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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

HANDBOOK ON INSPECTION OF BRIDGES

CAMTECH/98/C/Bridge/1.0

December - 1997

Centre for Advanced Maintenance TECHnology

Excellence in Maintenance

Maharajpur, GWALIOR - 474 020

FOREWORD

As per current statistics, Indian Railways have almost 1,20,000 bridges spread all over the country. The Railway bridges cost enormously and occupy strategic importance in the movement of goods, passengers and defence materials all over the country. It goes without saying that these bridges have to be kept in sound working condition preserving adequate strength through well laid out inspection and maintenance programme.

This handbook is prepared to meet the above objective and provide assistance to the staff involved in bridge inspection and maintenance. CAMTECH has taken utmost care to include all necessary details and attention has been paid to include even such items as a consolidated list of tools and equipment required by bridge inspection and maintenance works.

I am sure that this handbook will go a long way in ensuring high reliability of bridges on Indian railways.

Gwalior ***D.K.Saraf***
March 3, 1998 ***Director***

PREFACE

In Indian Railway bridges are withstanding day to day increasing axle load resulting in need of precise and maximum utilisation of assets.

Objective of this handbook is to give a fairly but concise knowledge about importance of Inspection procedures. List of equipments required for inspection and a checklist of items of inspection has been added to make this handbook more useful for inspecting personals.

This handbook does not supercede any provisions contained in I.R.W.W.M. except where necessary correction slips intimating the required changes are issued by Railway Board.

No words can describe the immense initiative and guidance received from Shri D.K.Saraf, Director and efforts taken by Mr. Sunil Gupta, CTA/Civil, who went through the complete text and procedures and collected informations, circulars, datas and presented in a bilingual handbook form. Nice data entry has been done by Miss Sangeeta Sinha, DEO/Civil.

I shall be grateful to the readers who will call attention to the errors of ommision or commission and give valuable suggestion for inproving this handbook to enhance its usefulness.

Gwalior ***R.S.Dubey***
March 2, 1998 ***Jt. Director (Civil)***

ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/98/C/Bridge/1.0/CS. # XX
date.....

Where "XX" is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

Sr. No. of C.Slip	Date of issue	Page no. and Item No. modified	Remarks

CHAPTER 1

INTRODUCTION

The Indian Railways with a holding of more than 1.20 lakhs track Bridges, 70,000 route kilometers, 40,000 coaches and 4 lakhs wagons are the ASIA's biggest and world's second largest public sector set up. Bridges are the expensive and key elements of the Railway net work because of their strategic location and of the dangerous consequences when they fail or when their capacity is impaired.

A bridge Inspection programme for the assurance of safety is required with timely and economic planning and programming of remedial and preventive maintenance even heavy repair or bridge replacement with the least interruption to traffic are dependent upon detailed Bridge Inspection. It is also applicable in case of old bridges which was not designed to modern loading standards.

Inspection is to be done to identify and measure the deterioration which may be caused by applied loads and other factors i.e. dead load, live load, wind load and physical and chemical influenous of climate apart of the natural or accidental calamities. Inspection can also needed to identify any built - in - imperfections and also help to increase the useful life of bridges.

1.2 Necessity For Inspection

The first steps to any maintenance programme is inspection. The purpose of inspection of a bridge can be identified as follows :

(a) To provide assurance that the bridge is structurally safe and fit for its designed use. This relates to the gradual deterioration of the bridge with time or to an accidental occurence such as earthquake. overloading, derailment etc.

(b) To identify actual and potential sources of trouble at the earliest possible stage.

(c) To record systematically and periodically the state of the structure. This enables one to know the time when defects occuued and to identify any significant structural changes.

(d) To provide feed-back of information to designers and custodians of bridges on those features which are likely to give maintenance problems and to which necessary attention is best given during design and construction stages ; and

(e) To provide necessary information on which decision will be made for carrying out maintenace repairs, strengthening or replacement of the structure.

Inspection lays the foundation of the entire maintenance programme. If inspection or maintenance is neglected or it is done at too long an interval or performed with insufficient effort, the consequences may lead to :

a) Loss of aesthetic appearance .

b) Loss of function, serviceability and possibly, of safety.

c) Loss of material value of the structure resulting in reduced service life.

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CHAPTER 2

TYPE AND SCHEDULE OF INSPECTION

There are three types of inspection as under :

2.1 General/ Routine Inspection

This consists of broad general visual inspection by Assistant Engineer once a year.

2.1.1 Detailed inspection

This also known as technical inspection during which thorough examination of each and every component of the Bridge and its super structure is carried out with the help of equipment covering all points against a prepared checklist. (Inspection proforma). This inspection is done by Jr.Engr. (Bridge) once in five year.

2.1.2 Special inspection.

This inspection is done for specified bridge which needs a inspection due to some extraordinary reasons i.e. ditressed and early steel bridges, bridge damaged due to accidents or natural calamities, bridge to be undergone heavy repairs etc., bridge showing built-in-imperfections or heavy deterioration etc. This inspection may be carried out by specified authority/ person.

2.2 Schedule of Inspection

The schedule of Inspection for various officials is prescribed in Indian Railways Bridge Mannual. As per mannual all the bridges are to be inspected by JE(Track)/ JE(WKS) once a year before monsoon and by AENs once ayear after monsoon and important bridges by DENs once a year. All the steel structures are inspected by JE (Bridges) once in a five years and selected bridges by Bridge Engrs./ Dy.CE(Bridges) as and when found necessary side by side track on the bridge should also be inspected thoroughly. The bridges that have been reffered to by AEN/ DEN/ Sr.DEN for inspection by a higher authority should also be inspected by higher authority in time. Bridges which are of early steel and bridges which are over stressed should be inspected more frequently and inspection reports should be filled properly in bridge registers.

The bridges over water are inspected at time of low water generally after the monsoon. The bridges requiring high climbing will be inspected during seasons when winds or extreme temperatures are not prevalent. Bridges suspected of having trouble on account of thermal movement should be inspected during extreme temperatures. The bridges are inspected starting from foundation and ending with super structure.

The schedule for bridge inspection and movement of bridge inspection registers are shown in tables as following :

TABLE

CHAPTER 3

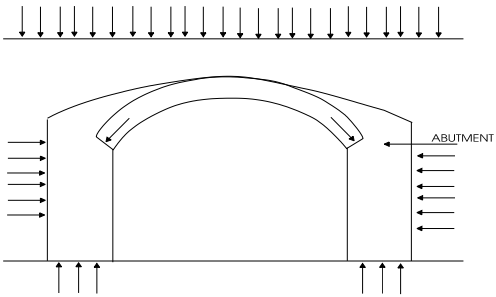
INSPECTION OF DIFFERENT TYPE OF BRIDGES

Following are the guide lines and general procedure for Inspection of different type of Bridges

3.1 Arch Bridges

Most of the arch bridges are old but they usually have such a reserve of strength that they have been able to carry the present day traffic with increased axle loads and longitudinal forces, without much signs of distress.

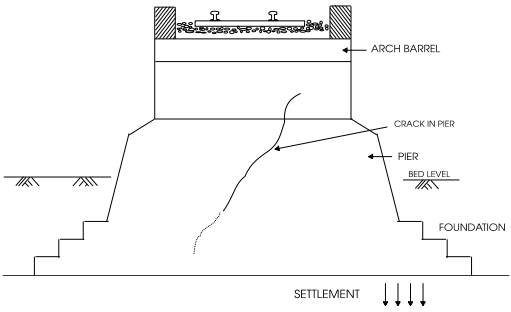
For proper inspection of any structure, it is necessary that the inspecting persons understands the load transfer mechanism in that structure. If one looks at the load transfer mechanism of an arch structure, it can be observed that the loads comming on the arch are transferred as a vertical reaction and horizontal thrust on the substructure (pier/ abutment). From this, one can easily conclude that soundness of foundations is extremely important in arch bridges.



MECHANISM OF LOAD TRANSFER IN ARCH BRIDGE

3.1.1 Cracks in abutments and piers

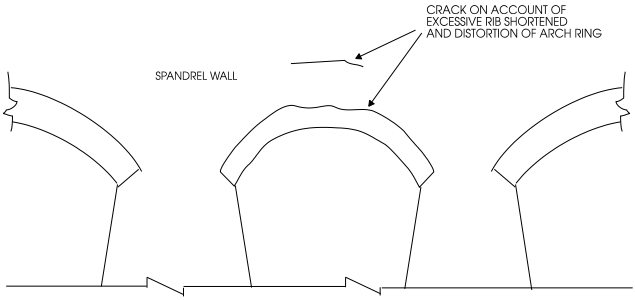
These cracks indicate uneven settlement of foundations. These are of serious nature. In the worst conditions, such cracks extend through the arch barrel and are seen as longitudinal cracks (cracks parallel to the direction of traffic) in the arch barrel.



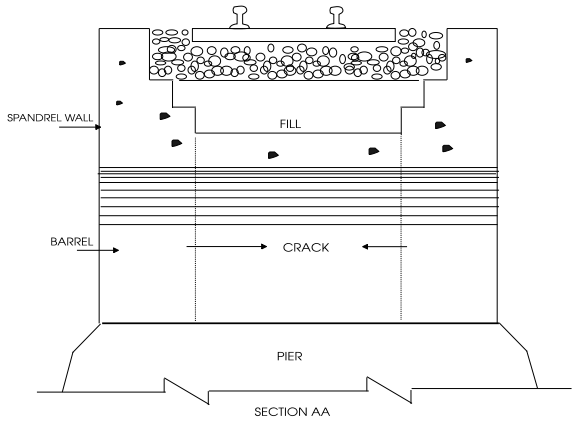
CRACKS IN PIER AND ABUTMENTS EXTENDING TO ARCH BARREL

3.1.2 Cracks associated with spandrel wall

In cases of brick masonry bridge where spandrel walls are constructed monolithically with the arch barrel, longitudinal cracks sometimes appear under the inside edge of spandrel wall on the intrados. Such cracks are not considered serious, but they must be kept under observation.



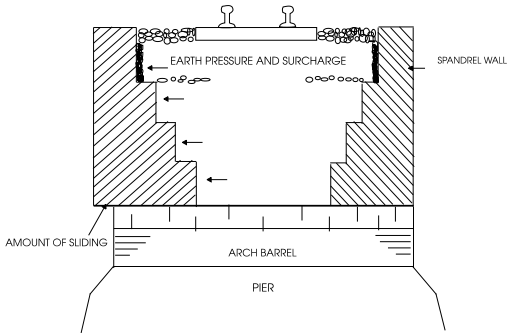
CRACKS IN SPANDREL WALL DUE TO WEAKNESS IN ARCH RING



LONGITUDINAL CRACKS UNDER SPANDREL WALL

If such cracks show tendency to widen with time, then the problem can be traced to excessive back pressure on the spandrel wall arising out of ineffective drainage or excessive surcharge load from the track. Many times, track level on the arch is raised bit by bit and new masonry courses are added on the spandrel wall without giving thought to the adequacy of spandrel wall cross section. This is also a cause for such cracks.

Blockage of drainage and excessive surcharge may also lead to sliding forward of the spandrel wall.



SLIDING FORWARD OF SPANDREL WALL

Excessive back pressure on spandrel walls can also lead to bulging and/ or tilting of the spandrel walls. The drainage of the arch should never be sought to be improved by drilling holes through tha arch barrel as it may lead to shaking of the barrel masonry and weakening of the arch bridge.

3.1.3 Cracks on the face of the arch bridge

Sometimes crack is noticed at the junction of the spandrel wall and extrados of the arch in the vicinity of the crown of the arch. Reason is excessive back pressure on the spandrel wall. The cause can be ascertained by observing such cracks under traffic. If the cracks breathe under traffic, they are serious in nature and they go to indicate inherent weakness in the arch.

Cracks in spandrel wall originating above the piers may be caused by sinking of pier. This is obviously a serious crack and needs immediate strengthening of foundation.

This type of distress is sometimes noticed in the vicinity of crown of the arch and can be traced to

1. Weathering of stones/ bricks.
2. Excessive loading
3. Inadequate cushion over the crown.

As per IRS Arch Bridge Code, a minimum cushion of 900 mm is recommended over the crown of the arch. Cushion is the vertical distance between the bottom of the sleeper and the top of the arch. Lesser cushion results in transfer of heavier impact on the crown which may result in cracking and crushing of the masonry in the vicinity of the crown. Existing cushion may be reduced while changing the metal or wooden sleepers over the bridge with concrete sleepers.

3.1.4 Leaching out of lime/ cement mortar in the barrel.

This condition is many times noticed in the arch barrel where water trapped in the full above the arch seeps through the joints. In such cases, the remedy lies in grouping the joints and improving the drainage through the weep holes in the spandrel wall.

3.1.5 Loosening of key stone and voussoirs of arch

This can happen on account of the tilting of abutment or pier because of excessive horizontal thrust. This is also likely to occur where more of dynamic forces are transmitted on account of lesser cushion.

3.1.6 Transverse cracks in the arch intrados

These cracks are very serious in nature. These cracks have a tendency to progress in diagonal/ zigzag directions in stone masonry arches along the mortar joints.These cracks indicate serious weakness in the arch and need proper investigation and adoption of appropriate strengthening measures.

3.2 Concrete Bridges

RCC/ Concrete bridge, composite girders and concrete deck bridges are now being widely adopted on Indian Railway. But suitable guidelines in respect of inspection, investigation, repairs and remedial measures in respects of these bridges are not known to the field staff. There is misconception that suchbridges last for long and need little care and maintenance. However, scenario is totally different after reports of signs of distress have been observed in some of the RCC/ Concrete bridge built up in 1960's and 1970's. Even in case of newly constructed box girders, Composite girders, no inspection and maintenance is being carried out by field officers/ staff, which has become a matter of serious concern.

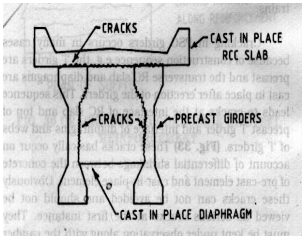
Concrete component may show following signs of visual damage which should be looked for-

3.2.1 Cracks

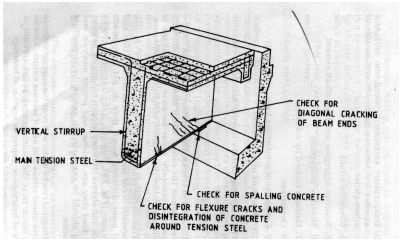
- Examine the defects very carefully.
- In case of any cracks do record the following observations.

  i) Location.
  ii) Width and Length of crack.
  iii) Type and pattern of cracking.
  iv) Whether active or dormant.

v) Behavior under load i.e. whether crack gets closed after passage of trains or otherwise.



CRACKS AT INTERFACES OF PRECAST AND CAST IN PLACE CONCRETE ELEMENTS



CRACKS IN CONCRETE GIRDERS

- Draw sketch for each particular crack to be shown.
- Mark the crack with dated tell tales both in concrete structure as well as in diagrams on registers.
- Analysis of each crack.

3.2.2 Spalling and Scaling

i) Record the area, depth and location of spalling.

ii) Also critically record, your observation on condition of reinforcement whether exposed or not.

iii) Record the location and area affected by scaling.

iv) Critically record the level of scaling whether light, medium or severe.

3.2.3 Disintegration

i) Location where disintegration of concrete is taking place.

ii) Analyze the reasons for this.

iii) Do take a sample for lab test.

iv) Assess the existing strength & disintegration of concrete by non-destructive tests.

3.2.4 Rust Streaks and Leaching

i) Record the location on rust streaks.

ii) Analyze the reason and simulate it with the reinforcement or cable profile.

iii) Any deposit, salt or lime deposit ; white in colour on concrete surface indicate leaching.

iv) Analyze the reasons of the leaching.

Please examine the locations critically for these specific defects.

3.2.5 Locations To Be Specially Looked For Defects

The following location to be specially inspected for the defects mentioned against them.

The top of deck slab

- Cracking in general
- Rusting
- Rust streaks
- Damage due to accidental loads.

Bottom of deck slab

- Cracking
- Spalling
- Rust streak along the reinforcement tendons.

Anchorage Zone

Cracks due to bursting, tensile and splitting force at the end of girders.

- Crushing of concrete at ends.
- The ends of cables are fully concealed and there is no sign of rust on surface.

Web in End Quarter span Support point of bearing

- Look for diagonal shear crack.

- Concrete/ masonry below the bearing to be checked for spalling/ crushing/ cracking.

  Also in girder portion above the bearing should also be checked for same defects.

Joints in segmental construction

- Cracks, disintegration of jointing material and corrosion of reinforcement.

Expansion Joint

- Check functioning - whether cracks in wearing course, the existence of normal gap.
- Check condition of scaling material, check for its hardening/cracking in case of bitumen filler and for splitting, oxidation, creep, flattening and bulging for neoprene sealing materials.
- Check condition of top sliding plate - check for corrosion, damage to welds etc.
- Check for locking of joints especially for finger type expansion joints.
- Check for debris in joints.

- Examine the under side of the joints if possible to detect any impounding problem. Lack of adequate room for expansion, especially in small areas, will concentrate thermal stresses causing the concrete to shear and spall.

- Check alignment and clearance.

Parapet and Railing

- to be examined for defects in concrete including accidental damage.

Diaphrams

- Cracks at the junction of diaphrams with web.

Drainage spouts and ventholes

- Check logging deterioration and damage in drainage pipes.

- Functioning of vent holes in box girder by measuring the temperature difference between inside and out side of box girder in evening hours.

3.2.6 Loss Of Camber

- Record the camber at near about same temperature each time.
- Record the temperature at which recording of camber reading taken.
- Compare the recorded reading of camber with previous reading.
- The instrument for recording should have same level of accuracy.

3.2.7 Bearings

- Record the condition of bearings for their cleanliness and rusting/ corrosion.
- Record observation for movement of the bearing.
- Analyse the behaviors of bearing with respect to movement recorded earlier.
- Examine the condition of Anchor bolts.
- If there is any crushing/ damage in concrete bearing then do examine the behavior under the load.

3.2.7.1 Elastomeric Bearing

- To clean the bearing and their surroundings at specified schedule.
- Avoid the contact with grease and oil etc.
- There should be no restriction in movements of elastomeric pads upto designed value.
- Observe carefully the physical conditions of bearing pads. Any flattening observed is indication of uneven loading or excessive loading.
- Do the distressing (off loading) of elastomeric pad by lifting the girder at prescribed interval as specified by manufacturer/ schedule.
- If there is any splitting/ tearing either vertically or horizontally it may be due to inferior quality of pads.
- Bulging caused by excessive compression.
- Record the displacement from original position in both direction longitudinally and laterally every 5 years.

3.2.7.2 Bearing with low friction sliding material

For bearings using a low friction sliding material such as polyatetrafluoroethylene (PTFE) on stainless steel, some special checks may be necassary. These should aim at establishing that movement is taking place at the sliding surface as cases are known where the high initial friction of the

bearing has not been overcome and large forces have been transmitted to the substructure. To preserve a durable and uniform sliding surface, measures are usually taken to prevent dirt from entering the bearing and this should be checked for its effectiveness.

3.2.8 Dampness and hollow sound

- Dampness may be noticed at top of deck slab at the time of removal of ballast.

- Trapping with a hammer or rod produces a dead sound, indicates low quality concrete.

3.2.9 Drainage arrangement and others

- Water stains on slabs and girders indicates leaky pipes.

- Accumulation of debris around the inlet after a storm indicates clogging or inadequate drainage pipes.

- Ensure that water from outlets is not discharged at a place where it is detrimental to any component of the structure.

- The run off pipes should be inspected for damage or leakage with water staining and accumulation of debris.

- Blowing or pumping sleepers should be noted.

3.3 Prestressed Concrete Bridge

Prestressed concrete bridges are now being widely adopted on Indian railway network, suitable guidelines in respect of inspection, investigation, repair & remedial measures have not received the required attention for prestressed concrete bridges. This may be partly due to the misconception that such bridges last for long and need little care and maintenance. However, the scenario is different after reports of signs if distress observed in some of the prestressed concrete bridges built in 1960's and 1970's.

Functional life of such bridges is observed to be getting adversely affected due to factors such as aggressive environment, atmospheric pollution, quality of materials, workmanship etc. A bridge is expected to have a usable life of 80 to 100 years. During the last 15 years, the number of prestressed concrete bridges requiring major repairs has increased substantially especially on road network. Few important road bridges have also collapsed incurring loss of material as well as of human life. Therefore inspection and maintenance of bridges has to be treated as a regular ongoing requirement and not a necessity to be undertaken only in the case where the bridge is damaged.

3.3.1 Inspection Procedure

3.3.1.1 General

Structures requiring high climbing should be inspected during those seasons when high winds or extremes of temperature are not prevalent. Inspection during temperature extremes should be made at bearings, joints etc., where trouble from thermal movements is expected. Details under deck. Condition of drainage, deck surface if ballastless. Condition of railing, ballast, retainer, foot path Expansion joints.

3.3.1.2 Means of Access

In order to have an effective inspection it is essential to have access to all elements of the bridge structures. The means of access should not only ensure convenience of inspection for inspecting official but should also ensure his safety during inspection. The quality of inspection will depend on the type of access provided at the bridge structure.

3.3.1.3 "Built - in" Means :

"Built-in" means allow a convenient, easy and economical inspection and direct physical or optical access to various bridge components. They are usually not suitable for a complete inspection of a bridge due to the cost of providing such means. Various `built-in' means that can be provided include access ladders, man-holes, cat-walks, platforms, scaffolding etc.

3.3.1.4 Temporary Means of Access

It is necessary to provide temporary means of access for the purpose of detailed as well as special inspection. These may include provision of ladders, swings, cat walks, scaffoldings and platform etc. required as per the site conditions. The major problem of access is encountered in the case of long span and high rise bridges and those across deep perennial rivers and tidual estuaries. Visual inspection with binoculars from a boat or from the bed of the river can hardly reveal the actual condition and state of distress in the vulnerable areas. The choice, therefore, automatically falls on mobile bridge inspection units, which can cater to the needs of both horizontal and vertical accessibility all along the span. Besides being a means for easy and reliable access for inspection and detailed investigation, it also provides a working platform for carrying out the repairs. The major advantage of this kind of equipment is its versatility for use of different types of bridges. In recent years this particulars type of equipment, generally designed for inspection of bridges has gained popularity in the countries abroad. Such eqipment has normally the following characteristics:

- self propelled
- load capacity of the platform/ bucket to carry the weight of at least two men plus standard inspection equipment.

- designed to provide access to all vital bridge components below and to some extent, above the bridge deck. Mobile bridge equipment helps to increase the effectiveness of bridge inspection.

3.3.2 Defects To Be Noticed

The inspection should be such as to discover all indication of damage, such as cracks, fissures or spalling of concrete, and unexpected deflections or deformations. Such deformations do not necessarily cause cracking immediately but cracks may develop later as a result of them. Other aspects to be noted are adequacy of clearance and drainage arrangements, and signs of damage by impact from rolling stock. Concrete components may show following signs of visual damage which should be looked for :

3.3.2.1 Cracking

Presence of cracks, in general, is a sign of distress/ weakness and needs to be investigated. Cracks may be structural or non-structural

i) Structural cracks - In general the factors affecting the formation of structural cracks are :

- Error in stress calculation

- Faulty constructoin, formwork misalignment and its premature removal etc. incorrect tensioning procedure
- Excessive loading under service condition
- Differential settlement of structure
- Deficiency of reinforcing steel
- Excessive loss of prestress
- Loss of steel by corrosion
- Accidental damage, earthquake etc
- Poisson effects due to high prestress level.

ii) Non- structural cracks - These can be due to

- Plasting shrinkage cracking
- Drying shrinkage cracking
- Differential shrinkage
- Transverse shrinkage & restrsint due to end block
- Thermal contraction cracking
- Poor workmanship
- Alkali aggregate reaction
- Cracks due to secondary bending effect in girders caused by rigid restraint of bearing.

Structure crack may lead to failure while non - structural cracks affect durability and in due lead to failure. Wherever, cracks are noticed, the following should be recorded.

- location
- width and length of crack

- type and pattern of cracking, viz-longitudinal, transverse, horizontal/ vertical/ diagonal. random or map cracking.
- whether active or dormant
- behaviour under live load

While reporting the presence of cracks, the details should be described by sketches elucidated further by photographs wherever required for better appreciation.

The observation of the earlier inspection should be reffered for the purpose of determining whether crack propagation is continuing further or cracks are dormant.

Dated tell tales should be extensively used to monitor the cracks. Dormant cracks indicates that the causes which led to the formation of cracks are no longer existing.

Corrosion induced cracks are located directly above or below the reinforcement. Horizontal cracks near the ends of pretressed members due to bursting stress may indicate a deficiency of reinforcing steel. Vertical cracking in the lower portion of the member not near the support could be due to overstressing or loss of prestress.

Measurement of cracks - A simple device available for measuring crack width is a small hand-held microscope having a graduated scale marked on the lens known as `crack comparer'. Where greater

accuracy of measurement is required, transducer or extensometer or strain gauges can be used. Crack movement indicators, which can give direct reading of crack translation and rotation can be attached to the concrete surface. Continuous monitoring and recording of crack movements for 24 hours may be required for separation of temperature effects from load effects.

3.3.2.2 Spalling

Spalling is defined as the phenomenon causing depression resulting when a fragment is detached from parent concrete by the action of weather, by pressure or by expansion within concrete. An area of concrete which sounds hollow when struck with a hammer may be an indication of the existance of a fracture plane below the surface. This will give rise to spalling of concrete afterwards.

The location, depth and area/ size of spalling should be noted.

3.3.2.3 Delamination

Delamination are separation along a plane parallel to the surface of the concrete. These can be caused by corrosion of reinforcement. Inadequate cover over reinforcement steel reduces the time to start of corrosion. Fire on bridges may also cause delaminations. Bridge decks and corners of concrete beams are perticularly susceptable to delamination.

3.3.2.4 Scaling

Scaling is gradual and continuing loss of surface mortar and aggregate over an area. As the process continunes the coarse aggregate partical are exposed and eventually become loose and are dislodged. Scaling is normally observed where repeated freeze thaw action on concrete take place. Scaling can also occur when concrete is subjected to cycles of wetting or drying of chloride deicers. Such attack can occur below top of decks lab. Location, area involved and character of scaling should be recorded.

3.3.2.5 Disintegration

Disintegration can be caused due to poor workmanship, weathering action, salt action, attack by chemicals, unsound aggregates, alkali-aggregates reaction, reaction with sulphates in soil and water etc.

Components showing signs of disintegration of concrete would require a detailed investigation, using non-destructive, techniques. Samples may have to be obtained for further laboratory testing.

3.3.2.6 Rust Streaks

Presence of rust/ strain marks on side surface and bottom surface of prestressed concrete girders, closely following the profile of prestressed cables

indicate corrosion of prestressing cables and should be considered a serious thrust to structural integrity of member. In severe cases of corrosion even steel may get exposed.

Corrosion is the most important cause for deterioration of PSC girders. The primary factors which influence the corrosion of steel in concrete are

i) PH value of concrete
ii) Chloride content
iii) Inadequacy of cover
iv) Permeable of concrete
v) Carbonation
vi) Exposure to aggressive environment.

Besides, the HTS strands/ cables are more prone to corrosion by phenomenon being known as `stress hydregen ions which destroys the steel structure.

3.3.2.7 Rutting

Rutting is removal of concrete by abrasive action. Due to abrasive action of ballast on deck top, depressions in deck slab may occur in due course of time which can speed up the process of deterioration by water stagnating in pockets over deck slab.

3.3.2.8 Dampness

Dampness may be noticed at top of deck slab at the time of removal of ballast. Dampness is

indication of improper drainage or poor quality of concrete.

3.3.2.9 Leaching

Leaching is the accumulation of salt of lime deposits white in colour on the concrete surface. These may be seen on underside of concrete decks. These indicate porous or cracked concrete.

3.3.2.10 Hollow or dead sound

If tapping with a hammer or rod produces a dead sound, this is indication of low quality concrete.

3.3.2.11 Loss of Camber

It should be recorded near about the temperature at which it was originally recorded. Temperature of girder should also be recorded. The camber can be recorded by any reliable method.

3.3.2.12 Locations to be specially looked for defects

The following location to be specially inspected for the defects mentioned against them.

The top of deck slab

- Cracking in general

- Rusting
- Rust streaks
- Damage due to accidental loads.

Bottom of deck slab

- Cracking
- Spalling
- Rust streak along the reinforcement tendons.

Anchorage Zone

- Cracks due to bursting, tensile and splitting force at the end of girders.
- Crushing of concrete at ends.
- The ends of cables are fully concealed and there is no sign of rust on surface.

Web in End Quarter span Support point of bearing

- Look for diagonal shear crack.

- Concrete/ masonry below the bearing to be checked

for spalling/ crushing/ cracking.

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Joints in segmental construction

- Cracks, disintegration of jointing material and corrosion of reinforcement.

Expansion Joint

- Check functioning - whether cracks in wearing course, the existence of normal gap.
- Check condition of scaling material, check for its hardening/cracking in case of bitumen filler and for splitting, oxidation, creep, flattening and bulging for neoprene sealing materials.
- Check condition of top sliding plate - check for corrosion, damage to welds etc.
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small areas, will concentrate thermal stresses causing the concrete to shear and spall.

- Check alignment and clearance.

Parapet and Railing

- to be examined for defects in concrete including accidental damage.

Diaphrams

- Cracks at the junction of diaphrams with web.

Drainage spouts and ventholes

- Check logging deterioration and damage in drainage pipes.

- Functioning of vent holes in box girder by measuring the temperature difference between inside and out side of box girder in evening hours.

3.4 Steel Girder Bridges

a) Rivetted steel girder bridge
b) Welded steel girder bridge
c) Composite girder bridge
d) Early Steel girder

On Indian Railways the steel girder bridges have been standardised as under :

3.4.1 Rivetted Girder Bridge

i) Plate girder (beam type) bridges for spans 9.15, 12.2, 18.3, 24.4, and 30 metre.

ii) Composite girder for spans 9.15, 12.2, 18.3 & 24.4 metre.

iii) Open web girder bridge -

a) Deck type (underslung) for span 30.5 metre.

b) Through type for spans 30.5, 45.7, 61.0 and 76.2 metre span.

3.4.2 Welded Girder Bridge

Only plate girders and composite girders of span 12.2, 18.3 and 24.4 m.

3.4.3 Composite Girder Bridge

It is a plate girder bridge with concrete top decking/ ballasted deck of suitable size. Steel portion is to be inspected as steel girder bridge and concrete top decking is to be inspected and checked for the items shown in RCC bridges.

3.4.4 Inspection of Steel Girder (Rivetted Construction)

The following aspect should be noted while inspecting rivetted construction.

3.4.4.1 Loss of Camber

Plate girder of spans above 35 metres and open web girders of 100' spans and above are provided with camber during fabrication or erection. Camber is provided in girder to compensate for deflection under load. Camber should be retained during service life of the girders if there is no distress. Original camber of a girder is indicated in the stress sheet. Camber observations are required to be taken at the same ambient temperature as adopted for the original camber mentioned in the stress sheet. The camber as observed during annual inspection is compared with the designed camber. The comparative camber levels should be checked by using high precision dumpy level on all intermediate panel points. A camber diagram should be made in the inspection register.

Any loss of camber should be thoroughly inspected and brought on record and submitted to design wing for examination through proper channel. Loss of camber may be on account of -

1. Heavy overstressing of girder members.
2. Overstressing of joint rivets at a splice in a plate girder or at the gusset in case of open web girders.
3. Play between rivet holes and rivet shanks.

If any loss of camber is noticed during inspection, as a first step, speed restriction is to be imposed and following investigation is to be carried out.

1. Girder should be throughly inspected to establish the cause by critically checking for loose rivets at paneljoints or at splice. Also all members should be throughly inspected for distortion or deformation.

2. Stress reading of various members under maximum load should also be taken either by Ferade Stress Recorder or strain gauge methods to check if any member is overstressed.

Based on the investigation results, proposal should be developed to replace all the loose rivets if any with over size rivets or strengthening of members or panel joint with the approval of Design office. in case even after strengthening, further loss of camber is noticed and the loss of camber is noticed and the loss reaches to about 60% of dead load camber, for replacement of the girder should be planned.

3.4.4.2 Distortion

In plate girder following members are likely to show distortion :

I) Top flange plate being a member carrying compressive stresses.

ii) Web plate near the bearings due to heavy concentration of stress is likely to buckle.

iii) Cross frame angles and top lateral bracing angles due to execessive lateral vibration.

In open web girder the following members are likely to show distortion :

i) Top chord members carry compressive stresses and likely to distort if not sufficiently restrained.

ii) Diagonal web members perticularly if they are made up of flats are to distort most likely at mid span due to stress reversal and vibration during passage of train.

iii) Bottom chord members which carry tension and longitudinal forces if not properly braced. The most likely location is near the bearing in case of frozen bearing.

iv) Top lateral and portal bracings are likely to distort due to excessive lateral forces.

Distortion is also possible when longitudinal movement of girders because of temperature variation is restrained by badly maintained bearing. The distortion can be checked by Piano wire by taking reading at every panel point.

3.4.4.3 Loose Rivets

Rivets driven in workshop during fabrication under ideal condition with efficient pneumatic or hydraulic rivetting equipment and suitable working place, are less prone to become loose. Rivets which are driven at site known as field rivets during asembly and launching of girder with pneumatic hand rivetting machine are prone to become loose in service. Also rivets which are subjected to heavy dynamic loads and vibrations tend to get loose. Therefore, during technical inspection it is essential to check critical location and record the status of the rivets properly. This is particularly true for open web girder for which a special proforma is used.

Rivets which are driven at site and rivets which are subjected to heavy vibrations are prone to get loose corrosion around rivets also cause loosening. To test whether a rivet is loose, left hand index finger is placed on one side of the rivet head in such a manner so that your finger touches both the

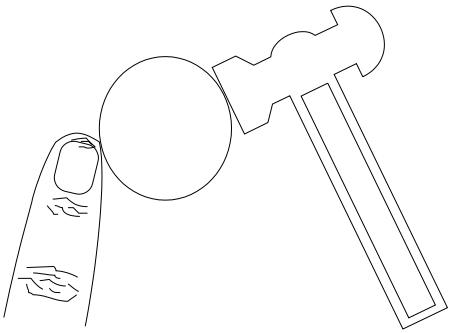


plate and the rivet head.

TESTING RIVET FOR LOOSENESS

Then hit the other side of the rivet head firmly, with a light hammer weighing 110 gms. If the rivet is loose, the movement of the rivet will be felt by left hand index finger. The loose rivets are marked with white paint and entered in loose rivet diagram.

Critical Location for testing loose rivets are as follows

a) In plate girder/ composite girder :

i) Rivets connecting web plate to flange angle of Top and bottom flange particularly at the ends of girder and below the sleeper for top flange plate.
ii) Bearing stiffner rivets.
iii) Splice rivets (if any)
iv) Bracing and cross frame connection.

b) For open web girder :

i) Rivets connecting rail bearer (stringer) to cross girder (in case of through span)

ii) Rivets connecting cross girder to panel point gusset (in case of through span)

iii) Rivets connection at all panel points (with main gussets to truss components) of top chord and bottom chord (field connections)

iv) Rivets connection bottom lateral bracing to end cross girder as well as top lateral bracings and portal bracings.

3.4.4.4 Corrosion

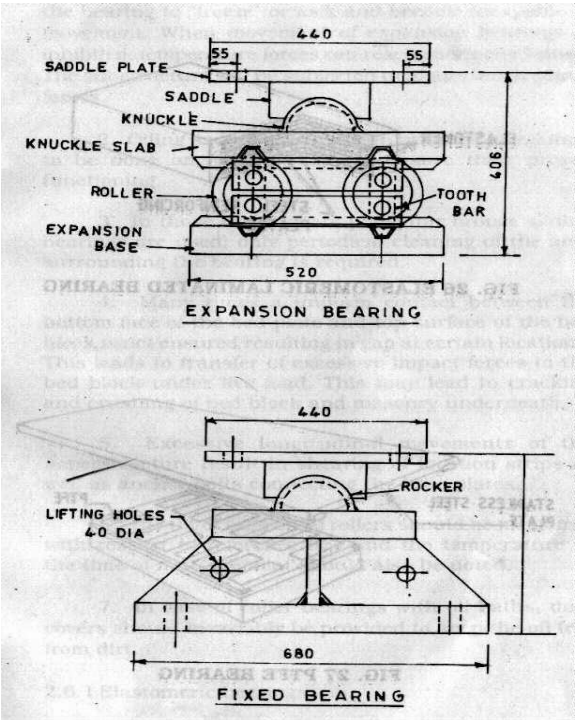
Corrosion is a well known problem in steel structures and there are several guidlines are already available to prevent corrosion.

3.4.4.5. Condition of bed block and H.D. bolts

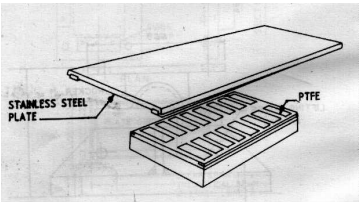
Bed Block receive the full load from bearings of the bridge and distribute and transmit the same to the masonry/ concrete below. Restriction of free movement in superstructure may result in -

- Development of transverse cracks in pier/ abutments.
- Failure of bed block joints leading to shaking of bed blocks.
- Shearing of H.D. bolts.

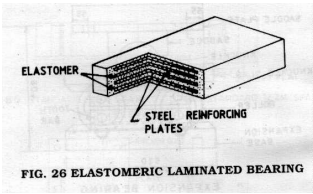
Various types of bearing and there component and arrangement are shown in the following sketches



ROLLER AND ROCKER BEARING



PTFE BEARING



ELASTOMERIC LAMINATED BEARING

CHAPTER 4

EQUIPMENT REQUIRED FOR INSPECTION

Following equipments are required for thorough Inspection of various element of bridges.

4.1 List of Equipments for Steel Bridges

1. Pocket tape (3 to 5 m long)
2. Chipping Hammer
3. Plumb bob
4. Straight edge (at least 2 m long)
5. 30 metre steel tape
6. Feeler gauge set (.1 to 5mm)
7. Log line with 20 kg lead ball to kept at bridge side to measure depth of water
8. Thermameter for measuring temperature
9. Elcometer to ascertain paint film thicknesses (Dry film thickness) etc.
10. Wire brush
11. Mirror (10 x 15 cm) to see hidden places/ part of bridges
12. Magnifying glass 100mm dia. to identify minor cracks
13. Crack meter to ascertain various configuration of cracks etc.
14. Chalk water proof pencil, pen of paint for marking concrete or steel

15. Centre punch to mark any correct/ reference point
16. Caliper(Inside & outside to measure correct gaps/ thickness of various parts of bridge.
17. Torch light (of 5 cell).
18. Screw drivers - to scrap/ mark a certain point etc.
19. Paint & paint brush for repainting areas damaged during inspection.
20. Gauge cum level
21. Nylon chord to check camber/ straight edge etc.
22. 15 cm. steel scale
23. Inspection hammer (350 - 450 gm)
24. Rivet testing hammer (110 gms)

Optional (where reqd.)

25. Binocular - to see distant objects
26. Camera,
27. Dumpy level set - to check camber etc.

Some additional equipments

01. Ladders
02. Scaffolding
03. Boats or Barges
04. Echo sounders (to assess the depth of water)
05. Dye penetrants (to detect cracks specially in welded girders)

4.2 Equipment Required for Inspection of Concrete Bridge

SR	INSTRUMENTS	PURPOSE
1	30M Steel tape	For taking measurements such as clear span, overall length of girder, etc.
2	Straight edge (1M Long)	For checking deformation, distortion, buckling and bulging of structure
3	Feeler Gauge (0.1 to 5mm)	For measureming width of cracks and cavity
4	Measuring microscope	For measuring invisible minute crack width by magnification scale.
5	Nylon chord or Piano wire with clamp and 2 nos. 10kg. weight	For measuring camber of PSC girder.
6	15 Cm steel scale	For measuring depth of spalled concrete and gap between parts.
7	Mirror (10 x 15 Cm)	For inspecting parts in any awkward location by reflection method and to lit object in dark location by directing sun rays.
8	Magnifying glass (100mm dia)	For identifying very fine cracks in member/ welds which may not be visible for naked eyes.
9.	Torch light (5 cell)/ Flash light	Used along with morror for identification of fine cracks in dark locations.

SR	INSTRUMENTS	PURPOSE

10	Plumb bob	For checking verticality of member , pier and abutment etc.
11	Inspection cum chipping hammer	For checking hollow pocket or honey comb in masonry and concrete structure including PSC girder by tapping and for examining the extent of corrosion, adherence of paint and removing loose disintegrated material during inspection.
12	Thermometer	For recording temperature at the time of measuring camber and for purpose of setting bearings at desired inclination.
13	Spirit level	For checking cross level of track on bridge or bed block. Also for setting of girders on bearing.
14	Chalk marker, plaster of Paris, Red Paint, Plain glass	To mark the cracks on concrete structure and make tel-tale for observing crack.
15	Binoculars	For inspection of bridge components which are at inaccessible location tall piers, arches in viaducts, etc. prior to closer examination.
16	Camera with flash	For taking photograph of cracks, spalled concrete or any distressed portion for clarity and record.
17	Pocket knife	For removing scaled or weathered surface of concrete for inspection.

S.No	**Instruction**	**Purpose**

	Dial Gauge	For measurement of deflection in case of load testing or to measure depth of cavity.
	Schmidt's rebound hammer for concrete	For assessing the strength of concrete structure for soundness as NDT method.
	Concrete cover meter (R meter)	For assessing the cover availability to reinforcement in existing concrete structure or diameter of steel bar or spacing.
	Ultrasonic pulse velocity test	To identify uniform dense concrete structure or hollow/ honey comb inside the concrete structures and to determine presence of discontinuity, crack etc.
	Windsor probe test	To evaluate the hardness of concrete by probing and penetration, which will help in assessing compressive strength of concrete.
	CORE drilling test	To determine actual strength of concrete in structure.
	Scaffolding/ Inspection cradle	To provide close assessibility to structure for inspection of girder, sub structure etc.

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CHAPTER 5

CHECK LIST FOR INSPECTION OF BRIDGES

This has been oftenly noticed that in the process of bridge inspection so many items either skipped or untouched. In due course of inspection following items must be inspected and recorded in a descriptive manner and brought to the notice of suitable authority.

5.1 Foundation and Flooring

(a) Scour over foundation A1, P1, P2, ... A2.
(b) Quantity of filing - Boulders/ Earthwork.
(c) Availability/ Requirement of flooring.
(c) Repair to curtain wall/ Drop walls.
(e) Obstruction to waterway if any.

5.2 Substructure

(a) Condition of masonry A1, P1, P2 ..... A2.
(b) Cracks/ Hollow masonry requiring grouting.
(c) Pointing of masonry joints.
(d) Leaning of abutments/ piers along the track and transverse to track.
(e) Condition of wing walls and return walls.
(f) Provision/ Cleaning of weep holes.
(g) Masonry below bed blocks.
(h) Condition of jacketted masonry.

5.3 Protection works

(a) Marking of HFL, Danger levels etc.
(b) Protection of banks upto HFL.
(c) Top level of guide bunds and their slope.
(d) Condition of flood protection works like RAT (RAW) etc. if, any.
(e) Condition of boulder pitching with pointing & slope in case of a burried abutment.

5.4 Bed Block

(a) General condition of bed blocks in A1, P1, P2,..... A2.
(b) Epoxy grouting/ pointing of bed blocks needed or not.
(c) Condition of Ballast wall-repairs, if any.

5.5 Bearings

(a) Cleaning around bearing area.
(b) Greasing of bearing with date.
(c) Gap in guide/ location strips of sliding bearing.
(d) Condition of rollers of bearing.
(e) Inclination of rocker bearing along with ambient temp.
(f) Seating of bearing properly.
(g) Distance between adjacent span girders/ girder and ballast wall.
(h) Condition of anchor/ holding down bolts.
(i) Location and condition of elastomeric bearing.

5.6 Super Structure

5.6.1 Steel - Span No. 1,2,3 ..... etc.

(a) Condition of painting along with last date of painting.
(b) Corrosion of members with details.
(c) Position of loose/ missing rivets.
(d) Distorted members, if any with measurements.
(e) Actual camber at various points where applicable along with theoretical camber.
(f) Cracks in welds or plates along with their location.
(g) Upto date GMT carried by the girder.
(h) Provision of Man and Trolley refuges and their condition.
(i) Any special repairs required to be done.

5.6.2 Arch Bridges

(a) Span and shape of the arch.
(b) General condition of masonry.
(c) Cracks-type and location-Longitudinal cracks.
Diagonal cracks
Transverse cracks.
(d) Separation of arch ring near the parapets from the main barrel.
(e) Shape and condition of parapet walls.
(f) Condition of spandrel walls and location of weep holes.
(g) Clear earth cushion over the crown of arch ..... mm.
(h) Condition of joints with extended portion with slab etc.

(i) Load test done on ..... crown deflection ..... mm spread at springing level ..... mm

5.6.3 Concrete Slab

(a) Condition of concrete in general span 1,2, ... etc.
(b) Cracks requiring grouting.
(c) Location of spalled concrete, if any.
(d) Rust streaks, cracks etc - location with date.
(e) Extent of exposed reinforcements.
(f) Provision of wearing course on top of slab and its conditions.
(g) Clear cushion of ballast/ earth and ballast.
(h) Condition near anchorages of PSC slabs.
(I) condition of drainage hole in deck slab.
(j) condition of ballast (caked up/ clear).

5.6.4 Concrete Girders

(a) Condition of concrete in general span 1,2..... etc.
(b) Cracks if any at a) near mid span
b) near support
c) near junction of main girder and diaphragms
d) in diaphragms.
(c) Cracks requiring epoxy grouting along with details of location,size etc.
(d) Spalled concrete with details of location. extent etc.
(e) Condition of concrete in soffit of deck slab.

(f) Junction of concrete slab and steel girders in composite girders.
(g) Inside portion of box girders - cracks condition of concrete etc.
(h) Rust streaks, crack etc. - location with details.
(i) Condition of concrete surface around prestressed cables with reference to cable profile.
(j) Condition of concrete near end blocks and condition of anchorages.
(k) Actual camber compared with original camber.
(l) Condition of drainage holes in the deck slab.
(m) Provision of wearing course on top slab and its conditions.
(n) Clear cushion of ballast/ earth and ballast.
(o) Condition of concrete in deck slab.
(p) Special repairs required if any.

5.6.5 Pipe culverts and other small openings.

(a) Alignment of the pipe.
(b) Slope and level of the pipe.
(c) Clearing of the water way.
(d) Condition of face wall and wing wall.
(e) Flooring on the approaches.
(f) Clear earth cushion available over the crown of the pipe.

5.7 Track Structure

5.7.1 Open Decks

(a) Eccentricity of track with respect to centre of girder span 1,2,..... etc.
(b) Gaurd rails, their conditions and fittings.
(c) Clearance and level of gaurd rails.
(d) End anchoring of gaurd rails with wooden blocks on the approaches of A1, and A2.
(e) Condition of footpath plates and their fixing.
(f) Location of fish plated joints and SEJs with respect to abutment and piers.
(g) Condition of sleepers and No. of sleeper requiring renewal.
(h) Spacing between sleepers and their squareness.
(i) Thickness of bridge timbers excluding gouging done for rivet heads.
(j) Level of rail at different location in cambered girder.
(k) Provision of hook bolts and their condition.
(l) Oiling of hook bolts and their plates markings.
(m) Condition of top flange plates under sleeper seats.
(n) Track parameters (Gauge level and alignment)
(o) Level portion on approaches of the the bridge (length).
(p) Ballast retainers on approaches and condition and adequacy of rails,sleepers, fittings and ballast.
(q) Proper placement of speed restriction boards, if any on both the approaches.
(r) Proper placement of Name boards, Bridge tablets and other markings.
(s) Provision of steps in the embankments at approaches of bridges.

(t) Location and condition of height gauges in case of RUBs.

5.7.2 Ballasted Decks

(a) Eccentricity of track with respect to centre line of bridge in span no 1,2, ... etc.
(b) Gaurd rails, their condition and fittings.
(c) Clearance and level of gaurd rails.
(d) End anchoring of gaurd rails with wooden block on the approaches of A1and A2.
(e) Location of joints with respect to abutments and pier.
(f) Type of sleepers and their conditions.
(g) Clear ballast cushion available.
(h) Track parameters. (Gauge level and alignment)
(i) Level portion on approaches of bridge.
(j) Ballast retainers on approaches and condition of track and fittings.
(k) Proper placement of speed restriction boards, if any, on both the approaches.
(l) Proper placement of Name boards, Bridge Tablets and other markings.
(m) Provision of steps in the embarkments at approaches of bridge.
(n) Location and condition of height gauges in case of RUBs.

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CHAPTER 6

TIPS FOR BRIDGE INSPECTION

While planning/ going for Bridge Inspection one should do the following :

(1) Read completion plans, when available
(2) See pile and well foundation details
(3) Go through earlier Inspection reports
(4) Go through reports regarding repairs/ strengthening carried out in past.
(5) Go through stress sheets for major girder Bridges.
(6) Decide the number of Bridges going to be inspected on a perticular date.
(7) Try to have plans and other details of important Bridges.
(8) Plan any special inspection equipments, staging etc. required in advance.
(9) Dont rush through the inspection just for completion sake. Remember that you are inspecting the Bridge only once in a year.

6.1 Safety Precautions

While Inspecting Bridges one should adopt certain safety measures which are listed below

(1) Wear suitable dress so that loose end don't get caught ; too-tight a dress may hamper your free movements

(2) If you normally wear glasses for improving your eye sight, wear them when climbing up or down sub-structures & super structures.

(3) Keep clothings & shoe free from grease and steel stars or naal etc which causes sliping.

(4) Scaffolding or platforms should be free from grease or other slippary substances.

(5) Scaffolding and working platforms should be adequate strength and be secured against slipping or overturning.

(6) No shortcut at any cost.Vigil over passing trains

(7) Keep your trolly and other equipments properly so that they should not infringe the track.

(8) Say **no** to liquer or any other sedetive medicine.

(9) Follow all operating rules and follow the guide lines while inspecting under any caution order/ block (power/ traffic or both)

(10) Insist your staff to be very carefull while walking moving through footpaths/ any other members.

(11) No chit chating and fun etc. while on Inspection.

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CHAPTER 7

NUMERICAL RATING SYSTEM (NRS) FOR BRIDGES

Introduction

At present this system has been widely used all over Indian Railways.

On the Indian Railway, bridges are inspected Assistant Engineer once a year after the monsoon season as per the provision in the Indian Railways way and Works Manual. The condition of various part of the bridge is recorded by AEN in bridge Inspection Register in short narrative manner. Extracts of AEN's remarks concerning repairs or replacement reauired are sent to the Inspections with instructions for compliance. Theregister there after is forwarded to the DEN/ Sr. DEN and the Territorial HOD for scrutiny and appropriate order. Action taken on the instructions of AEN/ DEN/ Sr.DEN/ Territorial HOD is also recorded in the register.

The present system of recording condition of bridges in Bridge Inspection Register being qualitative in nature, it is not possible to readily identifythe relative seriousness of the detcts/ distress conditions in the bridge, required for rebuilding rehabilitation/ major repairs etc. The number of bridges on the railways is very large. It is, therefore, difficult to have an overall picture of the condition of bridges, as the registers are returned to the AEN's after they are scrutinised by Territorial HOD.

7.1 Numerical Rating System For Indian Railways.

7.1.1 The existing system of recording in the Bridge Inspection Register will continue. NRS is meant to supplement the present system. The numerical rating is not in any way liked to load carrying capasity of the bridge.

7.1.2 The numerical Rating System for Bridge inspection envisages assigning numerical rating to the physical condition of bridge as whole, as also to its components.

7.1.3 The following table gives the condition Rating number (CRN) and brief description of the corresponding condition.

Condition Rating Number (CRN)	Description
1.	A condition which warrants rebuilding / rehabilitation immediately.
2.	A condition which requires rebuilding/ rehabilitation on programmed basis.
3.	A condition which requires major/ special repairs.
4.	A condition which requires routine maintenance.

Condition Rating Number (CRN)	Description
5.	Sound condition.
6.	Not applicable.
0.	Not inspected.

7.3 ORN

In addition to CRN for different bridge components, an over all rating number (ORN) for the bridge as a whole is also to be given which in general, will be the lowest rating number, except 0 , given to any of the bridge components.

7.4 URN

The physical condition of each major bridge is to be represented by a Unique Rating Number (URN) consisting of 8 digits. The first digit will represent the ORN and each of the subsequent digits will represent the CRN of the different bridge components in the following sequence.

(a) foundation and flooring
(b) masonry/ concrete in substructure.
(c) training and protective works
(d) bed blocks
(e) bearing and expansion arrangements.
(f) superstructure - girder/ arch/ pipe/ slab etc. and
(g) track structure.

7.5 Minor Bridge

Physical condition of minor bridge is to be represented by only one digit ORN (Overall Rating Number) to indicate the overall condition of the bridge.

7.5.1 Road Over Bridge

The Physical condition of road over bridge is to be represented as for rail bridge.

7.6 Recording in Bridge Inspection Register

7.6.1 During the annual bridge inspection, the condition of different components of the bridge should be recorded by the AEN in the Bridge Inspection on Register, as hitherto being done. He should record the overall condition of the bridge given CRN in red ink in the existing registers.

7.6.2 Such Bridges are rated with CRN of 3 less should be specifically included among the bridges reffered to by the AEN to Sectional DEN/Sr.DEN as these are actually potentially detressed bridge. The sectional DEN/Sr.DEN should inspect all those bridges for which the CRN is 1.2 or 3 and revise/ confirm the rating given by the Sectional AEN/DEN. All those bridges for which the CRN/CRN after the review, is 1 & 2 should be placed in the detressed category I & II respectively.

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CHAPTER 8

INSPECTION PROFORMA AND SPECIAL INSTRUCTIONS

There are different type of procedures and proformas for recording the inspection notes which have been adopted by various Zonal Railways as per their requirement and standing orders/ instructions, but ultimate aim of an inspection proforma is to provide complete and detailed report on various item of inspection, and remedial measures to be taken by suitable authorities. An inspection proforma must be such that it should provide a complete,comprehensive, and precise perspective over all items of inspection and defects. Following are the sample bilingual proformas which have been adopted in Bridge Department since long. It is proposed that items described in chapter 5 must be included in all type of bridge inspection.

8.1 Inspection Report Of Foot-Over Bridge

(1) Name of the Inspector
(2) Date of Inspection
(3) AEN's SUB-Division
(4) Section
(5) Km./ T.P.
(6) Station/ Location
(7) When put into Road

(8) Provided for
C.Rly
Municipality
Private body

(9) No. and length of span.
(10) No. and width of staircases/ ramps
(11) Total length of FOB including staircases/ Ramps.

(12) With or without cover
(13) Type of steel
(14) Type of covering & Staircases
(15) Type of girders.
(16) Centre to Centre of Main girders
(17) Clear width of the FOB.
(18) Drg. No. (1) General
(2) Steel work

(19) Date of last painting
(20) Condition of paint
(21) Camber of each span as per Drg.
(22) Actual camber recorded at the time of inspection

(23) Distance from Rl to underdside of Floor/Beam/ Bottom most member-
(a) Actual
(b) Minimum required
(c) Infringement

(24) Condition of steel work
- (a) Main girder
- (b) Flooring
- (c) Cross beams & Bottom bracings
- (d) Protection
- (e) Smoke Baffles
- (f) Staircases/ Ramps
- (g) Covering & side sheet
- (h) Landing columns
- (i) Main columns

(25) Condition of Revets Broken Loose Corroded Badly driven Total
- (a) Main girder
- (b) Floor system
- (c) Staircase & Landing
- (d) Columns

(26) Any additions & alterations carried out to the steel work during the last 5 years apart from normal repairs

(27) Condition of FOB

(28) General Remarks

(29) Classification of detects into those requiring action by
- (a) Division
- (b) Bridge Inspector
- (c) Dy. CE (B&F)

No..... Date ..... Office of BRI .....

Copy forwarded to :

(1) Dy.CE(B&F) .....
(2) Sr.DEN/DEN .....
(3) SEN/AEN.....
(4) PWI .....
(5) IOW .....
for information and necessary action .....

Signature of BRI .....

Memo No. ..... Date ..... Office of ABE .....
Dy. CE (B&F)

I have scrutinised the above Inspection Report in detail and initiated after carrying out necessary correction, if, any and put for further necessary action.

Asstt. Bridge Engineer.....

8.2 Inspection Report of Girder Bridge/ Road Under bridge.

(1) Name of the Inspector
(2) Date of Inspection
(3) Section
(4) AEN's Sub-Division
(5) Kms/ TP
(6) Bridge No.
(7) Name of the Bridge or River
(8) Between Stations
(9) No. of spans
(10) Clear span square/ skew
(11) Effective span
(12) Overall length of span between centres of bearings

(13) Wether bridge is skew or on curve
(14) Speed restrictions if any and its reason
(15) Type of Girder
(16) No. of girders per span
(17) No. of track on Bridge
(18) Standard of loading
(19) When put into Road
(20) When strengthened/ registered and Drg. No.
(21) Drg. No.for steel work in girders
(22) Type of steel

(23) Camber of span
- (a) As per Drg.
- (b) At the time of last inspection
- (c) At the time of present inspection
- (d) Method of measurement

(24) Camber of each span measured at the time of inspection

(25) The clear height between RD/ RL level to bottom most member of girder (if any) respectively
- (a) Actual
- (b) Minimum required
- (c) Infringement

(26) Type and condition of piers and abutments

(27) Type and condition and size of Bed Blocks

(28) Condition of bed blocks

(29) Type of bearing

(30) No. of holding down bolts on each bed plate

(31) Condition of HD bolts

(32) Type of pads below bed plate

(33)
- (a) No. of trolly refuge on Bridge. And how many required.
- (b) Infringement if any after placing the trolly
- (c) No. of man refuge on bridge. And how many required.
- (d) Footpath provided on which side. Up/ Down/ Both.

(34) Defective rivets Broken Loose Corroded Badly Total

Bent/ driven
cracked

(a) Boom flanges
(b) Web
(c) Main joints
(d) Cross girders
(e) Stringers
(f) Bracing & Footpath
(g) Base Plate

(35) Damage of members of span such as bulking, Crack, Distoration etc.

(36) Date of last painting Complete Patch
(37) Condition of paint
(38) Date of cleaning & Greasing of bearings and present condition.

(39) Condition of cylinders or tresties.
(40) Movement of girders (if any)
(41) Condition of Bridge
(42) General remarks
(43) Classification of defects into those requiring action by
(a) Division
(b) Bridge Inspector
(c) Dy. CE (B&F)

C.Rly.
No..... Date ..... Office of BRI .....

Copy forwarded to - (1) Dy. CE (B&F)
(2) Sr. DEN/ DEN
(3) SEN/ AEN
(4) PWI
(5) IOW For information & n/a.

BRI's SignatureOffice of ABE .....
No. date .....
Dy. CE (B&F)

I have scrutinised the above inspection report in detail & initiated after carrying necessary corrections if any put up for further necessary action.

Signature ABE

8.3 Inspection Report of Road Over Bridge

(1) Name of the Inspector
(2) Date of Inspection
(3) AEN's Sub-Division
(4) Section
(5) Kms./T.P./No.
(6) Station/ Location
(7) When put into road
(8) Provided for C.Rly/ Municipality/ Private Body
(9) Clear Width
    (a) Road way
    (b) Footpath
    (c) Total
(10) Clear length of span Square and Skew
(11) Effective span
(12) Overall length of span
(13) Square/ Skew (if skew, angle of span)
(14) Type of steel
(15) Type of girder
(16) Length Centre to Centre of main girders
(17) No. of girders per span.
(18) Drg. No. General Steel work
(19) Camber of each span
    (a) As per Drg.
    (b) At the time of last inspection
    (c) Camber recorded at time of inspection
    (d) Method of measurement.
(20) Clear height between RL to underside of bottom most member
    (a) Actual
    (b) Minimum required
    (c) Infringement

(21) Clear distance between Centre of track & outer edge of column
   (a) Actual
   (b) Minimum required
   (c) Infringement

(22) Thickness of wearing coat & slab 9at Junction & Footpath)
   (a) Actual
   (b) As per Drg.
   (c) Extra dead load (if any)

(23) Date of last painting

(24) Condition of paint

(25) Condition of steel work
   (a) Maint girder
   (b) Parapet girders/ Screens
   (c) Cross girders
   (d) Floorings (steel trough etc.)
   (e) Drainage arrangement
   (f) Smoke Baffles
   (g) Pier/ Abutments
   (h) Bearings

(26) Condition of Rivets, with break up of defective rivets

	Broken Bent/ Cracked	Loose	Corroded	Badly driven	Total
(a) Main girder					
(b) Bracings					
(c) Tresties					

(27) Any additions & alterations carried out during the last five years apart from normal repairs

(28) Condition of R.O.B.

(29) Wether parapet wall provided around the bearings

(30) Central Railway
(31) Classification of defects into those requiring action by
(a) Division
(b) Bridge Inspector
(c) Dy.CE(B&F)

C.Rly
Memo No. Date Office of BRI

Copy forwarded to :

(1) Dy. CE(B&F)
(2) Sr. DEN/ DEN
(3) SEN/ AEN
(4) PWI
(5) IOW

For information and necessary action

Signature of BRI

Memo no.
Date
Dy.CE(B&F) Office of Asstt. Bridge Engineer

I have scrutinised the above inspection report in detail and initiated after carrying out necessary corrections if any and put for further necessary action.

Asstt. Bridge Engineer

8.4 Special Instruction on Inspection Reports of Steel Girder Bridges

Following are the special instructions to be followed while preparing inspection report of of steel girder bridges.

8.4.1. For proper recording Technical Inspection Reports of Steel Girder Bridges over 40 feet Spans ROBs,RUBs, FOBs the following procedure shall be observed in supersession to all procedure order issued so far.

8.4.2. Technical Inspection Reports as per existing practice and proforma shall continue to be prepared by BRI's Incharge of the section on the existing form. After thorough inspection of the bridge by the Inspection parties. The schedule of inspection shall be once in 5 year except for open web early steel girder bridges, where technical inspection shall be made every year. Each bridge will have a separate technical Inspection Report.

8.4.3 B.R.I's Bridge Inspection registers shall be maintained by the Bridge Inspectors, which will be properly numbered. The registers will be maintained separately as per the following :-

(a) One register each for ore triangulated bridge.
(b) One or more registers forplate girder bridges.
(c) One or more registers for ROBs/ RUBs and FOBs.
(d) One register for turntables.

Each register will contain about 200 pages and will accomodate at least 5 subsequent reports of each structure.

8.4.3.1 After recording the inspection details in B.R.I's Bridge Inspection Register, one extra copy of the same will be made by BRI on the loose sheet with present form (as mentioned in 8.4.2) and will be submitted to Asst. Bridge Engineer. The Bridge Inspection Register shall be kept by the Bridge Inspector in his office and will be available at the time of inspections by superior officers. The BRI will underline portions where action is required or has been taken so as to make important points prominent. BRI should start action on points noted by him without waiting of anyone's orders.

8.4.4 Action to be taken by ABE's

8.4.4.1 On receipts of technicalinspection reports from the BRI, ABE will scrutinise the entries made by the inspector specially those underlined. He will also make test check of some of the important items of inspection such as paint condition, camber, distortion on triangulated girders, corrosion etc. He will make test check entries in his own handwriting and indicate action to be taken by BRI.He will also write separately to the Division foritems requiring their attention. The scrutiny of the reports including test checks will be completed within 30 days from the date of its receipt. ABEs will also issue instruction to BRIs regarding additional items where action is to be taken.

8.4.4.2 Loose technical inspection reports after scrutiny and necessary remarks by ABE shall be sent to the SEN/Br. line forreview. The important point shall be underlined and points reffered above must be brought out in the covering letter.

8.4.5.1 On receipt of technical Inspection report from ABE,SEN/ Br. Line will scrutinise the entries and remarksof BRI/ ABE and issue order on points specially reffered by ABE, in addition to other points. He will also carryout inspections where over considerednecessary. He shall then convey the extract of such orders to ABE, BRI. He will also refer the points to division requiring attention where he feels necessary.

8.4.5.2 The technical inspection reports of all open web girders shall be sent to SEN/ Br. Design alongwith specific points requiring attention of the Design wing. The reports will be retained and kept in folders by Design Wing. A separate folder will be maintained for each bridge, Specific references shall be made by SEN/Br. line to SEN/Br. Design in case of other structures,where Assistance of design wing is needed.

8.4.6 Action to be taken by SEN/BR.D - SEN/Br.D will scrutinise the points specially reffered for consideration ofDesign Wing and take necessary action and advise the action to be taken by SEN/Br.L. In case of bridge requiring major strengthening /modification / re-girdering . SEN/ Br. D will arrange

to open a case for development and finalisation of the proposal.

8.4.7 Custody of Technical of Inspection Reports - For structures other than triangulated girders, the technical inspection reports shall be kept in record by ABE/Line. For triangulated girders, the technical inspection reports shall be kept in record by design cell under the control of SEN/Br. Design.

8.4.7.1 Technical Inspection report movement register shall be maintained by the offices of BRI ABE and SEN/ BL to ensure expeditious disposal of reports.

8.4.7.2 For taking the follow up action, Bridge Girder maintenance register on the proforma shall be maintained by each BRI and ABE. This register will have one or more pages earmarked for each bridge and will contain items requiring action to be taken either by bridge branch or by the Division. The register will also record compliance of each item. The register will be handy tool to ensure early compliance of the item observed during technical inspection of the structure. This register will be scrutinise by bridge officer during the time of their inspection of the office of ABE/ BRI, APEs would submit their register every quarter (in the first week of January April, July and Oct) to SEN/Br.line concerned for scrutiny of outstanding items.

8.4.7.3 Bridges having defects/ deficiencies will be inspected by the BRI every year till these defects/deficiencies are rectified/ removed. In this annualinspection BRI may limit his inspections to the defective/ defficient portions only and need not inspect the entire bridge.

8.4.7.4 BRIS will promptly attend toall the defects / deficiencies in bridge under their charge, ensure that they are maintained in an excellent condition and will in no case allow unsafe condition to exist.

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OUR OBJECTIVE

To upgrade Maintenance Technologies and Methodologies and achieve improvement in productivity and performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability, and Utilisation.

If you have any suggestion & any specific comments, please write to us :

Contact person	:	Jt. Director (Civil)
Postal Address	:	Centre for Advanced Maintenance Technology, Maharajpur, Gwalior (M.P.) Pin code – 474 020
Phone	:	(0751) - 470869, 470803
Fax	:	(0751) - 470841