4320.3.

No. NHVI-67 (29)/76 *Dated the 2nd March, 1983*

To

All Chief Engineers of States/Union Territories dealing with National Highways and other Central Sector Bridge Works

Sub : Periodic Inspection and Maintenance of Highway Structures on National Highways

The importance of periodic inspection of bridge structures on National Highways has been highlighted and brought to the notice of State Chief Engineers vide D.O. letter of even No. dated the 28th Feb'83 from Brig. Gobindar Singh, Director General (Road Development) & Addl. Secretary and circular letters issued from time to time. In this connection the I.R.C. have also issued "Special Publication 18-Manual for Highway Bridge Maintenance Inspection" in Feb'78 for providing uniformity throughout the country and to serve as a guideline to maintenance Engineers. The State Chief Engineers dealing with National Highways and other Central Sector bridge works were also requested to refer to the above mentioned Special Publication vide this office circular letter of even number dated the 22nd September, 1978 and again highlighted vide circular letter of even number dated the 26th August, 1982. So far the response in this connection has not been encouraging, and therefore, to stress the importance of regular maintenance inspection of bridges for ensuring long term serviceability, it has become imperative to enumerate below the salient aspects once again for guidance :

1.1. Manual of Inspections :

For uniformity in Maintenance inspection, various aspects as brought out in the I.R.C. Special Publication No. 18-Manual for Highway Bridge Maintenance Inspection should be strictly followed.

1.2. Periodicity and Timing of Inspections :

1.2.1. It is desirable to undertake inspection in those periods of the year which offer the most critical evaluation of the performance, as suggested below :

Items	Time of Inspection
(a) Foundations, protective, works, scour effects, maximum flood level etc.	During and after monsoon
(b) High structures	During season of high velocity winds
(c) Bearings and expansion joints	During the extreme seasons and after floods
(d) Bridges in hilly terrain	Before and after monsoon

Apart from these, special inspections shall also be undertaken for unusual occurrence like earthquake, passage of abnormal loads, heavy impact of barges or floating debris on substructure, foundations or fenders etc., to ascertain their performance.

1.2.2. All bridges shall be inspected once a year. However, bridges located in hilly terrain and prone to effects of slips, etc., shall be inspected twice a year i.e. once before the monsoons and then after the monsoons are over.

1.3. Level and Extent of Inspection :

Bridges shall be inspected by a competent qualified engineer, who has a thorough knowledge about bridge engineering. In general the status of the Inspecting Officer shall be as mentioned below but the same can be altered depending upon the importance of the work.

Bridge length	Status of Inspecting Officer of the State PWD
(i) Upto 30 m.	Junior Engineer
(ii) From 30 to 60 m.	Assistant Engineer/ Assistant Executive Engineer
(iii) From 60 to 200 m.	Executive Engineer
(iv) Above 200 m and all prestressed concrete continuous structures, suspension bridges, cable stayed girder bridges and special structures.	Chief Engineers and Superintending Engineers

1.4. Details of Inspection :

Inspection of each part of the bridge structure should be planned and outlined in detail before hand to avoid any over-sight. For this, systematic inspection procedures should be followed. Check list techniques should be employed to preclude the possibility of any bridge component being overlooked during the course of inspection. Inspection results of each bridge should provide a comprehensive records of bridge deterioration over a period of time. Aspects regarding details of inspection of various components are already covered in the I.R.C. Special Publication No. 18, however, some points regarding inspection of bearings, expansion joints, corrosion in bridge members, scour effects and protective works are highlighted below :

1.4.1 Bearings :

Bearings transmit and distribute the superstructure loads both vertical and horizontal to the substructure, and they permit the superstructure to undergo necessary deformations without developing harmful over-stresses. It is very necessary to ensure that the bearings actually perform the functions for which they have been designed. This can be achieved only by proper maintenance and regular inspection. Improper functioning of bearings can lead to major failures. All bearings should normally be inspected during temperature extremes and after floods have receded. These should also be inspected for unusual occurrences.

What to Look for During Inspection :

(i) Metallic bearings :

(a) The general conditions like cleanliness, collection of dust, sand etc., rusting easing of plates etc.

(b) Check that rockers, pins, and rollers are free of corrosion and debris. Excessive corrosion may cause bearing to "freeze" or look and become incapable of movement.

(c) Rocker bearings, where slots are provided for anchor bolts, should be checked to ensure that the bolt is not frozen to the bearing.

(d) Check that the bearing surfaces of rockers and rollers and the deflection slots around pins are clean and free of corrosion.

(e) Determine whether the bearings are in proper alignment, in complete contact across the bearing surface and that the bearing surfaces are clean.

(f) Check the condition of grease/oil, when last greased and whether it needs replacement. The bearings should be inspected for this aspect at least twice a year i.e. before and after monsoons and the grease/oiling should be done, whenever found necessary. (It has been found in a bridge on a N.H. that when the grease boxes of the bearings were opened, at least 1/2" thick muck had collected on all the surfaces of the bearings).

(g) Detect rattling of bearings under live load. If present, the condition usually indicates that the bearings are loose. Determine the cause of this condition.

(h) Check anchor bolts for loseness and for missing nuts.

(i) See whether rollers are in proper position, and are not jumping off the guide. Look for unusual tilting of rollers and see whether adequate clearance is available for rollers to roll.

(j) Measure the rocker tilt to the nearest 3 mm offset from the reference line. Record the temperature at the time of inspection.

(k) Measure horizontal travel of the sliding bearing as well as roller bearing to the nearest 3 mm. from reference point. Record the temperature at the time of observations.

(l) Special care should be taken while inspecting special joints such as central hinges in cantilevers, articulations etc. It should be observed whether the supporting arrangement for these bearings are well in tact.

(m) Observe for any structural cracks in supporting members like abutment cap, pier cap, pedestal, R.C.C. cantilever, wing walls etc.

(ii) ELASTOMERIC BEARINGS :

(a) Splitting or tearing either vertically or horizontally, if any, should be properly investigated. This is often due to inferior quality pads.

(b) Bulging caused by excessive compression may be looked for.

(c) Inspect the physical condition of the bearing for defects like oxidation, creep, flattening etc.

(d) Look for the cleanliness of the bearings and its surroundings, particularly to avoid contact with grease, oil, petrol etc.

(e) Look for variable thickness other than that which is due to normal rotation of the bearing.

(f) Observe for any abnormal deformation.

(g) See whether any structural crack in supporting member like abutment cap, pier cap, pedestal etc. are present.

1.4.2. Expansion Joints :

Since all materials expand and contract with change in temperature, provisions must be made in the bridge superstructure to permit movement to take place without damage to the bridge.

What to Look for During Inspection

(a) Check all expansion joints for freedom of movement, proper clearance and proper vertical alignment. There should be sufficient room for expansion but the joint should not be unduly open. Closed or widely opened joints can result from substructure movements.

(b) Look for cracks, if any in the wearing coat of the deck slab in the neighbourhood of the expansion joints. Such cracks are observed in most of the bridges. Careful observation for the reasons of such cracks in wearing coat adjacent to expansion joints should be made to formulate remedial measures and such measures should be taken early.

(c) Check seals for water tightness and general condition such as seal or sealant pulling away from the edges of the joints, abrasion, or other physical deterioration of the seal, stain and other signs of leakage underneath the deck. Leaking seal permit water and brine to flow on to the bridge seat and the pier cap causing erosion of bearings, disintegration of concrete and staining. Sealant will have to be poured if a gap has formed between the sealant and the adjacent wearing coat.

(d) Check for locking of joints, especially for finger type expansion joints.

(e) Look for corrosion in top sliding plate, connecting member etc.

(f) Check to see that the expansion joints are free from stones and other debris. This is most important as such obstacles impede the movement of the expansion joint.

(g) Examine steel finger type joints and sliding plate joints for evidence of loose anchorages, cracking or breaking of welds or other defective details.

(h) Verify that surfacing material has not jammed the finger joints on the bridges that have been resurfaced.

(i) Examine specifically the under side of the expansion joint regardless of accessibility to detect any existing or potential problem.

1.4.3. Corrosion in Bridge Members :

Concrete bridges mainly in the coastal area are most vulnerable to corrosion. All bridges shall be inspected once a year to ascertain if there are any signs of distress such as appearance of stains, cracks, spalling etc. and action taken to remedy such defects. Such bridges shall be kept under constant observations by resorting to frequent inspections and further immediate remedial measures undertaken as considered necessary.

The durability of the structure varies in various zones of exposures such as submerged zones, splash zones and atmospheric zones. The inspection should cover the items listed in the Proforma at Annexure-A. The items requiring special attention during inspection are mentioned briefly in notes at the end of Annexure-A. This has already been brought to the notice of State Chief Engineers vide this office letter No. RW/PL-17 (14)/76-Vol. II dated 31.3.1981. Various points mentioned in the above circular should be kept in view.

The reports should be compared with previous reports to get an idea of the rate of deterioration. If the rate of deterioration is alarming then further detailed investigations should be undertaken and immediate remedial measures adopted.

1.4.4. Foundations, Scour Level etc :

In the case of major bridges built across alluvial rivers deep scour may occur near some of the piers even with discharges much smaller than the design discharge. Such deep scour may result in tilting of foundations and consequent damages to various components of the bridges. During inspection, proper attention should be given to the following points :

(a) To take soundings before during and after each flood at all foundation locations for all bridges built across major rivers with alluvial beds (foundations seated on soils), particularly where the rivers show a tendency to meander and give rise to concentrated flows, and maintain a permanent record of the same.
(b) To observe the high flood level, discharge, obliquity of flow, erosion of banks, functioning of the bridge waterway, changes in flow pattern, etc. as already brought out in the circular letter of even number dated 26th May 1977.
(c) In cases where such records reveal that scours as observed have a tendency to exceed the earlier anticipated/design scour depths, appropriate protective steps like dumping of boulders around the foundation locations or resorting to fullfledged garlanding of the foundations laid at suitable levels which will not cause adverse or deteriorating flow conditions of the river around the piers, may be resorted to after obtaining necessary approval of the Competent Authority.
(d) In some cases it may even be found necessary to train the river and guide the flow more uniformly through the various openings, by means of proper training works, such as guide-bunds, or spurs, etc.
(e) Since even small settlement of foundations may adversely effect the safety of superstructure resting on bearings, particularly cut-roller bearings, it is suggested that suitable concrete blocks/wooden packings be provided under the beams near the bearings to ensure that in the event of the superstructure getting dislodged from the bearings, it would ultimately rest on such concrete blocks/wooden packings, avoiding the risk of a total collapse.

1.4.5. Protective Works :

(a) Most careful patrolling and watch is necessary during each flood season especially the first flood season to detect any weakness in construction and to take prompt action.
(b) The Engineer in charge should acquaint himself with the past history of the protective works and the behaviour of the river as it is only when he possesses all this knowledge that he can deal effectively with any problem that may arise.
(c) It is advisable to have a reserve quantity of stones which can be used in case of an emergency. A part of the stones may be stacked on the guide bund itself and a part in the nearest store from where it can be loaded and transported quickly to the site. The quantity of reserve boulders would depend upon site conditions. However, a minimum of 1% of the total quantity of boulders used in the apron and slope pitching should be kept as reserve.
(d) It is necessary that during the flood season,the field Engineers remain vigilant and keep a careful watch on the behaviour of the river as it affects the training works. During flood season it is advisable to have regular patrolling of the guide bund and the approach banks and taking proper action when any abnormal swirls, eddies or scour is apprehended. Any small rain cuts or wave cuts along the guide bund or the approach bank must be repaired immediately as there is always the danger of a small cut developing into a major disaster.
(e) Any settlement in the bank or bridge or slip in the slope needs immediate attention.
(f) During winter or dry weather a survey of river course has to be carried out to a sufficient distance on the upstream and downstream of bridges with guide bunds.
(g) Soundings preferably with the help of an echo sounder shall be taken near the guide bund when the river is in flood.

1.4.6. General

(a) Elements like wearing coat, drainage spouts hand rails, footpaths and construction joints should be inspected to see whether their performance is satisfactory. Surface condition such as cracks, spalling of concrete, disintegration etc. shall be looked for. Reinforcement should be inspected for corrosion. The condition of joints where pre-cast slabs resting on kerbs are used shall be examined to ascertain that no slab falls off the support. Any missing footpath slab shall be reported and replaced immediately so that pedestrians do not fall into the gap caused by the absence of footpath slabs. Hand rails near the maximum rotation point shall be inspected to see whether the gap between the two adjacent hand rails is widening or coming closer.

(b) Construction joints should be examined to see whether there is a possibility for water to percolate through the construction joints. Important construction joints like the joints between main deck and kerb in the case of cantilever footpaths etc. should be inspected carefully.

1.5. System of Reporting to Higher Authorities :

The inspection reports should cover the items listed in IRC Special Publication No. 18 and also items mentioned above, wherever applicable. The inspecting officer should also indicate as to whether the repairs that had to be carried out based on the past inspection have been undertaken or not. Bridge register shall be maintained national highway-wise and again division-wise and should be made available to the inspecting officers of this Ministry as well as the Regional Officers. The inspection reports in respect of various bridges should be sent to the headquarters of the State PWDs. The State PWDs have to examine these reports critically and assess the gravity of situation in case of each of the severely affected bridges. Problematic cases should be reported to this Ministry, alongwith the details of inspection carried out on these bridges, in the month of January every year. While sending such proposals the PWD should also outline their proposals for rectification. Any special repair estimate, if required, shall follow subsequently. If in any particular State, in any particular year there is no problematic bridge, a "nil" report should be submitted without fail to the Ministry.

1.6. The inspection reports of major bridges as well as bridges which rquire repairs should be sent to the concerned Regional Office of this Ministry. Such bridges should be independently inspected by ELO/RO and their observations sent to the Headquarters of the Ministry separately. For specific cases, senior officers of the Ministry will also visit the site and assess the extent of damage depending on the gravity of the problem.

1.7. Facilities for Maintenance and Inspection

To facilitate proper inspection and maintenance of bridges, espcially major bridges, special permanent fixures may be provided in the bridge at suitable points at construction stage itself. These could be like provision of catwalk ladders for reaching pier, provision of manhole in foot-paths near central hinges or articulations in the case of cantilever bridges for leading to the underside of deck, bearings etc. through a system of ladders and platforms alongwith required connecting member. Provision of fixtures such as railing supported platform, which could be moved by hand operated winches between the piers can be examined and provided at the construction stage. For inspection of existing bridges the P.W.D. can make arrangement for procuring movable platforms which can move on rails located at deck level. Fixed type of platform will also be useful in inspecting bridge girders and members, underside of the deck hinges etc.

2. Necessary action in the light of above may please be taken and the field officers instructed accordingly. One copy of the instructions issued by the State Chief Engineer to the lower formation of State P.W.D. in this connection may please be sent to this Ministry for record. It is once again emphasised that proper upkeep, regular inspection and maintenance will alone ensure long term serviceability of the bridges. "A stitch in time seves nine".

Enclosure to letter No. NH VI-67 (29)/76 dt. 2.3.83

ANNEXURE 'A'

PROFORMA FOR INSPECTION

A. HISTORY OF BRIDGE :

1. Name of Bridge
2. Location of Bridge. (with map showing predominant direction of wind)
3. Age of Bridge on the date of inspection
4. Approximate distance from sea. Whether located in back waters
5. Whether any chemical industry is nearby or harmful affluent passing in the river
6. Type of bridge along with GAD-R.C.C./prestressed
7. Grade of concrete with cement content
8. W/C ratio used (if available)
9. Chemical analysis of all the materials (if available)
10. Minumum cover to steel reinforcement used
11. Whether any anti-corrosive treatment adopted at the time of construction
12. Position of construction joints (if available)

B. INSPECTION REPORT :

1. BRIDGE COMPONENT AFFECTED
   i) Superstructure
   ii) Substructure
   iii) Foundations
   iv) Bearings
   v) Any other
2. NATURE OF DISTRESS OBSERVED :
   i) Rusting or staining of concrete
   ii) Bulging and/or cracking of concrete
   iii) Spalling of concrete
   iv) Rusting of metallic bearings
3. Extent of increase in deterioration since previous inspection
4. Repair measures proposed to be taken

C. Any other observation

NOTE :

The items of inspection, as listed in proforma (item B1) are briefly elucidated here

1. BEARINGS

While inspecting the bearings, following shall be kept in mind :

i) The general condition like cleanliness, rusting and ceasing of metallic/plate bearings
ii) Condition of rubber bearings, deterioration due to oxidation, flattening, bulging and splitting
iii) Condition of grease/oil (if provided) in case of metallic bearings
iv) Whether any structural cracks in supporting members like abutment cap, pier cap, pedestal, etc.

2. SUPERSTRUCTURE :

The inspection officer shall inspect the superstructure and report in respect of the followings :

(i) REINFORCED CONCRETE MEMBERS: The following aspects shall specially be looked for spotting (rusting), cracking, leaching, spalling and other signs of deterioration in critical areas of the structure viz., splash zone, water line at low tide level and portions exposed to atmospheric action on the windward side. For the latter the web of concrete girder and box girder, articulations, underside of decks etc., shall particularly be inspected.

(ii) PRESTRESSED CONCRETE MEMBERS : For prestressed concrete members, aspects like loss of camber, excessive deflection, cracking, deterioration in concrete viz., spalling etc., shall be looked for. The critical areas being the end anchorage zones, junction of diapharms, under-side at the centre of span for longitudinal cracking etc.

3. EXPANSION JOINTS

Besides inspection for proper functioning of the expansion joint, any deterioration in the material such as rusting etc., shall be looked for alongwith remedial measures required.

4. WEARING COAT :

The surface condition i.e. whether there are any cracks, spalling of concrete, disintegration etc. need to be reported alongwith remedial measures.

5. HAND RAILS AND FOOTPATHS :

Hand rails, being slender members are susceptible to corrosive distress. Appearance of rust stains, cracks, scaling, deterioration in concrete, spalling etc. need to be reported alongwith remedial measures.