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No. NHI-4(6)/69 *Dated the 24th July 1969*

FINAL REPORTS OF THE TECHNICAL GROUP SET UP BY THE GOVERNMENT OF INDIA REGARDING NORMS FOR MAINTENANCE OF NATIONAL AND STATE HIGHWAYS (1968)

Page No.

PART I

COMPOSITION OF THE COMMITTEE AND TERMS OF REFERENCE

1.1. INTRODUCTION

For the preservation of the huge public investment in highways, their timely upkeep and maintenance is an inescapale necessity. In so far as Indian Roads go, the problem of maintenance has acquired a fresh colour in recent years as the traffic using the roads has shown a steep climb and this has been to the accompaniment of an all round rise in the cost of materials and labour. Highway maintenance budgets have, however, not risen correspondingly over this period in keeping with these changed conditions. As a consequence there has been a general fall in the maintenance standards and deterioration of surfaces in many cases. With maintenance slipping behind actual requirements, attention has been focussed on the need for enlarged maintenance allotments.

The problem is however, very acute in the case of the National Highways which form the backbone of the country's road system and carry the bulk of the nation's long-distance heavy traffic. The maintenance of National Highways figured prominently at the Transport Development Council meeting held at Bangalore in June 1968 where the consensus was that the maintenance allocations needed to be stepped up in tune with the spiralling traffic and prices of construction. The Council further expressed the view that in order to fix suitable norms for assessing maintenance costs, a small technical group should be set up at the Centre.

1.2. COMPOSITION OF THE COMMITTEE

Pursuant to this conclusion, the Government of India set up a Technical Group of the following composition vide their letter No. NHI-41 (11)/68 dated the 9th July, 1968 (Appendix A):

Director General (Road Development)	......Chairman
Chief Engineer, Haryana	......Member
Chief Engineer, U.P.	...... "
Chief Engineer, Bihar	...... "
Chief Engineer, Mysore	...... "
Chief Engineer, Madras	...... "
Chief Engineer, Roads Wing	......Member Secretary

1.3. TERMS OF RERERENCE

The terms of reference to the Group were as follows:

i) to suggest suitable norms for assessing maintenance costs; and
ii) to recommend a formula for the widening of roads from single-lane to doube lane carriageway.

1.4. SCOPE OF THE REPORT

This report by the Technical Group relates to maintenance problem of the National Highways and State Highways

1.5. FRAMEWORK OF THE REPORT

The report of the Committee has been divided into four parts as under:

Part I —Composition of the Committee and Terms of Reference
Part II —Considerations involved in maintenance of National Highways
Part III—Estimation of maintenance costs for National Highways
Part IV—Norms for computing Maintenance costs for State Highways

PART II

CONSIDERATION INVOLVED ON MAINTENANCE OF NATIONAL HIGHWAYS

2.1. The problem of maintenance of National Highways can be properly appreciated only if factors peculiar to their past development and present use are well understood. The different factors are indentified and commented upon in the succeeding paragraphs first before going to a discussion of the components of maintenance and making suggestions for estimation of the cost of these.

2.2. Factors Affecting Maintenance of the National Highways

2.2.1. **Inherent Deficiencies of the Crust:** The National Highway system came into being in 1947 when at one stroke over 12,200 miles of roads belonging to the State Governments or other local authorities were brought within fold of the Central Government. Some of these roads were old through routes like Grand Trunk Road running from Peshawar to Calcutta and the trunk road between Bombay and Delhi. But many other sections were mere District Board roads replete with deficiencies and having substandard surfaces and temporary or low capacity culverts/bridge crossings National Highway No. 6 traversing Orissa is one example of such roads. The thickness of the road pavements in majority of these newly designated National Highways ranged from barely 6 to 10 inches. As explained later this thickness is far from sufficient for the traffic intensities actually sustained by most of the National Highways Sections. Although in the past two decades a lot of effort has been exerted in the direction of strenghtening as many weak sections as possible, the stark facts stares in the face that all the National Highways by and large have only inadequte crust thickness. This inherent deficient factor aggregating the maintenance problem.

The majority of the National Highways have a flexible type of pavement surface. For the purpose of checking if a road is provided with sufficient crust thickness, the most widely used method of flexible pavement desgn is an empirical method going by the designation Calififornia Bearing Ratio Method. This method has been evolved after extensive observation of actual behaviour of thousands of miles of existing roads, situated under varying traffic and climatic conditions, by different road authorities. The minimum thickness of pavement is determined after finding out the strength of the soil in the laboratory at the worst moisture content the subgrade is expected to attain during its entire service life. This parameter of soil strength is known as the C.B.R. value. Curves have been developed correlating the CBR value with pavement thickness/for various traffic intensities. One such set of curves which has emanated from the Road Research Laboratory. U.K. is at Figure I. It will be seen that the range of traffic of these curves is from 0 to over 7,000 commercial vehicles of 30 CWT unladen weight per day.

As mentioned above, for very long lengths in our National Highway System, the thickness of metalling is between 6 to 10 inches only. The average CBR value of the subgrade at the same time is of the order of 3 to 6%. For these values of CBR and the amount of traffic actually plying over the National Highway sections (usually in E curve range) the designed thickness according to CBR design charts works out to between 14 and 19 inches. Thus, there is wide gap in the thickness of crust actually existing and what are to be available.The effect of deficient thickness the surfaces are increasingly showing signs of distress and pavement failures have become common place. As an end result, heavy patch repairs and frequent renewals of surfaces are a common feature of maintenance even for retaining the surface in their present substandard condition.

2.2.2. **Preponderance of Single lane Carriageways:**Another factor aggregating the maintenance problem of National Highways is that almost 70% of the total mileage belongs to single lane category. In such lengths both passing and crossing manoeuvres of vehicles are made most difficult as the vehicles are forced to frequently get on and off the Central paved width. Barring few stretches most of the National Highways have got only earth shoulders and these get very soon badly rutted under passage of vehicles. The deterioration is even more in the monsoon periods when the softening effect of water is an additional source of destruction causing practically a dislocation of traffic on certain sections of the National Highways.

* Studies carried out by the Road Research Laboratory, U.K. have sufficiently shown that on a single lane road where traffic is about 100 vehicles per day each vehicles has to cross the edge of the running surface about once every two miles. When traffic flow is 100 vehicles per day each vehicle must cross the edge about 5 times every mile and it will be running on the shoulders for approximately a quarter of the time. At the moment about 80% of the single lane sections of the N. Highways (which means about 8,000 miles out of the total length. of about 15,000 miles) are supporting traffic in excess of 1000 vehicles per day. All these sections are, therefore, obviously badly stressed and the side shoulders and edges of the pavement in their case require additional care to keep them traffic worthy.

Another feature of extra strain on signle lane roads which does not exist in the case of 2 lane carriageways is the concentration of wheel loads at a particular spot across the transverse width of the carriageway. Experiments conducted "elsewhere have demonstrated that this concentration of wheel loads can be of the order of 3 to 4 times than that in the case of two lane roads which should be stronger and fit for 3 to 4 times the intensity of traffic than that on comparable two lane sections. Unfortunately this is not true of the single lane sections of the National Highways.

The preponderance of single lane carriageways, therefore, is a major cause for the fact degenerating maintenance of the National Highways. It will be not out of place to mention that in other advanced countries two lanes of traffic are considered the barest minimum for all arterial roads connecting major centres of population, commerce and industry. In the introduction to the Highway Capacity Manual (3) this requirement has

(*) Road Research Technical Paper No. 76, published by Her Majesty's Stationery Office, U.K.

(") Millard, R.S.: "Road Transport and Traffic in developing countries" Conference on Civil Engineering Problems Overseas 1962, organised by the Institution of Civil Engineers, U.K.

been stressed in following words:

("At least two lanes for traffic movement, one in each direction, represent the minimum Highway installation normally, provided. The decision to provide a two lane highway many times is not justified on demand and capacity requirements alone, but on minimum level of service requirements which justify at least one travel lane in each direction for safety convenience and tolerable operating conditions."

2.2.3. **Increase in the Intensity of Traffic:** Although the National Highway network constitutes just 21.5% of the country's road system it carries traffic much in excess of its linear share on purely mileage basis. Practically all long distance traffic is concentrated along the National Highways and in it the major component is of the heavily laden commercial vehicles. Therefore, the number of commercial vehicles as per cent of the total traffic is a higher on National Highways than on other roads. The number of commercial vehicles in the traffic stream has a direct bearing on the thickness of pavement requirement.

Further, gross laden weight of vehicles have risen substantially in the course of the past few years. A contributory factor has been the permission granted by the Central Government some years back for an ad *hoc* increase of 25% over the maximum axle weights certified previous to that with the objective of relieving the then occurring serious shortage in the country's goods carrying capacity. The result was that whereas the axle weight did not previously exceeded about 18,000 lbs their limit was increased to over 23,000 lbs. In the recent multi-million dollar AASHO Road Test (4) if has been proved that the destructive effect on pavement of a 22,000 lbs axle load is a little over two times than for a 18,000 lbs axle. In actual practice even overloading beyond this limit is not uncommon. In contract, the axle loads of buses and trucks playing on highways of India in 1940 hardly exceeded 9,000 lbs.

Some of our highways cater for even higher loads when special machinery required for factories has to be transported by road owing to dimensional limitations of the railways wagons. An example of this demand for increasing the permissible loads is the Madras-Navyali Section of N.H. 45 where all the structures had to be reconstructed for the transport of machinery required for Navyali Lignite complex.

Increasing axle loads, therefore, are a major cause of deterioration of the National Highway surfaces.

Apart from this, traffic within the country has increased by leaps and bounds to phenomenal levels in the course of just 10-15 years. This is examplified by the figures of motor vehicle registrations (5) in the country from 1951 to 1967 reproduced below which show that the vehicle number shot up by three times over this period. The magnitude of this increase is about 8% compound every year.

YEAR	NUMBER OF VEHICLES	INDEX
1950-51	1,59,263	100
1955-56	2,03,184	128
1960-61	3.09.576	194
1961-62	3,39,644	213
1962-63	3,75,396	236
1963-64	3,87,947	243
1964-65	4,28,055	269
1965-66	4,56,793	287
1966-67	4,77,250	299

Maintenance allotments for National Highways have, however, not sympathetically increased over the same period. As a consequence the maintenance operations have been left behind in relation to the requirements generated by heavier and larger number of vehicles.

2.2.4. **Increase in Cost of labour and Materials:** In the years immediately proceeding there has been an appreciable rise in the cost of labour and materials. But the maintenance grants have not increased at the same pace with the result that it has not been possible to pay the desired amount of attention to National Highways and in the process their riding quality has steadily gone down. The maintenance grants (6) for the past ten years are shown below along with the length of the National Highways in that year and the index number (7) of the wholesale prices:

(3) "Highway Capacity Manual—1965 Highway Research Board, U.S.A., Special Report No. 37.

(4) "The AASHO Road Tests, Special Report No. 61, Highway Research Board, U.S.A., 1962.

(5) *Basic Road Statistics, published yearly by the Ministry of Transport and Shipping, Government of India.

(6) Annual Reports of the Ministry of Transport.

(7) "Records and Statistics" issue of August 1968.

5. To facilitate the erection and passing of erected centering, the Check-Lists-Annexure—'A' for Bridges and Annexure 'B' for building should be strictly followed and observed. The Check-list should be got duly filled in and entry about passing of the erected centering should be got duly recorded by the competent authority in the work Order Book and copies of these should invariably be posted by the Junior Engineer in charge of the work to the office of the Executive Engineer before starting actual concreting work.

6. One carpenter should be detailed to watch the behaviour of the centering from below, while concreting operations are going on to notice any cracking noises or movement of props (wobbling) so as to alert the staff concerned of the first signs of failure. The failure should be forestalled by taking immediate remedial measures, duly stopping the concreting work for a while if necessary.

ANNEXURE A

CHECK-LIST FOR ERECTION AND PASSING OF THE CENTERING FOR EACH SPAN OF A BRIDGE

1. Span Number
2. a Is the design of the centering duly approved by the competent authority as prescribed in para 2 (a) of the Chief Engineer's circular No. BRG 1076/233-DSK-4, dated 31st January, 1977?
2. b Are detailed drawings of approved design of centering kept on record?
3. If the design is approved subject to certain remarks, are these remarks duly and properly complied with before erection?
4. a What is the depth of river flow in the span at the time of passing the centering?
4. b What is its velocity at the time of passing the centering?
4. c Is the post monsoon flow in the River/Nalla properly diverted ?
5. a In case of mud centering, does the top 30 to 35 cms. consist essentially of selected soil such as good moorum?
5.b Is this layer thoroughly consolidated?
5. c Is the height of earth filling as per approved design of centering?
5. d Is the filling evenly done on both sides of the pier to avoid earth pressure acting on one side of the pier?
6. Is the top of centering covered with non-absorbant material?
7. a Are the side slopes of the mud centering to proper prescribed slope ?
7. b Are they steeper than 1½ : 1 ?
7. c Alternatively is the filling closed by dry rubble walls on upstream and downstream faces?
7. d Is the extra width of 1.5 m on both sides provided as a working platform as required by para 4.1.1. of the prescribed code of practice?
8. In the case of timber post type centering is the ground (Bed) strong enough, say rocky or of hard murum and boulders, so that the verticle can be kept directly on the levelled ground?
9. a In case the ground is not firm, is the top 60 cms. filled up with good selected material such as hard murum properly rammed and levelled and protected by masonry walls on u/s and d/s?
9. b Is the bearing capacity of the filling material adequate to withstand the maximum designed loads?
10. a In case of steel trestles, where concentrated loads are coming are T.W. sleepers placed in 2 or 3 tiers in a crib form to satisfactorily distribute the load on to the ground?
10. b Are all members of the crib properly secured and connected to each other?
11. a In case the timber posts need to be spliced, are the ends made square to abut against each other?
11. b Is the solicing, done with timber plates and using proper nuts and bolts?
11. c Is the length of the splicing piece at least 75 cms. or more as per design?
11. d Are all posts across or along in one line?
12. Is the splicing of timber posts in one tier well dispersed?

(i.e. a number of spliced posts are not grouped in one area and that not more than 25% spliced joints are provided at any one level in the tier)

13. In case of multi-tier type of centering is horizontal connection provided in both the directions at the tier level?
14. a Are the timber posts or steel trestles adequately braced along and across the roadway?
14. b Is the first bracing provided at least 2 mts. from the bottom of vertical props?
14. c Is the spacing of bracing within permissible limits?
(1.5 mts. for, timber posts and 2.5 mts. for steel trestles).
15. Are suitable cleats provided at crossings or junctions of any two members?
16. Are proper lateral supports of scantlings given to the vertical faces of the webs of beams?
17. Is every individual beam supported independently right upto ground level?
18. Are proper steel clamps used to tie the wooden brackings to the steel trestles?
19. a In case of C.C. arches and beams with curved soffit is a tier necessarily provided near the springing level?
19. b Is the profile of arch/curve soffit of beam checked as per approved plan?
20. In case of C.C. arches and balanced cantilever T-beams and slabs is the sequence of concreting and the sequence of removal of centering shown on the drawing of centering?
21. Have wedges of good materials been properly and adequetely provided below the props?
22. Is a set of photos of the created centering kept on record as per para 3 of the Chief Engineer's Circular No. BRG 1076/233-Desk-4, dated the 31st January 1977 before commencement of concreting?
23. a Has the erection of centering been passed by the competent authority as per para 2 b of the Chief Engineer's Circular No. BRG 1076/233-DSK 4, dated 31st January 1977?
23. b Has a note to that effect been recorded in the work order book?
23. c Mention the name of the officer who has passed the centering and the date on which he has passed the same.

Officer-in-Charge of Sub-Division/Executive Engineer

(Signature of the authority competent to pass the centering).

ANNEXURE-'B'

CHECK LIST FOR ERECTION AND PASSING OF CENTERING FOR EACH FLOOR OF A BUILDING

1. a Building Number.
1. b Floor Number.
2. a Is the design of the centering duly approved by the competent authority as prescribed in para 2 (a) of the Chief Engineer's circular No. BRG 1076/233-DSK-4 dated the 31st January 1977?
2. b Are detailed drawings of approved design of centering kept on record?
3. If the design is approved subject to certain remarks, are these remarks duly and properly complied with before erection?
4. Is the bearing capacity of the material used in the plinth filling adequate to withstand the maximum designed loads?
5. a In case the timber posts need to be spliced, are the ends made square to abut against each other?
5. b In the splicing done with timber plates and using proper nuts and bolts?
5. c Is the length of the splicing piece at least 75 cm or more as per design?
5. d Are all posts across or along in one line?
6. Is the splicing of timber posts in one tier well dispersed? (i.e. a number of spliced posts are not grouped in one area and that not more than 25% spliced joints are provided at any one level in the tier).
7. In case or multi-tier type of centering, is a horizontal connection provided in both the direction at the tier level?
8. a Are the timber posts or steel trestles adequately braced in both the direction?
8. b Is the first bracing provided at least 2 mts. from the bottom of vertical props?
8. c Is the spacing of bracing within permissible limits (1.5 mts for timbers-posts and 2.5 mts. for steel trestles).
9. Are suitable cleats provided at crossings on junctions of any two members?
10. Are proper lateral supports of scantlings given to the vertical faces of the webs of beams?
11. Is every individual beam supported independently upto ground/floor level?
12. Are proper steel clamps used to tie the wooden bracings to the steel trestles?
13. Have wedges of good materials been properly and adequately provided below the props?
14. In case of load bearing walls, are C.C. bed blocks provided below soffit of R.C.C. beams, prior to erection of centering?
15. Is a set of Photos of the erected centering kept on record as per para 3 of the Chief Engineer's Circular No. BRG 1076/233-DSK-4, dated 31st January 1977 before commencement of concreting?
16. a Has the erection of centering been passed by the competent authority as per para 2 b of the Chief Engineer's circular No. BRG 1076/233-DSK 4, dated 31st January 1977?
16. b Has a note to that effect been recorded in the work order book?
16. c Mention the name of the Officer who has passed the centering and the date on which he has passed the same.

Officer-in-Charge of Sub-Division/Executive Engineer

(Signature of the authority competent to pass the centering).

Responsibility of engineering Officers in respect of supervising various items of work.

GOVERNMENT OF MAHARASHTRA Public Works & Housing Department, Chief Engineer's Circular No...... Bombay.

CHIEF ENGINEER'S CIRCULAR

Detailed instructions have been issued, prescribing the level at which the different types of centerings for the bridges and buildings are to be approved and passed on site by different engineering Officers. Many a times, certain important operations like concreting of major structures, stressing of cables, launching of girders etc. are carried out in absence of personal supervision at the minimum adequate level necessary for a particular operation. Sometimes, execution of such important elements is left entirely to the contractor and lower level supervisors. It has thus become necessary to prescribe the responsibility of officers at different levels who should personally supervise and guide by remaining present during various important operations of works in the interest of better and safe execution of works in this Department. Accordngly the following instructions are issued for guidance of engineering officers in this Department and strict observance in future :

A. *Prestressed Concrete Bridges :*

(A-1) *Laying of reinforcement and cables*

(i) The Executive Engineer shall generally check the technical correctness of laying of reinforcement and cable profiles, their junctions, couplings, anchorages etc. before the shuttering is closed for concreting of the first unit. (He need not necessarily check the measurements).

(ii) The Deputy Engineer shall check and record measurements of cent-per cent components, irrespective of whether the work is on item rate or lumpsum contract.

*(A-2) *Concreting*

(i) The Superintending Engineer shall generally inspect the arrangements a few days before commencing concreting of the first girder to satisfy himself about the various arrangements made and to issue detailed instructions on spot as may be relevant for the guidance of the supervisory field staff and contractor. (A similar visit by Executive Engineer, Quality Control and designs should also be arranged).

(ii) The Executive Engineer shall remain present and supervise concreting of the first girder to be cast. In addition, he may also supervise or remain present for casting of the further girders, as he may feel necessary.

(iii) The Deputy Engineer shall remain present and supervise concreting of the cent percent girders and other components in prestressed concrete.

*(A-3) *Stressing of cables and grouting*

(i) The Superintending Engineer shall generally inspect the arrangements a few days before commencing stressing of cables and grouting of the cables of first girder to satisfy himself about the various arrangements made and to issue detailed instructions on spot as may be relevant for the guidance of the supervisory field staff and contractor. (A similar visit by Executive Engineer, Quality Control and Designs should also be arranged).

(ii) The Executive Engineer shall remain present and personally supervise and guide the stressing and grouting of all the cables foı all the stages of the first girder and the cables of the first unit of any other prestressed component of the bridge.

(iii) The Deputy Engineer shall remain present and personally supervise stressing and grouting of all the cables of first three girders of a bridge and cables of the first three units of any other prestressed component of the bridge. In addition, he shall personally supervise and remain present for stressing and grouting of at least 50% of the balance number of cables stressed and grouted on the bridge during his tenure.

(iv) The Junior Engineer shall supervise and personally remain present during stressing and grouting of cent percent cables of all the prestressed components on the bridge.

(A-4) *Launching, conveying, side shifting etc. of girders and other precast components (prestressed as well as R.C.C.)*

(i) The Superintending Engineer shall generally inspect the arrangements a few days before commencing launching, conveying, side shifting etc. of the first girder to satisfy himself about the various arrangements made and to issue detailed instructions on spot as may be relevant for the guidance of the supervisory field staff and contractor (A similar visit by E.E. Designs may also be arranged).

(ii) The Executive Engineer shall remain present and personally supervise the entire operation for the first girder or the unit of each type.

(iii) The Deputy Engineer shall remain present and personally supervise the entire operation for the first 3 units of each type and in addition, 50% of the subsequent units executed during his tenure.

(iv) The Junior Engineer shall remain present and personally supervise the entire operation of cent percent units executed during his tenure.

B. *R.C.C. Bridges (Major as well as Minor)*

(B-1) *Reinforcement of superstructure*

(i) The Executive Engineer shall generally check the technical correctness of laying of reinforcement before the concreting of the first unit (He need not necessarily check the measurements).

(ii) The Deputy Engineer shall check and record measurements of cent percent components, irrespective of whether the work is on item rate or lumpsum contract.

(B-2) *Concreting of-(a) components of bridges involving more than 20 Cum concrete at a time and (b) concreting of superstructure.*

(i) The Executive Engineer shall generally inspect the arrangements a few days before commencing concreting of the first unit. satisfy himself about the arrangements made and to issue detailed instructions on spot as may be relevant for the guidance of the supervisory field staff. However, for casting of deck units for spans in excess of 10 metres and centering heights in excess of 5 metres the Executive Engineer shall remain present and supervise the entire concreting of the first unit.

(ii) The Deputy Engineer shall remain present and supervise concreting of cent percent girders or units to be cast.

(B-3) *Concreting of other components involving quantities-less than 20-Cum at a time.*

(i) The Deputy Engineer shall remain present and supervise concreting of the cent percent units to be cast.

(ii) However, the Suprintending Engineer may, by written prior approval, allow selected Junior Engineers to supervise concreting of smaller elements or where concreting is carried out in lifts involving less than 10 Cum. concreting at a time, with the stipulation that at least 25% of such concreting carried out during the tenure of any Deputy Engineer should be supervised by the Deputy Engineer.

C. *Buildings*

(C-1) *Reinforcement for RC/PSC*

(i) The Executive Engineer shall generally check the technical correctness of laying of reinforcement before the concreting of the first unit (He need not necessarily check the measurements).

(ii) The Deputy Engineer shall check and record measurements of cent percent components.

*(C-2) *Concreting of beams longer than 5 metres, slabs bigger than 20 Sq. m in area and components involving more than 20 Cum. concreting :*

(i) The Deputy Engineer shall remain present and supervise concreting of cent percent units.

(C-3) *Concreting of smaller components and columns, footings etc.*

(i) The Deputy Engineer shall remain present and supervise concreting to the extent of 25% of the quantity concreted during his tenure.

(ii) The Jr. Engineer shall remain present and supervise concreting cent percent units.

D. *Roads :*

*(D-1) *Asphalt works like hot mix asphaltic concrete and premix carpets of more than 25 mm thickness.*

(i) The Executive Engineer shall remain present and personally supervise the first 200 metre length.

(ii) The Deputy Engineer shall remain present and personally supervise at least 50% of the length executed during his tenure.

(iii) The Junior Engineer shall present and personally supervise sent percent length executed during his tenure.

*(D-2) *Soil stabilisation and other experimental surfaces overlays etc.*

(i) The Executive Engineer shall remain present and personally supervise the first 200 metre length.

(ii) The Deputy Engineer shall remain present and supervise at least 50% of the length executed during his tenure.

(iii) The Junior Engineer shall remain present and personally supervise cent percent length executed during his tenure.

E. *Miscellaneous :*

*(E-1) *Load testing of any component of bridge or building or other structure :*

(i) Any load testing of a component of a bridge building or structure to be carried out either in compliance of the requirements of contract specifications or in case of doubt about strength/efficacy shall be carried out under the direction and guidance of the Superintending Engineer who may lay down any particular guidelines over and above those given by Codes/Designs Circle/ M.E.R.I. before start of the test.

(ii) The Executive Engineer shall remain present and personally supervise the important stages of the load testing, taking observations, etc. The decision about whether the test was satisfactorily conducted and about the acceptance or rejection will be taken by the Executive Engineer who may seek guidance or consult his superior officers and/or Designs Circle/M.E.R.I.

(iii) The Deputy Engineer shall remain present and supervise the entire operation of the load testing and taking observations as well as recording the same.

(E-2) *Execution of all unusual items, like mastic asphalt experiments, laying of bearings and expansion joints (for bridges as well as buildings) any patented processes, special water proofing treatments, anchors for foundations etc.*

(i) The Executive Engineer shall remain present and personally supervise the entire operation of the first such unit.
(ii) The Deputy Engineer shall remain present and personally supervise at least 50% of the work executed during his tenure.
(iii) The Jr. Engineer shall remain present and personally supervise cent per cent work executed during his tenure.

2. The levels of officers required to remain present for personal supervision as indicated above, are the lowest level of officer who has to supervise the particular items to the minimum extent indicated above. It goes without saying that all the engineering officers below that rank have necessarily to remain present and supervise along with that officer. On the other hand, this does not prevent any officers at higher levels to themselves remain present for giving their guidance and directions to satisfy themselves that any work is being carried out properly. Further the frequencies of personal supervision at different levels indicated above, are the minimum prescribed and it is open to the respective officers to exceed those as may be found necessary and possible by them.

3. Advance intimation with at least two days notice before commencing any of the operations marked with "*" above, shall be given in case of every unit or component to the Executive Engineer and Deputy Engineer of the quality control organisation for information to enable them to arrange surprise inspections, as may be necessary. The responsibility for ensuring proper quality and proper execution, however, vests with the engineers in charge of execution.

4. In order to ensure proper quality control and record of the various operations and work on different items during execution, a number of registers should be maintained and reviewed periodically by the Deputy Engineer, Executive Engineer and the Superintending Engineer. These registers will give all the detailed information of various operations taken from time to time such as material consumption register, well sinking, casting, operations, cube registers, stressing register, blasting register, testing register, log books of testing machines, Ghani register, register of supervisory staff with duties, register of inspecting officers, diary of works, etc. These should also contain information about the level of engineering officer supervising a particular item, in accordance with the schedule. Such information in an abstract form should also be attached with all Running Account and Final Bills of works as may be relevant.

Chief Engineer and Joint Secretary to Government

To

All Additional Chief Engineers in Public Works and Housing Deptt.

All Superintending Engineers and Executive Engineers of Public Works and Housing Department (including Zilla Parishad) with 10 spare copies).