed joint has been re-prepared by heating and/or coating with binder as necessary.

5. **Handling and Storage :**

All the aggregates and binder shall be pre-bagged and clearly marked. All the material shall be stored on concrete platform at 150mm above the ground in covered enclosures to avoid contamination.

6. **Tests and Standard of Acceptance :**

The material shall be tested in accordance with these specifications and shall meet prescribed criteria. The manufacturer/supplier shall furnish the requisite certificates from the recognised testing laboratory of India or abroad.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

III. COMPRESSION SEAL JOINT

1. Compression seal joint shall consist of steel armoured nosing at two edges of the joint gap suitably anchored to the deck concrete and a preformed chloroprene elastomer or closed cell foam joint sealer compressed and fixed into the joint gap with special adhesive binder.

2. Material

2.1. **Steel nosing** : The steel nosing shall be of angle section ISA 100x100 conforming to weldable structural steel as per IS: 2062. The thickness of legs shall not be less than 12mm. The top face of the angle shall be provided with Bleeder holes of 12mm diameter spaced at maximum 100mm centres so as to ensure that there are no voids in the concrete beneath the angle.

2.2. **Anchorage** : The anchorage steel shall conform to IS : 2062 or equivalent.

The steel nosing shall be anchored to the deck by reinforcing bars, headed studs or bolts or anchor plates cast in concrete or a combination of anchor plate and reinforcing bars, headed studs or bolts. Anchor bars, studs or bolts shall engage the main structural reinforcement of the deck and in case of anchor plates or anchor loops, this shall be achieved by passing transverse bars through the loops or plates.

The minimum thickness of anchor plate shall be 12mm. Total cross sectional area of bars, studs or bolts on each side of the joint shall not be less than 1600mm sq. per metre length of the joint and the centre to centre spacing shall not exceed 250mm. The ultimate resistance of anchorages shall not be less than 500KN/m in any direction.

2.3. **Corrosion Protection** : All steel section shall be protected against corrosion by hot dip galvanising or any other approved anti-corrosive coating with a minimum thickness of 100 micron.

2.4. Joint Seal :

2.4.1. The sealing element shall be a preformed continuous chloroprene or closed cell foam seal with high tear strength, insensitive to soil, gasoline and ozone. It shall have high resistance to aging and ensure water tightness. The seal should be vulcanised in a single operation for the full length of the joint required for carriageway, kerbs and footpaths, if any. The seal shall cater for a horizontal movement upto 40mm and vertical movement of 3mm.

2.4.2. The physical properties of chloroprene/closed cell foam sealing element shall conform to the following :

(a) Chloroprene seal :

Shall be preformed extruded multiweb cellular section of chloroprene of such a shape as to promote self removal of foreign material during normal service operations. Chloroprene of joint seal shall conform to Clause 915.1 of IRC:83(Part-II) and satisfy the properties stipulated in Table-1 of these specifications except in respect of the working movement range of the sealing element which shall be as specified in Clause 2.4.1. above.

(b) Closed Cell Foam Seal :

Shall be of preformed non-extruded non-cellular section made from low density closed cell, cross linked ethylene vinyl acetate, polyethylene copolymer that is physically blown using nitrogen. The material shall possess properties as indicated in the Table.

Table - 1

Property	Specified Value
(i) Density	41.7-51.3 kg/cu.m
(ii) Compression Set on 25mm	50 per cent compression samples (ASTM D 3575) for 22 hours at 23 degree Celcius, 2 hour recovery; 13 per cent set.
(iii) Working temperature	-70 to +70 deg. C.
(iv) Water absorption (total immersion for 3 months) (ASTM D 3575)	0.09766 kg/sq.m
(v) Tensile strength	0.9 MPa
(vi) Elongation at break (ASTM D 3575)	195 +/-20 per cent

2.5. **Lubricant-cum-Adhesive :** The type and application of material used in bonding the preformed joint seal to the steel nosing and concrete shall be as recommended by the manufacturer/supplier of the seal system.

3. **Handling and storage :**

- (i) The expansion joint materials shall be handled with care and stored under cover.
- (ii) All joint material and assemblies shall be protected from damage and assemblies shall be supported to maintain true shape and alignment during transportation and storage.

4. **Installation :**

4.1. The expansion joint shall be installed by the manufacturer/supplier or their authorised representative, who will ensure compliance of installation procedure and instructions.

4.2. The dimension of the joint recess and the width of the gap shall conform to the approved drawing.

4.3. Anchoring steel shall be welded to the main reinforcement in the deck maintaining the level and alignment of the joint.

4.4. Concreting of pocket/recess shall be done with great care using proper mix conforming to same grade as that of the deck concrete but not less than M30 grade in any case. The water-cement ratio shall not be more than 0.40. If needed, suitable admixtures may be used to achieve the workability. The width of pocket shall not be less than 300mm on either side of the joint. Care shall also be taken to ensure efficient bonding between already cast/existing deck concrete and the concrete in the joint recess.

4.5. At the time of installation, joint shall be clean and dry and free from spalls and irregularities which might impair a proper joint seal.

4.6. Concrete or metal surfaces shall be clean, free of rust, laitance, oils, dirt, dust or other deleterious materials.

4.7. The lubricant-cum-Adhesive shall be applied to both faces of the joint and joint seal prior to installation in accordance with the manufacturer's instructions.

4.8. The joint seal shall be compressed to the specified thickness for the rated joint opening and ambient temperature at the time of installation which shall be between +50 to +35 degree C.

1720/11

4.9. The joint seal shall be installed without damage to the seal. Loose fitting or open joints shall not be permitted.

5. **Acceptance criteria :**

5.1. All steel elements shall be furnished with corrosion protection system.

5.2. For the joint seal the acceptance test shall conform to the requirements stipulated in Para 2.4. The manufacturer/supplier of this type of joint shall produce a test certificate to this effect conducted in a recognised laboratory in India or abroad.

5.3. Prior to acceptance 25 per cent of the completed and installed joints, subject to a minimum of one joint, shall be subjected to water tightness test. Water shall be continuously ponded along the entire length for a minimum period of 4 hours for a depth of 25mm above the highest point of deck. The width of ponding shall be atleast 50mm beyond the anchorage block of the joint on either side. The depth of water shall not fall below 25mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.

6. **Tests and Standards of Acceptance :**

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria. The manufacturer/supplier shall furnish the requisite certificates from the recognised testing laboratory of India or abroad.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

IV. STRIP SEAL EXPANSION JOINT

Components :

Strip seal expansion joint shall comprise the following items :

a) **Edge beam :**

This shall be either extruded or hot rolled steel section or cold rolled cellular steel section with suitable profile to mechanically lock the sealing element in place throughout the normal movement cycle. Further the configuration shall be such that the section has a minimum thickness of 6mm all along the cross section. The minimum height of the edge beam section shall be 75mm.

b) **Anchorage :**

Edge beams shall be anchored to the deck by reinforcing bars, headed studs or bolts or anchor plates cast in concrete or a combination of anchor plate and reinforcing bars, headed studs or bolts. Anchor bars, studs or bolts shall engage the main structural reinforcement of the deck and in case of anchor plates or loops, this shall be achieved by passing transverse bars through the loops or plates.

The minimum thickness of anchor plate shall be 12mm. Total cross sectional area of bar studs or bolts on each side of the joint shall not be less than 1600mm sq. per metre length of the joint and the centre to centre spacing shall not exceed 250mm. The ultimate resistance of anchorages shall not be less than 500 KN/m in any direction.

Material

- a) The steel for edge beams shall conform to any of the steel grade corresponding to RST 37-2 or 37-3 (DIN), ASTM A36 or A588, CAN/CSA Standard G 40.21 Grade 300 W or equivalent.
- b) Anchorage steel shall conform to IS:2062 or equivalent.
- c) All steel sections shall be protected against corrosion by hot dip galvanising or any other approved anti-corrosive coating with a minimum thickness of 100 micron.
- d) Chloroprene of strip seal element shall conform to Clause 915.1 of IRC: 83 (Part-II). The properties of chloroprene shall be as specified in Table-1.

Fabrication (Pre-installation)

- a) The strip seal joint system and all its component parts including anchorages shall be supplied by the manufacturer/system supplier.
- b) The width of the gap to cater for movement due to thermal effect, prestress, shrinkage and creep, superstructure deformations (if any) and sub-structure deformations (if any) shall be determined and intimated to the manufacturer. Depending upon the temperature at which the joint is to be installed, the gap dimension shall be preset.

TABLE 1 - STRIP SEAL ELEMENT SPECIFICATION

Sealing element is made of chloroprene and must be a extruded section. The working movement range of the sealing element shall be at 70mm.

PROPERTY	SPECIFIED VALUE
Hardness*	
DIN 53505	63 ± 5 Shore A
ASTM D 2240 (Modified)	55 ± 5 Shore A
Tensile Strength*	
DIN 53504	Min 11 MPa
ASTM D 412	Min 13.8 MPa
Elongation at fracture*	
DIN 53504	Min 350 per cent
ASTM D 412	Min 250 per cent
Tear Propagation Strength	
Longitudinal	Min 10 N/mm
Transverse	Min 10 N/mm
Shock Elasticity	Min 25 per cent
Abrasion	Min 220 Cu.mm.
Residual Compressive Strain (22 h/70 deg C/30 per cent strain)	Max 28 per cent
Ageing in hot air (14 days/70 deg C)	
Change in hardness	Max + 7 Shore A
Change in tensile strength	Max - 20 per cent
Change in elongation at fracture	Max - 20 per cent
Ageing in ozone (24 h/50 pphm/25 deg C/20 per cent elongation)	No cracks
Swelling behaviour in Oil (168h/25 deg C)	
ASTM Oil No. 1	
Volume Change	Max + 5 per cent
Change in hardness	Max - 10 Shore A
ASTM Oil No. 3	
Volume Change	Max + 25 per cent
Change in hardness	Max - 20 Shore A
Cold Hardening Point	Max - 35 deg C

* Only one set of specifications viz. ASTM or DIN shall be followed depending on the source of supply.

- c) Each strip seal expansion joint system shall be fabricated as a single entity unless stage construction or excessive length prohibits monolithic fabrication. It shall fit the full width of the structure as indicated on the approved drawing. The system shall be pre-set by the manufacturer prior to transportation. Presetting shall be done in accordance with the joint opening indicated on the drawing.

- d) The finally assembled joint shall then be clamped and transported to the work site.

4. Handling and Storage :

- a) For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together.

- b) The manufacturer/supplier shall supply either directly to the Engineer or to the Bridge Contractor all the materials to strip seal joints including sealants and all other accessories for the effective installation of the jointing.
- c) Expansion joint material shall be handled with care. It shall be stored under cover on suitable lumber padding.

5. **Installation :**

5.1. The joint shall be installed by the manufacturer/supplier or their authorised representative who will ensure compliance to the manufacturer's instructions for installation.

5.2. Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer. The surfaces of the recess shall be thoroughly cleaned and all dirt and debris removed. The exposed reinforcement shall be suitably adjusted to permit unobstructed lowering of the joint into the recess.

5.3. The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The formwork shall be rigid and firm.

5.4. Immediately prior to placing the joint, the presetting shall be inspected. Should the actual temperature of the structure be different from the temperature provided for presetting, correction of the presetting shall be done. After adjustment, the brackets shall be tightened again.

5.5. The joint shall be lowered in a pre-determined position. Following placement of the joint in the prepared recess, the joint shall be levelled and finally aligned and the anchorage steel on one side of the joint welded to the exposed reinforcement bars of the structure. Upon completion, the same procedure shall be followed for the other side of the joint. With the expansion joint finally held at both sides, the auxiliary brackets shall be released, allowing the joint to take up the movement of the structure.

5.6. High quality concrete shall then be filled into the recess. The packing concrete must feature low shrinkage and have the same strength as that of the superstructure, but in any case not less than M 35 grade. Good compaction and careful curing of concrete is particularly important. After the concrete has cured, the movable installation brackets and shuttering still in place shall be removed.

5.7. The neoprene seal shall be field installed in continuous length spanning the entire roadway width. To ensure proper fit of the seal and enhance the ease of installation, dirt, spatter or standing water shall be removed from the steel cavity using a brush, scrapper or compressed air. The seal shall be installed without any damage to the seal by suitable hand method or machine tools.

5.8. As soon as the concrete in the recess has become initially set, a sturdy ramp shall be placed over the joint to protect the exposed steel beams and neoprene seals from the site traffic. Expansion joint shall not be exposed to traffic loading before the carriageway surfacing is placed.

5.9. The carriageway surfacing shall be finished flush with the top of the steel sections. The actual junction of the surfacing/wearing coat with the steel edge section shall be formed by a wedge shaped joint with a sealing compound. The horizontal leg of the edge beam shall be cleaned beforehand. It is particularly important to ensure thorough and careful compaction of the surfacing in order to prevent any premature depression forming in it.

6. **Acceptance Criteria :**

- i) All steel elements shall be finished with corrosion protection system.
- ii) For neoprene seal, the acceptance test shall conform to the requirements stipulated in Table 1. The manufacturer/supplier shall produce a test certificate accordingly, conducted in a recognised laboratory, in India or abroad.

- iii) The manufacturer shall produce test certificates indicating that anchorage system had been tested in a recognised laboratory to determine optimum configuration of anchorage assembly under dynamic loading.
- iv) Prior to acceptance 25 per cent of the completed and installed joints, subject to a minimum of one joint, shall be subjected to water tightness test. Water shall be continuously ponded along the entire length for a minimum period of 4 hours for a depth of 25mm above the highest point of deck. The width of ponding shall be atleast 50mm beyond the anchorage block of the joint on either side. The depth of water shall not fall below 25mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.
- v) As strip seal type of joint is specialised in nature, generally of the proprietary type, the manufacturer shall be required to produce evidence of satisfactory performance of this type of joint.

7. Tests and Standards of Acceptance :

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria. The manufacturer/supplier shall furnish the requisite certificates from the recognised testing laboratory of India or abroad.

V. MODULAR STRIP/BOX SEAL JOINT

1. A modular expansion joint shall consist of two or more modules/cells to cater to a horizontal movement in excess of 70mm. It shall allow movements in all 3 directions and rotation about all 3 axes as per the design requirements. It shall also ensure that during all movement cycles of the joint, opening and closing (gaps) of all modules are equal.

2. **Component :**

2.1. The structural system consisting of two edge beams, one or more central/separation beams or lamellas and cross support bars supporting individual or multiple central beams to transfer the loads to the bridge deck through the anchorage system.

2.2. Resilient or shock absorption support system for central beams as well as support bars to dampen dynamic loading thus reducing the forces transmitted to the substructure and anchorages as also to accommodate vertical and transverse movements apart from longitudinal movement.

2.3. Sliding or control system which allows closing and opening of the joint and also ensures that all modules open and close equally.

2.4. Mechanically locked sealing system of chloroprene which provides watertight, noiseless and easy replacement system.

3. **Materials :**

3.1. **Edge and central beams :** These shall be either extruded or hot rolled steel sections or cold rolled cellular steel sections including continuously shop welded sections for central beams with suitable profile to mechanically lock the sealing element in place throughout the normal movement cycle. Further, the configuration shall be such that the section has a minimum thickness of 6mm all along the cross section. The cold rolled cellular sections shall be relieved of any locked in stresses through annealing process. These shall be closed at both ends and be air tight after installation of seal to prevent ingress of moisture in the hollow portion. The minimum height of edge beams and central beam sections shall be 75mm. The material shall conform to any of the steel grade corresponding to RST 37-2 or 37-3 or 52-3 (DIN), ASTM A36 or A558, CAN/CSA standard G-40.21 Grade 300W or equivalent. The material for support bars may be same as that of edge/central beams or as per manufacturer's recommendations.

3.2. **Chloroprene Seal :** This shall be a preformed extruded single strip or cellular section of chloroprene of such a shape as to promote self removal of foreign material during normal joint operation. The seal shall possess high tear strength and be insensitive to oil, gasoline and ozone. It shall have high resistance to aging and ensure water tightness.

Chloroprene seal shall conform to Clause 915.1 of IRC:83 (Part-II). The properties of chloroprene shall conform to Table-1 of these specification.

3.3. **Anchorage :** The anchorage steel shall conform to IS: 2062 or equivalent.

Edge beams shall be anchored to the deck by anchor plates cast in concrete or a combination of anchor plate and reinforcing bars, headed studs or bolts. Anchor bars, studs or bolts shall engage the main structural reinforcement of the deck and in case of anchor plates or loops, this shall be achieved by passing transverse bars through the loops or plates.

The minimum thickness of anchor plate shall be 12mm. Total cross sectional area of bars, studs or bolts on each side of the joint shall not be less than 1600mm sq. per metre length of the joint and the centre to centre spacing shall not exceed 250mm. The ultimate resistance of anchorages shall not be less than 500KN/m in any direction.

3.4. **Support and Control System :** The overall system and components of the resilient/shock absorption system and sliding/control system shall conform to the specifications recommended by the manufacturer. The centre to centre spacing of transverse support bars shall not exceed 1.75m.

3.5. **Corrosion Protection :** All Steel sections shall be protected against corrosion by hot dip galvanising or any other approved anti-corrosive coating with a minimum thickness of 100 micron).

4. **Fabrication (Pre-installation) :**

4.1. The modular expansion joint system and all its component parts including anchorages shall be supplied by the Manufacturer.

4.2. The width of the gap to cater for movement due to thermal effect, prestress, shrinkage and creep, superstructure deformations (if any) and sub-structure deformations (if any) shall be determined and intimated to the manufacturer. Depending upon the range of temperature at which the joint is likely to be installed, the gap dimension shall be preset.

4.3. Each modular expansion joint system shall be fabricated as a single entity free from any joint in the longitudinal direction unless stage construction or excessive length prohibits monolithic fabrication. It shall fit the full width of the structure as indicated on the approved drawing. The system shall be pre-set by the manufacturer prior to transportation. Pre-setting shall be done in accordance with the joint opening indicated on the drawing.

4.4. The finally assembled joint shall then be clamped and transported to the work site.

5. **Handling and Storage :**

5.1. For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together.

5.2. The manufacturer/supplier shall supply either directly to the Engineer or to the Bridge Contractor entire assembly of Modular Strip/Box Seal joints including sealants and all other accessories for the effective installation of the jointing.

5.3. Expansion joint material shall be handled with care. It shall be stored under cover on suitable lumber padding.

6. **Installation :**

6.1. The joint shall be installed by the manufacturer/supplier only.

6.2. Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of the manufacturer. The surface of the recess shall be thoroughly cleaned and all dirt and debris removed. The exposed reinforcement shall be suitably adjusted to permit unobstructed lowering of the joint into the recess.

6.3. The recess shall be shuttered in such a way that dimensions in the drawing are maintained. The formwork shall be rigid and firm.

6.4. Immediately prior to placing the joint, the presetting shall be inspected. Should the actual temperature of the structure be different from the temperature provided for presetting, correction of the presetting shall be done. After adjustment, the brackets shall be tightened again.

6.5. The joint shall be lowered in a pre-determined position. Following placement of the joint in the prepared recess, the joint shall be levelled and finally aligned and the anchorage steel on one side of the joint welded to the exposed reinforcement bars of the structure. Upon completion, the same procedure shall be followed for the other side of the joint. With the expansion joint finally held at both sides, the auxiliary brackets shall be released, allowing the joint to take up the movement of the structure.

6.6. Controlled concrete having strength not less than that in superstructure subject to the minimum of M35 shall be filled into the recess. The packing concrete must feature low shrinkage. Good compaction and careful curing of concrete is particularly important. After the concrete has cured, the movable installation brackets and shuttering still in place shall be removed.

6.7. The chloroprene seal shall be field installed in continuous lengths spanning the entire roadway width. To ensure proper fit of the seal and increase the ease of installation, dirt, spatter or standing water shall be removed from the steel cavity using a brush, scraper or compressed air. The seal shall be installed without damage to the seal by suitable hand method or machine tools.

6.8. As soon as the concrete in the recess has become initially set, a sturdy ramp shall be placed over the joint to protect the exposed steel beams and neoprene seals from site traffic. Expansion joint shall not be exposed to traffic loading before the carriageway surfacing is placed.

6.9. The carriageway surfacing shall be finished flush with the top of the steel sections. The actual junction of the surfacing/wearing coat with the steel edge section shall be formed by a wedge shaped joint with a sealing compound. The horizontal leg of the edge beam shall be cleaned beforehand. It is particularly important to ensure thorough and careful compaction of the surfacing in order to prevent any premature depression forming in it.

7. Acceptance criteria :

7.1. All steel elements shall be finished with corrosion protection system.

7.2. For Chloroprene seal, the acceptance test shall conform to the requirements stipulated in para 3.2. The manufacturer/supplier shall produce a test certificate accordingly, conducted in a recognised laboratory, in India or abroad.

7.3. Fatigue strength of internal beams and support connections shall be investigated to withstand 2 million cycles of vertical load of 85 KN and a horizontal load of 10KN without showing signs of distress. The supplier shall have to produce a test certificate in this regard conducted by a recognised laboratory from India or abroad.

7.4. The manufacturer/supplier shall produce test certificates indicating that anchorage system had been tested in a recognised laboratory to determine optimum configuration of anchorage assembly under dynamic loading.

7.5. Prior to acceptance 25 per cent of the completed and installed joints, subject to a minimum of one joint, shall be subjected to water tightness test. Water shall be continuously ponded along the entire length for a minimum period of 4 hours for a depth of 25mm above the highest point of deck. The width of ponding shall be atleast 50mm beyond the anchorage block of the joint on either side. The depth of water shall not fall below 25mm anytime during the test. A close inspection of the underside of the joint shall not reveal any leakage.

7.6. As modular strip/box seal type of joint is specialised in nature, generally of the proprietary type, the manufacturer shall be required to produce evidence of satisfactory performance of his product.

8. Tests and Standards of Acceptance :

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria. The manufacturer/supplier shall furnish the requisite certificates from the recognised testing laboratory in India or abroad.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

**SUITABILITY CRITERIA
FOR
ADOPTION OF DIFFERENT TYPES OF EXPANSION JOINTS**

Sl. No.	Type of Expansion	Suitability for adoption Joint	Expected Service life	Special consideration
1	2	3	4	5
1.	Buried Joint	Simply supported spans up to 10 metres	10 Years	Only for decks with bituminous/asphaltic wearing coat. Steel plate may need replacement if found corroded or distorted at the time of relaying/renewal of wearing coat.
2.	Filler Joint	Fixed end of simply supported spans with insignificant movement or simply supported spans not exceeding 10 metres.	10 Years	The sealant and joint filler would need replacement if found damaged.
3.	Asphaltic Plug Joint	Simply supported spans for right or skew (upto 20 degree), moderately curved or wide deck with maximum horizontal movement not exceeding 25mm. Ambient temperature should be in the range of 5 degree to 50 degree celcius.	10 Years	Only for decks with bituminous/asphaltic wearing coat. Not suitable for bridge with longitudinal gradient more than 2 per cent and cross camber/superelevation exceeding 3 per cent. Not suitable for curved spans and spans resting on yielding supports.
4.	Compression Seal Joint* (Chloroprene Seal and Closed Cell Foam Seal)	Simply supported or continuous spans right or skew (upto 30 degree), moderately curved with maximum horizontal movement not exceeding 40mm.	10 Years	Chloroprene/Closed Foam Seal may need replacement during service.
5.	Elastomeric Slab Seal Joint*	Simply supported or continuous spans. Right or skew (less than 20 degree), moderately curved with maximum horizontal movement upto 50mm.	10 Years	Liable to excessive wear and tear under high traffic intensity. Not suitable for bridges located in heavy rainfall area and spans resting on yielding support.
6.	Single Strip Seal Joint*	Moderate to large simply supported. Cantilever/continuous construction having right, skew or curved deck with maximum horizontal movement upto 70mm.	25 Years	Elastomeric seal may need replacement during service.
7.	Modular Strip/Box Seal Joint*	Large to very large continuous/cantilever construction with right, skew or curved deck having maximum horizontal movement in excess of 70mm.	25 Years	Elastomeric seals may need replacement during service.
8.	Special Joints for special conditions	For bridges having wide decks/span length of more than 120m or/and involving complex movements/rotations in different directions/planes, provision of special type of modular expansion joints such as Swivel joints may be made.	25 Years	Elastomeric seal may need replacement during service. Provision of these joints may be made with prior approval of the Ministry.

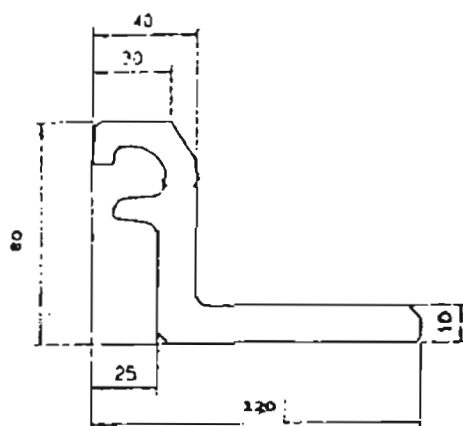
* These are proprietary items for which 10 years warranty shall be insisted upon from the suppliers.

ANNEXURE-II

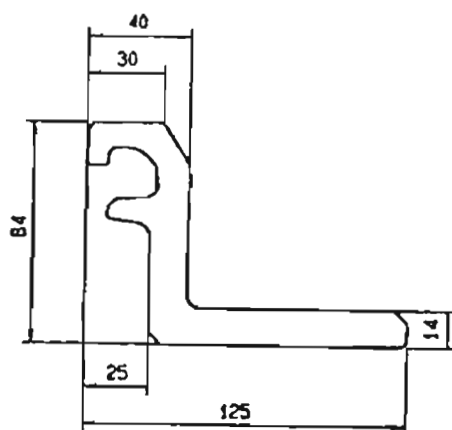
**LIST OF INDIAN SUPPLIERS OF DIFFERENT NEW TYPES OF EXPANSION JOINTS FOR
HIGHWAY BRIDGES**

Sl. No.	Name and Address of Supplier	Name of Manufacturers/ Foreign Collaborators	Type of Expansion Joints	Details of items to be imported from foreign manufacturer/ collaborator	Remarks
1.	J. Sons Engineering Corporation Ltd., J. Sons House, Garh Road, Meerut-250002	i) Maurer Sohne, P.O. Box-440145, D-8000, Munchen-44 Germany	(a) Strip Seal (b) Modular Strip Seal	Edge Beam and Strip Seal All items	
		(ii) E-Poxy Industries Inc. 14, West Shore Street/Revena, New York-12143 USA	(a) Strip Seal (b) Compression Seal (Closed Cell Foam Seal)	Edge Beam and Strip Seal Joint Seal & Adhesive-cum-lubricant.	
2.	Metal Engineering & Treatment Co. Pvt. Ltd., 4/1B, Nirmal Chunder Street, 3rd Floor, Calcutta-12.	Megeba Sa, solistrasse 68, CH-8189 Baluch. Switzerland	(a) Strip Seal (b) Modular Strip Seal (c) Asphaltic Plug	Edge Beam and Strip Seal All items Binder	
3.	Saufield (India) Pvt. Ltd., 5-Zone-II, Maharana Pratap Nagar, Bhopal-461011	Watson Bowman Acme Manufacturing and Order Processing, 95, Pinview Drive. Ambrest, New York, USA-14228.	(a) Strip Seal (b) Modular Strip/ Box Seal (c) Compression Seal (Chloroprene Seal) (d) Asphaltic Plug	Edge Beam and Strip Seal All items Joint Seal & Adhesive-cum-lubricant Binder	
4.	Thorma Expan, B-36-C, Sidhartha Extension, New Delhi-110014	Prismo Limited, West Sussex, United Kingdom	Asphaltic Plug	Binder	
5.	Z-Tech (India) Pvt. Ltd., J-1867, C.R. Park, New Delhi-110019	Z-Tech Inc., Z-Tech International, 4230, Marcel Lacasse, Boisbriand, Quebec. Canada IN3.	(a) Strip Seal	Edge Beam & Strip Seal	Suitable for max. movement of 50mm only.
			(b) Modular Strip Seal	All items	Max. opening of each module should be limited to 50mm
			(c) Compression Seal (Chloroprene Seal)	Joint Seal and Adhesive-cum-lubricant	
			(d) Asphaltic Plug	Binder	

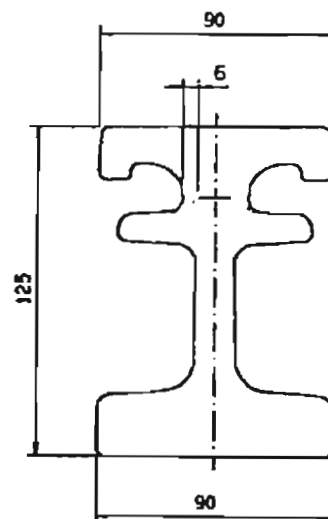
**MAURER SOHNE'S
EDGE BEAMS & CENTRAL BEAM
FOR
EXPANSION JOINTS**



EDGE BEAM FOR SINGLE STRIP SEAL JOINTS



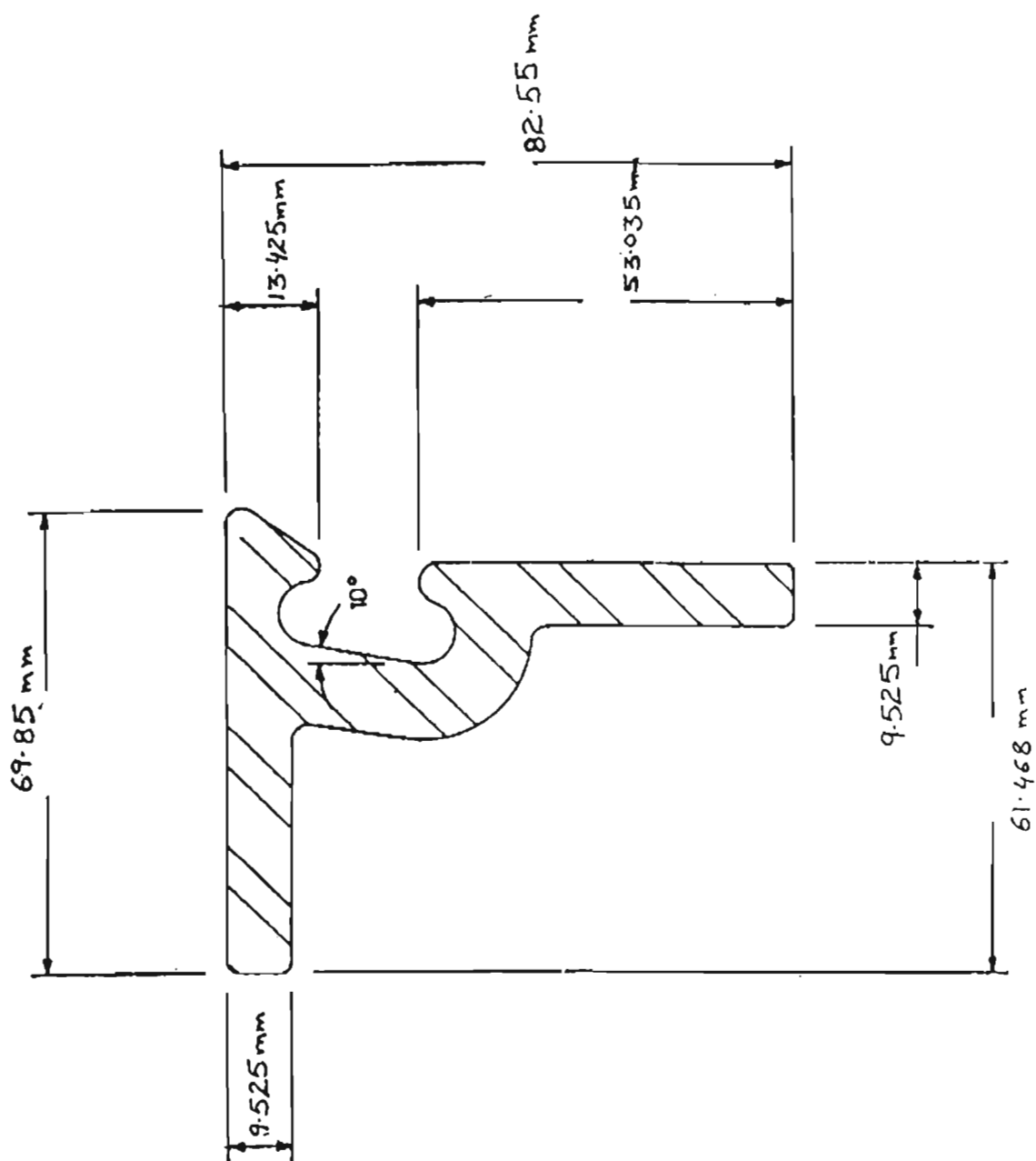
A. EDGE BEAM

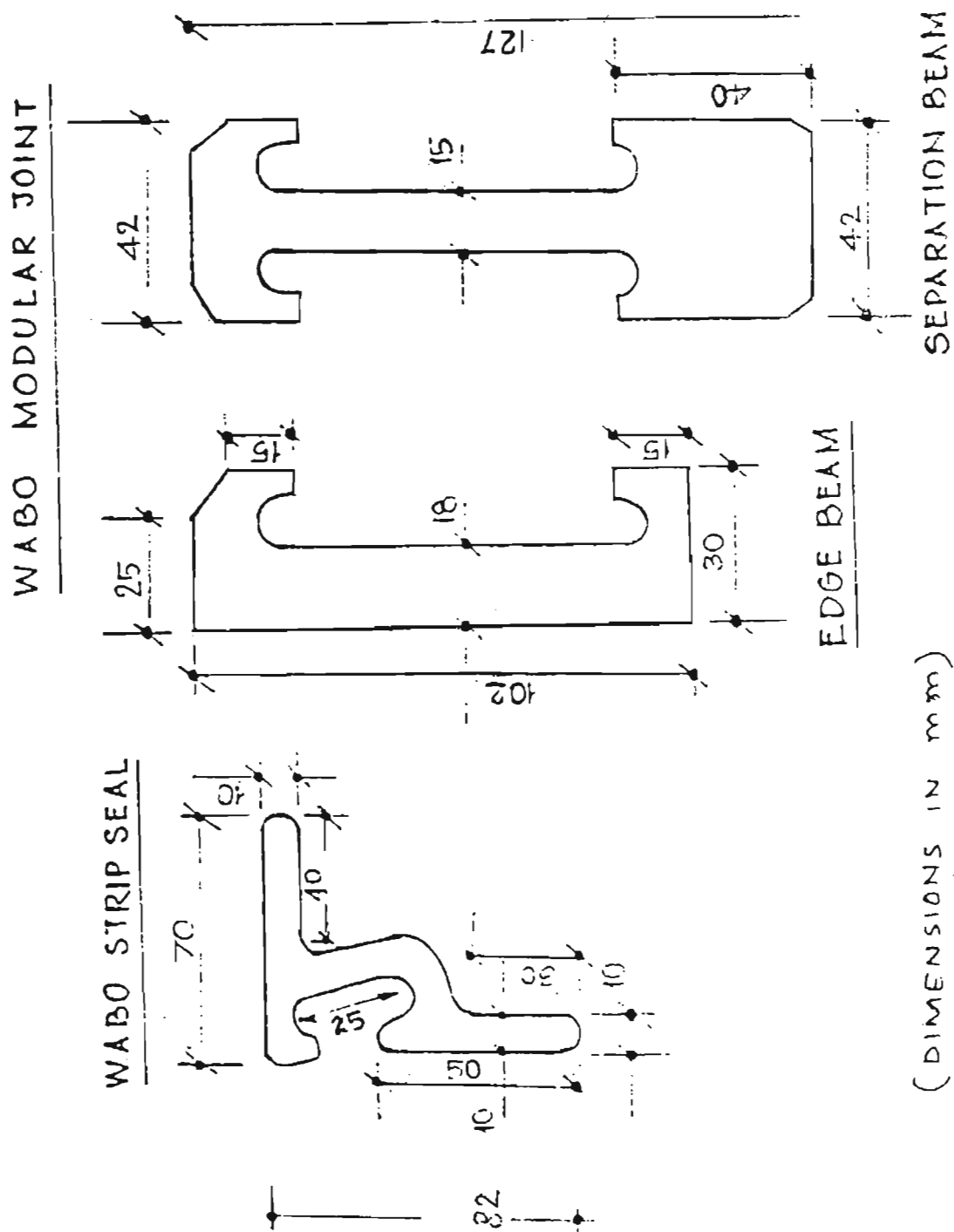


B. CENTRAL BEAM

MODULAR JOINTS

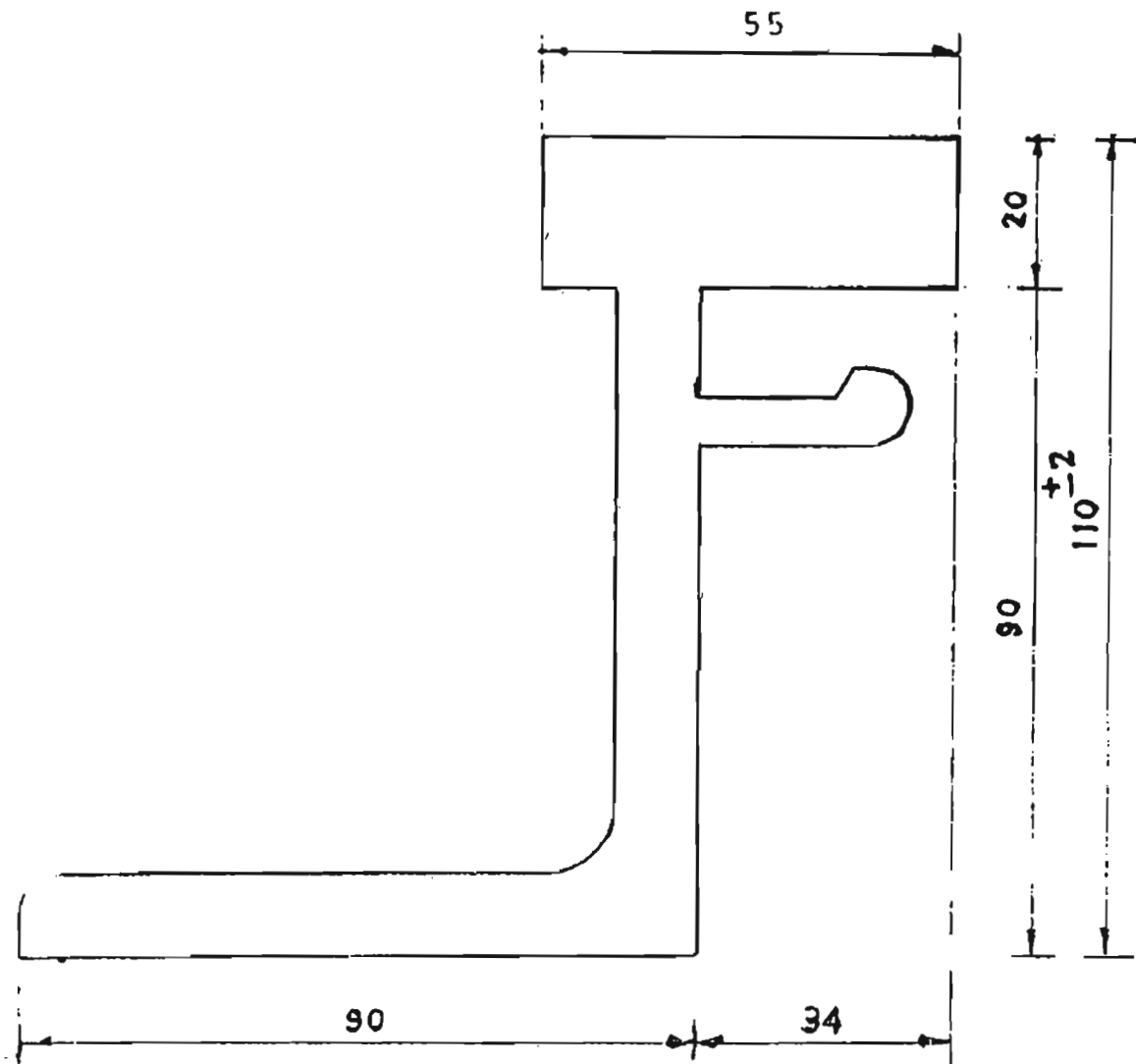
STEEL EXTRUSION (TYPE W)





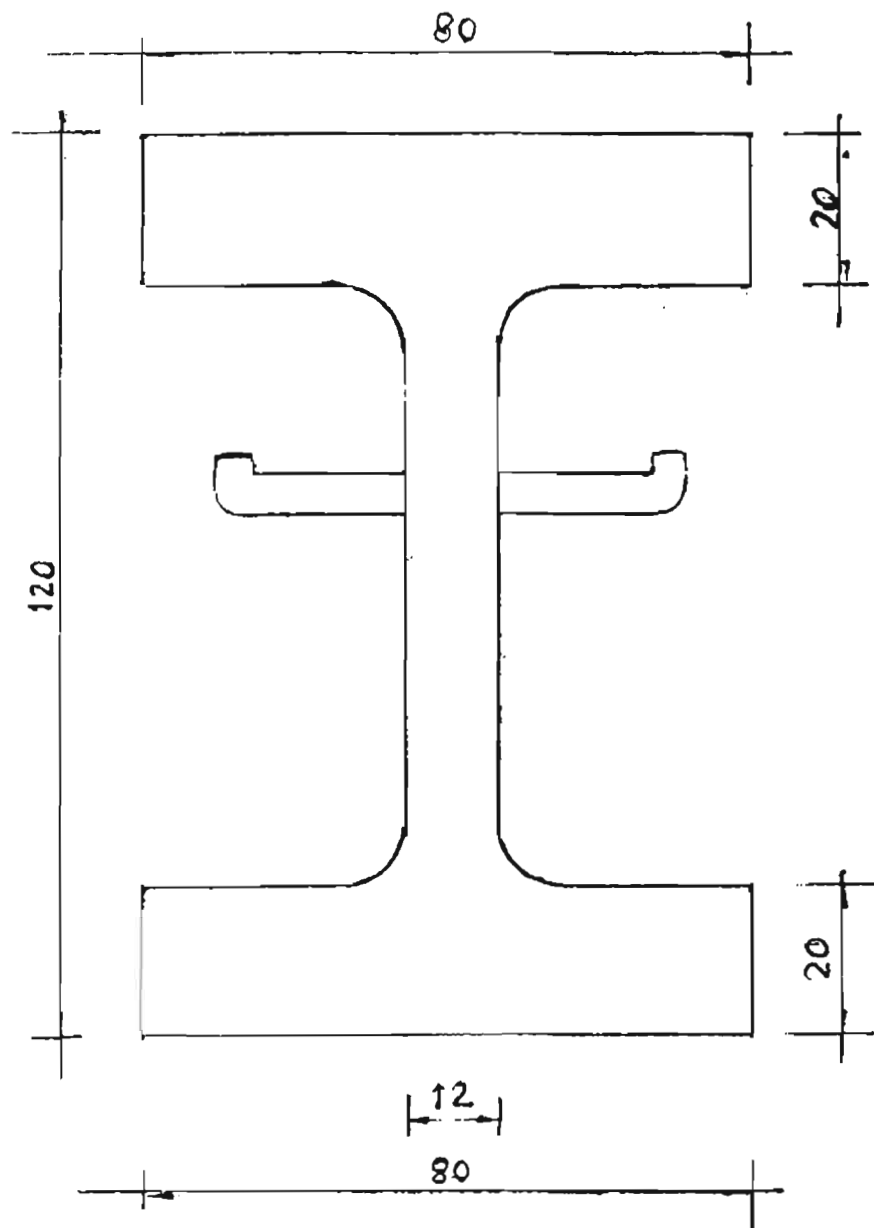
ANNEXURE-III

(4 of 6)



EDGE BEAM OF
MAGELBA STRIP SEAL
(UNITARY & MODULAR JOINT)

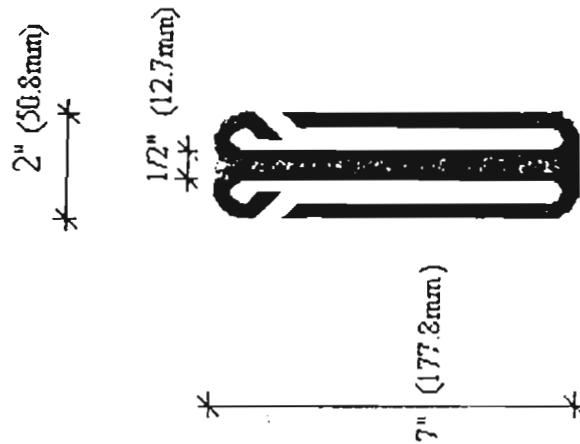
(DIMENSIONS IN mm)



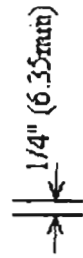
CENTRE BEAM / LAMELLA OF
MAGEBA MODULAR EXPANSION JOINT
(dimensions in mm)

DIMENSIONAL DETAILS OF Z-TECH STRIP-SEAL AND MODULAR EXPANSION JOINT BEAMS

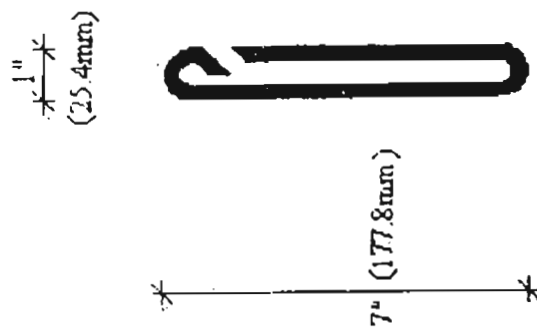
CENTRE BEAMS FOR
MODULAR JOINTS



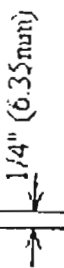
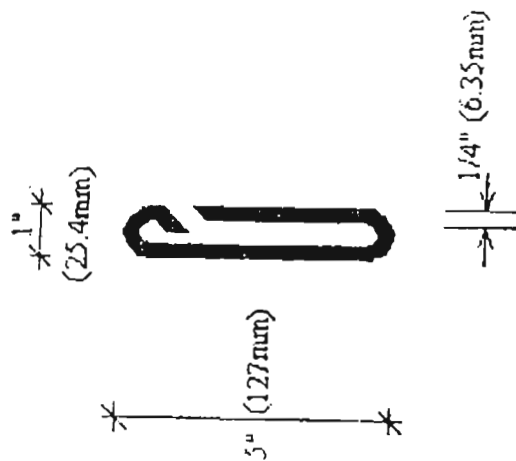
(6 of 6)



EDGE BEAMS FOR
MODULAR JOINTS



EDGE BEAMS FOR
STRIP-SEAL JOINT



7300 DUTIES, JURISDICTION & SPECIFIC INSTRUCTIONS TO ROs AND ELOs

<i>Code No.</i>	<i>Circular No. & Date</i>	<i>Brief Subject</i>	<i>Page No.</i>
7300.21	RW/NH-11052/4/89-DO I dated 2.8.89	NH works - Proper execution thereof	7300/17 & 18

No.RW/NH-11052/4/89-DO I***Dated the 2nd August, 1989***

To

The Secretaries, PWD of all State Govts./UTs, Director General, Border Roads Organisation, Director General (Works), Central Public Works Department

Subject: NH works - Proper execution thereof

I am directed to state that it has been observed that proper attention is not being paid by some of the executing Agencies to execution of NH works, resulting in sub-standard construction. In this connection, attention of the Executing Agencies is invited to the provisions of National Highways Rules which inter alia provide that the responsibility for the sub-standard work, if any, shall rest with the executing agency and all defects arising out of such sub-standard work shall be rectified by the executing agency at its own cost.

2. In view of the above, it is reiterated that prime responsibility for satisfactory completion of works as per specifications lies solely with the Agency executing the work. Mere inspection of the site by the Ministry's officials will not absolve the Agency of their responsibility for executing quality work strictly as per the prescribed standards and specifications.

3. It is requested that suitable instructions in this regard may please be issued to all concerned.

Govt. of India
Ministry of Surface Transport
(Roads Wing)

NH-24035/23/94-PL-Vol.III

New Delhi, Dated the 22nd June, 1997

To

The Secretaries (dealing with National Highways), Public Works Department of all States and Union Territories, Director General (Works), Central Public Works Department, Director General, Border Roads Organisation, Chairman, National Highways Authority of India

Subject: Toll Structures for 4 laned National Highways and other related issues

Certain measures pertaining to toll structures for 4 laned National Highways and other related issues have recently been taken to attract more investments in the Highway Sector. These are detailed for your information in the following paras.

2. Toll rates on completed 4-lane National Highways annually indexed to whole sale price index (WPI) shall be levied on case to case basis which may vary from area to area keeping in view the cost of project, financial viability and acceptability criteria, subject to the upper limit as given in the table below with effect from 1.7.97.

Upper limit of toll structure for 4 laned National Highways

S.No.	Type of Vehicle	Toll rate in Rupees per km
1.	Car/Jeep/Van	0.4
2.	Light Commercial Vehicle (LCV)	0.7
3.	Truck and Buses	1.4
4.	Heavy construction machinery and earth moving equipment	3.0

These rates shall be reviewed periodically by Government of India after every 3 years. Ministry of Surface Transport is authorised to levy higher rates of toll on expressways, major bridges, new bypasses, tunnels and in some exceptional cases (after obtaining approval of High Powered Committee) where so justified by level of traffic after competitive bidding process.

3. National Highways Authority of India/Govt. of India has been authorised to provide capital grants for BOT projects on National Highways not exceeding 40 per cent of the total cost of project.

The final decision regarding the quantum of such grants would be taken by the High Powered Committee set up by Cabinet comprising representatives of Ministry of Finance, Ministry of Law, Planning Commission under the Chairmanship of Secretary, Ministry of Surface Transport, Government of India.

4. Further tax concession is detailed below have now been approved :

- (i) The period for availing tax holiday/tax reduction for road infrastructure projects is being increased from 12 year to 20 years.
- (ii) The profits from Housing and other development activities which are an integrated part of BOT road projects would be treated as income from "infrastructure" projects for the purposes of tax exemptions/concessions provided, these profits are ploughed back to the development of roads (including repayment of long term debt for the project) on BOT basis within a period of 3 years.
- (iii) Exemptions from import duty on identified high quality construction plants and equipments used in the highway projects has been approved.

The steps for amending the relevant acts/notifications to give effect to the above are being taken separately by Ministry of Finance, Government of India.

5. The land required for Housing and other development activities which are an integral part of Highway projects would be considered as land required for Highway development and such acquisition would be treated as land required for "Public Purpose". Steps for amending the National Highways Act to this effect are being taken separately.