Lesson -2

Inspection & Maintenance of Railway Bridges

1.0 Inpection

1.1. Why Inspection is Necessary?

Although utmost care is taken at the time of planning, designing and construction of a bridge, it is still necessary to inspect the bridges at regular intervals so that this vital link of communication is maintained and can function properly.

The purpose of inspection of a bridge is:

(i) To confirm that the bridge is in fit condition to carry the designed load, and

(ii) To plan its maintenance.

With passage of time, some wear and tear of the elements of the bridge structure does take place and its maintenance and repairs have to be planned. Inspection of such a bridge is necessary not only to plan its maintenance but also to fix correct priority of maintenance so that the worst affected bridge is taken up first for repairs.

The wear and tear in a bridge may be caused due to the following factors.

(i) Settlement of foundations.

(ii) Cracks in super structure of bed blocks

(iii) Blockage of weep holes.

(iv) Scour under piers and abutments.

(v) Change of direction of flow of the river.

(vi) Corrosion in the steel girder.

(vii) Looseness of rivets and bolts due to elongation or ovelity of holes.

(viii) Fatigue-cracks in the girders caused due to reversal of stresses.

(ix) Movement of the bridge elements caused by creep.

(x) Damage due to accident etc.

In addition to the above the axle loads of the vehicles or the speed of the section might have increased over the years causing considerable increase in longitudinal stresses. Change of bearings of the girder or strengthening of holding down arrangements might be necessary to cater for these excessive longitudinal stresses. All the above mentioned factors require the bridge to be rehabilitated/repaired or undergo routine maintenance which can only be planned after proper inspection.

1.2 Who inspects the bridge?

The bridge is inspected by the engineering officials including Asstt. Engineer of the section. He is supposed to inspect all the bridges on his section once a year immediately after the monsoons and carry out the repairs as deemed necessary before the onset of the next rainy season. In this way, all the damages caused by the floods is taken care of, and the bridge is again ready for sustaining the floods of the next monsoons.

As per the present instructions, the inspection of Railway bridges on any section is carried out by the following personnel:

1,3 Inspection by PWI/IOW (Now SSE/SE/JE/P.Way&SSE/SE/JE/WKS)

The PWI/IOW of the division, inspects all the bridges in his jurisdiction once a year before mansoon. While the IOW inspects the substructure as well as the condition of protection works provided on a bridge, the PWI inspects the condition of girders, bearings, approach track and clearance of waterways. Both the inspectors after inspection give a certificate to the AEN in regard to have inspected the bridge and referring any defects/problems to Asstt. Engineer for his decision. Detail inspection of steel girders of minor bridges are be inspected by PWI/IOW once in five years.

1.4 Inspection by Bridge Inspector (JE/Br.)

The bridge inspector inspects all steel girder bridges of 12.2 meters and above 12.2m span in his jurisdiction once in five years. He is also required to inspect the super structure of pre stressed concrete girders, composite girders and welded girders with the same frequency. However, inspection of new welded girders are to be done within one year of insertion. Note that the early steel girders have to be inspected every year, particularly their flooring system. The nominated over stressed girders are continuously kept under his observation and should be inspected in detail at least once a year. The bridge inspector also gives a certificate to his ABE confirming his inspection of all the bridges and referring any problems for his decision.

The following items are normally inspected by the Bridge inspector at the time of technical inspection.

1. *Creep:* i.e. longitudinal movement of the girder.
2. *Camber:* The negative deflection provided at the time of fabrication of girder.
3. *Distortion.* The offset of the various panel points of the girder from their correct alignment.
4. *Seating of bearings.*
5. *Condition of bed block and holding down bolts. Loose rivets.*
6. *Lateral bracings.*
7. *Position and level of track.*

8. *Corrosion and painting.*
9. *Drain holes and smoke plates.*
10. *Structural condition of different members*
11. *Any serious defect requiring immediate attention.*

1.5 Inspection by AEN

Asstt. Engineer inspects all the bridges in his jurisdiction once a year immediately after the monsoons. He is also supposed to inspect the canal crossings jointly with his counterpart of the State Government of the Public Works Department. The AEN also inspects steel work of bridges of span less than 12.2 meters and may refer any point to the DEN for his decision along with his certificate of having inspected all the bridges on his section.

1.6 Inspection by DENs and CE

The Divisional Engineer has to scrutinize the bridge inspection register sent by his AEN after inspection, and has to give his decision on any point referred to him. He has also to ensure that the AEN has done his inspections properly and effectively. The Chief Engineer concerned also scrutinizes the register and gives his orders on any point which might have been referred to him for his decision.

1.7 Inspection by ABE

The Assistant Bridge Engineer should scrutinize the register of all important bridges (Bridges having a linear water way of 300 meters) as well as major bridges (bridges having clear opening of 12 linear meters or total water way of 18 linear meters or more) on his jurisdiction after the inspection has been conducted by Bridge Inspector. He should also give necessary orders/decisions on the points referred to him by the bridge inspector, after site inspections, if required.

1.8 Inspection by Dy. CE/Bridges

The Dy. Chief Engineer (Bridges) shall examine the register which has been filled up after inspection by Bridge Inspector and necessary orders have been given in it by the ABE. Any point referred to him should also be resolved. Any difference in Camber with the previous reading should be taken as a indication of deterioration of the bridge and should be referred to design office for imposing any speed restriction on the bridge as necessary.

1.9 Inspection by CBE

The Chief Bridge Engineer may visit any bridge on the railway and also which might have been referred to him for his inspection and decision. He should also see that the bridges have been properly inspected by both the Bridge Inspector and Asstt. Engineer and effective repairs have been carried out to maintain the designed capacity of the bridge.

2.0 Inspection Equipments

The normal equipments carried to the site for inspection of a bridge, are given below: This will help the inspection partly in ensuring several parameters which are normally not possible to be measured under ordinary circumstances.

1. Pocket tape
2. Plumb bob
3. Chipping Hammer
4. Straight edge
5. 30 m steel tape
6. Feeler gauge
7. Long line with weight (keep at Bridge site)
8. Thermometer
9. Elcometer
10. Wire Bush
11. Magnifying glass.
12. Centre Punch
13. Torch light
14. Screw Driver
15. Paint & Brush
16. Gauge cum level
17. Nylon cord.
18. Inspection Hammer
19. Rivet testing hammer

3.0 Bridge Register

Basic data of the Bridge is to be noted and the items to be noted consist of :

1. Bridge no.
2. Spans
3. Materials of construction
4. Type of bearings
5. Depth of cushion
6. Previous history
7. Class of structure
8. Type of Girders
9. Strength of Girders

In addition to above the important levels to be maintained are :-

1. Rail level (If not available assume 1000.0 m)
2. Bottom of Girder/slab.
3. Danger levels
4. H.F.L./F.S.L. (with year)

4.0 Maintenance of Railway Bridges (Sub Structure)

4.1 General: After inspection of bridges the substructure of minor and major bridges are required to be maintained according to the items pointed out during inspection.

Normal defects in masonry or concrete consist of cracks whereas the bed blocks supporting the superstructure may get shaken during vibration due to traffic.

4.2 Defects in Bridges

The main types of defects found in major steel girder bridges are usually of the following nature.

(i) The cracks in the masonry or bed blocks: These are repaired by:

(a) Cement grouting under pressure. (b) Epoxy grouting

(c) Guniting. (d) Jacketing.

(ii) Replacing loose rivets.

(iii) Loss of camber.

(iv) Repair to cracks in steel work and buckling and bending of members.

(v) Repairs to steel girder members.

Each of these repair processes is applied according to site requirement. Each process is described briefly below:

4.3 Cement Grouting under pressure

25 mm dia holes are drilled to a depth of 200 mm in a staggered manner in the area in which pressure grouting is to be done particularly along cracked and hollow joints. G.I. pipes 25 mm dia and 200 mm long duly threaded are fixed with rich cement mortar. Any cracks and annular space around the G.I. pipes are sealed with rich cement mortar. Grout holes should be sluiced (circulation and filling of water) with water the day before grouting so as to saturate the masonry.

Cement grouting with cement and water in ratio 1.1 is done from bottom to top and left to right using grout injecting machine. The cement grout should be completely used up within 15 minutes of mixing.

Curing with water is to be done for 14 days over the grouted portion. Effective grouting is also achieved with the help of hand grouting machine if the holes are provided in every 3rd layer of masonry or at intervals of 1.2 to 1.5 meters in staggered position.

4.4 Epoxy Grouting

The structure built of stone masonry or brick masonry gets affected by weathering action. The ingress of moisture sometime combined with extraneous chemicals such as nitrates, chlorides and sulphates combined with proximity of sea or aggressive ground soil conditions accelerate the deterioration of the structures. Leaching of cement and lime on account of poor drainage and consequential deterioration of strength also takes place.

It is a known fact that adhesion between the old damaged masonry or concrete is poor. Besides this, the cement does not get enough time for setting and hardening before traffic is allowed over the newly-repaired structures. This also leads to frequent repairs at the same spot.

It is also known that the cement shrinks on setting thus causing cracks to reappear. Some shrinkage preventive liquids preserve the volume of cement grout

Epoxy resins have the following advantages over cement as a bonding medium.

1. Quick setting.
2. Low viscosity to fill up hair cracks.
3. Low shrinkage
4. High adhesion to any material.
5. Stable at all temperatures

Epoxy resins consist of condensation products of Epichlorydrin and Bisphenol.

These materials are thermosetting with high adhesive strength and practically no shrinkage with good resistance to wear and to most of the chemicals. The resin and hardener have to be mixed for starting the chemical reaction of hardening. The pot life of the mixture varies between 30 minutes and 2 hours depending on the ambient temperature and the type of hardener for preparing mortars, silica flour is added. For mixing epoxy components, the use of polythene vessels is recommended.

The surface over which epoxy is to be applied must be strong and sound as well as dry and clean. It should be free from oil, grease, loose materials, dust and debris.

Low viscosity resins may be adopted for thin cracks. In case of vertical cracks the injection of resin should be done from, bottom to the top to ensure complete filling.

A "V" grove is made all along the crack by mechanical or manual means. All loose fragment of concrete are removed by using a jet of air. Nails are driven into the cracks at 15 to 30 cm intervals. Copper or Aluminium pipes or M.S. sheath 40 to 50 mm long and 6 to 9 mm die are inserted around the nails and allowed to rest on them. All the cracks are now sealed along groove with epoxy putty. The tubes furnish an unobstructed passage for the epoxy resin into the crack and also form on outlet for the entrapped air. Epoxy of suitable formulation is injected from the bottom most pipe, keeping all other pipes except the adjacent on blocked by wooden plugs. The injection is done using suitable nozzles connected to air compressor by modified grease guns or hand operated guns. Pressure of 3.5 to 7 kg per sq. cm is normally used. As soon as the epoxy comes out from the adjacent open pipe it is plugged and the pressure increased to the desired level and maintained for 2 to 3 minutes. The process is repeated for other pipes till the top one is reached.

It is recommended that persons who work with epoxy wear rubber gloves. The grease gun or syringe should be washed with acetone immediately after the completion of the work.

Since epoxy is a costly material its use should be restricted to areas where dynamic forces are to be transmitted e.g. areas below and around the bed blocks, cracks in PSC/RCC slabs or girders etc.

4.5 Guniting

The process of depositing a dense layer of sand-cement mixture can be used profitably for repairing spalled concrete structures or weathered stone or brick masonry. The mortar or concrete is conveyed through a hose and pneumatically projected at high velocity on the surface. The force of jet impinging on the surface compacts the materials. Generally, a relative dry mixture is used so that the material is capable of supporting itself without sagging or slogging even during vertical and overhead applications.

The equipment used for this process is cement gun which is operated throughout by compressed air. The optimum moisture content for sand is in the range of 3 to 6 %. The mixing time shall be not less than 1 minute. The mixed material is carried in suspension by compressed air through the delivery hose nozzle. As the material passes through the nozzle body, it is hydrated with water introduced in the form of a fine needle spray controlled through a valve in the nozzle body. The water cement ratio shall be in the range of 0.3 to 0.5 and the air pressure at nozzle shall be 3.0 kg per sq.cm.

4.6 Jacketing

Besides strengthening the supports and repairing cracks, Jacketing can also be used from several other considerations which the Railways are often required to examine.

1. Increase in vertical clearance to satisfy Codal provisions.
2. Re-grading of track.
3. Introduction of heavier type of locomotives and other rolling stock higher longitudinal forces.

With the raising of formation levels the existing substructures are subjected to higher loading by way of higher earth pressure and increased moments. To strengthen the substructure the cross sectional area may require to be increased. For this purpose jacketing of existing substructure is resorted to. Jacketing is normally undertaken only when the existing structure is fairly sound and does not show sign of distress. All cracks should be thoroughly and does not show sign of distress All cracks should be thoroughly grouted before providing, the jacket. For the jacketing to be effective it has to be taken right up to the foundation and integrated at this level with the existing foundation.

The foundation shall be exposed for only limited width at a time and for the shortest time necessary for strengthening so as to avoid endangering the safety of structure. Site and soil conditions including water table shall be considered for deciding the width of foundation to be exposed at time. The minimum thickness of jacketing should be 150 mm.

A speed restriction of 20 Kmph is to be imposed till the strengthening is done and may be relaxed in proportion to the gain in strength.

4.7 Attention to Steel Girders

The steel work of girders in major bridges can also develop cracks and other defects during its service life. These also have to be maintained according to the item of defects noticed during inspection. These normally are:

4.7.1 Replacing loose Rivets

Loose rivets occur more frequently at certain location / especially where dynamic stresses, reversal of stresses and vibrations are at their maximum. Generally the loose rivets are replaced by using pneumatic equipment; by pressing the rivets head tightly against the member through a pneumatically/hand pressed dolly. The rivets shank is about 1.5 mm less than the diameter of the drilled hole. The normal working pressure of the compressed air should be between 5.6 and 7 kg per sq.cm.

4.7.2 Loss of Camber

Steel girders are provided with camber to compensate for deflection under load. Out of the total design camber that part corresponding to deflection under dead load is called dead load Camber.

The balance called live load camber should be available as visible and measurable camber in the girder when not carrying load. Loss of camber can be attributed to:

1. Heavy overstressing of members beyond elastic limit.
2. Overstressing of joint rivets.
3. Play between rivet holes and rivet shank because of faulty riveting.

Out of the above, in case of item (1) action should be taker for immediate replacement of the girder. Item (2) can be got checked from design. The action required to be taken is to lift the panel points on trestles and jack up to full design camber (including dead load camber) or till the bearings start floating. The existing rivets should be removed and replaced with larger diameter rivets or with thicker gussets and more number of rivets. As regards item (3), if the number of rivets and diameter are sufficient then the existing rivets can be replaced by sound rivets.

4.7.3. Repair to cracks in steel work

It is difficult to detect any cracks in the steel work due to the presence of a film of paint or corrosion. Normally the locations where the cracks occur are joints where shear is transmitted badly corroded members, members made or wrought iron early steel and roots of flange angles due to defective rolling.

If the cracks are observed at isolated locations, cover plates or cover angles with an adequate number of rivets on either side can be provided. Alternatively, the defective member or girder can be replaced by temporary member, the old one removed fully repaired and replaced. An even better alternative is to manufacture a new member identical to the original one and replace it. There may be cases in which identical members in a series of girders may show signs of crack. In such cases a thorough examination of the design of the structure as well as the conditions of the material by testing is called for.

4.7.4 Buckling and Bending in members

Webs of girders and flanges of members/ girders/ subjected to compression should be examined for buckling and bends. Buckling in webs would indicate the need for stiffening the girder. Buckling and bending in other members can be either due to an accident when a moving vehicle or dropped weight may have caused the damage or due to overstressing.

5.0 Maintenance Of Steel Girders

The steel girders in service have to be maintained in proper manner so that they can continue to carry the designed load without any speed restriction. Normally the under mentioned items have to be carried out for maintenance of steel girders.

1. Inspection and Maintenance of bearings.
2. Technical inspection of bridge girders
3. Painting of steel work of girders

All these 3 items are described below in details.

5.1 Inspection and Maintenance of bearings

Generally, the following types of bearings are provided for the steel girders:

5.1.1 Flat Bearings

It is the simplest type of bearing in which upper plate attached to the bottom of the girder beam slides over another bed plate which is fastened to the abutment of the pier cap.

5.1.2 Centralized ArticulatedBearings

These are similar to flat bearings but for having chamfering at the inner edge of the bearing strip and free to move in wards at both ends.

5.1.3 Rocker Bearings (circular pin or cup type)

The rocker end is made by providing a knuckle and saddle block with plate. To make the difference in the height a grillage is provided below the knuckle plate. The rocker end of bearing permits only rotation.These can be of mild steel as well as of cast steel according to the requirement.

5.1.4 Rockerand Roller Bearings (circular roller or segmental roller along with rocker arrangement)

The roller bearing consists of a base plate, two or more rollers and a knuckle plate with saddle block and a plate on top. The rocker & roller end is made by providing a saddle and knuckle plate on top of the rollers. The rocker & roller end of bearing permits translation as well as rotation.These can be of mild steel as well as of cast steel according to the requirement.

5.1.5 Oil Bath Bearings

These types of bearings are encased in oil baths and need to be inspected after monsoon every

year and replacement of oil at every five year along with detailed inspection.

5.1.6 Phosphor Bronze Bearings

These bearings do not need oiling and greasing as coefficient of friction is very less (0.15) for this special type of metal.

5.1.7 P.T.F.E. Bearings

The poly tetra floro ethylene along with stainless steel has very low coefficient of friction (0.08). This sheet is fixed on a mild steel plate. A smooth stainless steel plate, fixed on a mild steel plate, slides on it. It provides non-rotational free sliding action.

5.1.8 Elastomeric (Neoprene) Bearing (Steel Lamination)

This is a special type of rubber known as "Chloprene". These bearings permit movements in all direction, e.g. longitudinal, lateral and rotational by visco-elastic properties of the rubber.

5.1.9 Maintenance of bearings

All steel girder bridges are subject to elongation and contraction due to variation in temperature. To allow these movements the bearings are required to be kept cleaned and free from dirt, debris and moisture. Bearings are required to be lubricated to prevent jamming and should be greased regularly. However, excess grease tends to attract dirt and dust which will cause jamming of Bearings.

All bearings elements should have full contact at interface. If partial surface contact is made, damage may occur either to the span or to the support and the bearing. Where a girder span may have moved horizontally and the sole plate rests partially on bearing plate the load transmitted to the abutment may exceed the bearing limit of the abutment masonry and it may crush. Which generally cause loose bed blocks. Conversely, buckling of girder may be resulted if the bearing and the support does not yield. Whenever uplift happened there will be gaps between the bearing and superstructure.

Shaking bed block are caused by the bearings which are not properly fixed or got loosed due to following reasons:

1. Sinking of bearing or movement of bearing away from the substructure.
2. Excessive rusting or corrosion which results in loss of material in the bearing itself.
3. Excessive deflection or vibrations in the bridge span members due to broken or lost members.
4. Loose fasteners such as rivets or bolts used to attach the bearings to either the bridge span or the bridge support.
5. Worn bearing members such as pins or pin shoes.
6. Curved superstructure.

The bearing seat should be checked for any cracks or restriction in movement due to jammed bearing.

5.1.10 Oiling and greasing of Steel bearing

The oiling and greasing is the most essential part of maintenance of steel bridges which is done after taking due safety precautions as laid down. The Bridge Inspector is required to do the cleaning and greasing of girders bearings once in three years and record the entries in the Bridge Register.Although the cleaning should be done on all the bearings butoiling-greasing is done only in the case of following types of bearings.

(i) Flat bearings

(ii) Centralised articulated bearings

(iii) Rocker & Roller bearings.

All the bearings where oil bath is provided are required to be inspected once every year just after the rainy season. It should be ensured that the oil bath tank is completely water tight and if any contamination is noticed, it should be immediately drain out and any deficiency in oil is recouped. The oil filled in the bath tank should be replaced after 5 years.

5.1.11 Procedure for Greasing Bearings

(i) The entire work of oiling and greasing should be done under a caution order or traffic block. The caution order should be cancelled every day after the work is completed. The protection of line should be done by deploying staff with Banner flags/Hand Flag/Detonators etc. as per prescribed rules.

(ii) All bearings are required to be greased and graphite. The graphite is normally mixed in the grease mineral in the ratio of 1:3. The quantum of graphite should be mixed so that the maximum quantity of graphite is retained in a workable mixture.

For oil bearings, the oil servo mesh 460 BP (Indian Oil) should be filled in the oil bath.

(iii) All T & P consumable stores etc. should be kept in advance over the pier/abutment before starting the actual jacking.

(iv) The staff should be divided in two groups. Two bearings on one end should be lifted at a time by applying proper type of jack at a proper jacking point.

(v) Special packing, if prescribed, or jacking should be utilized where special schemes are laid down in case of very heavy girders like Yamuna Bridge at Delhi.

(vi) After lifting, the roller bearings should be taken out and all rollers, bottom plate, top plate etc.

(vii) After dry cleaning, the K. Oil should be applied to all the rollers and top, bottom plate and bearings should be thoroughly cleaned with the help of gunny bag rags and waste cotton. Sand papers should be utilized wherever necessary to clean the excessive rust etc.

(viii) Next, the K.Oil applied should be thoroughly dried up with the help of waste cotton and all

surfaces should be thoroughly cleaned before application of grease graphite all around and the rollers are pushed back into their proper position.

(ix) The packing should be removed gently and the jacks should be lowered so as to place the girders on its proper position.

Before shifting to the next pier, the excessive grease sticking to the bearings or lying around the bearings should be cleaned.

5.1.12 Repairs of Bearing

If a bearing is severely tilted or out of alignment, normal maintenance such as rust removal and lubrication will not provide sufficient repair; therefore resetting of the bearing is required.

Corrective measures should depend on the cause of failure. Before resetting bearings, the possible tilting of the abutment should be investigated. If tilt is the result of abutment movement, the abutment weep holes should be cleaned, and if required, additional drainage provision should be made. Also, relief joints adjacent to the abutment may be placed to prevent further abutment movement.

Resetting bearings can be done by jacking the girders and removing the masonry plate. The existing girders shall be raised by jacks supported on suitable false work, or on the bearing seat or by other methods capable of raising and supporting the ends of all girders simultaneously at one end only. The bearings shall be removed and replaced. Care shall be exercised to avoid any damage to the structure.

5.2 Technical Inspections of Bridges

Bridge Branch is responsible for upkeep and maintenance of girder bridges of 12.2m and above 12.2 M span. These are required to be technically inspected by BRI/Technical every 5 years. Inspection must be done thoroughly and its result recorded in such a manner that it can be referred to and understood at any time by engineering officials.

The frequency of inspection of bridges has been fixed as once in five years, but a special inspection of trouble-prone bridges can always be carried out more frequently. BRI/Incharge, at random, should test check 20% of all the inspections carried out by his BRI/Tech. This test check should be spread over the entire jurisdiction and all important items of the technical inspection should be included. The following points should be thoroughly examined during the course of technical inspections.

5.2.1 Creep

The longitudinal movement of a girder is termed as creep. The rails are connected with the girders rigidly, the girders also tend to move in the direction of pre-dominant traffic along with the creep in the rails. In case of multi-span bridges, some-times the girders of one span have the tendency to push the girder of the next span. This has been found where proper stopper plates have not been provided in the bed plates.

This point should be checked carefully, girders got pulled back, if necessary, to the proper position, and in such old bed plates, where there are no stopper plates, the same should be got provided.

5.2.2 Camber

Plate girders of large span and open web girders are provided with camber during fabrication/ erection. Camber is provided in the girder to compensate for deflection under load. Once provided camber should be retained during the service life of a girder.

Any loss of a camber should be brought on record and submitted to the design wing for examination. Camber is checked by dumpy level on all intermediate panel points of the girder. A camber diagram should be made in the inspection register.

5.2.3 Distortion

With variation of temperature, the girder is likely to have, longitudinal movement due to contraction and expansion. This movement is dependent on the temperature range to which the bridge is exposed and the degree of restrain on the bearings Absolute freedom of movement, even in best of the bearings is impossible and there is always a residual force which develops internal stresses in girder, causing tendency to distort. Distortion of girder is measured on the bottom chord or on the top chord. The same can also be checked by a theodolite by taking readings at every panel point.

5.2.4. Condition of bed block & H.D. Bolts

Bed blocks receive the full load from the bearings of the bridge, and distribute and transmit the same to the masonry below. Restriction of free movement in superstructure may result in :

(1) Development of transverse cracks in piers/abutments.

(2) Failure of bed blocks joints to shaking of the bed blocks.

(3) Shearing of H.D. Bolts.

All these should be critically examined by the BRI

5.2.5. Lateral bracings

Normally a span of a bridge consists of two or more girders braced together with lateral bracing. These bracings should be thoroughly checked for any corrosion or loose rivets and deformity, viz buckling, distortion etc.

5.3 Painting of steel structure

Painting of steel structures is done to avoid corrosion thus increasing its life as also for beautifying it.

5.3.1 Corrosion

Corrosion of steel structure takes place when steel comes in contact with oxygen and moisture Corrosion has to be avoided as it eats away into the section of the steel and reduces the strength on the structure. Oxidation of iron in presence of moisture and air forms ferric oxide known as rust.

5.3.2 Prevention of Corrosion

Corrosion can be prevented by the following methods.

(i) Cathodes protection.

(ii) Surface treatment.

(iii) Use of protective coatings. Only protective coating will be discussed here:

Metallic protection coatings consist of 3 major components:

(1) BINDER –which is of varnish or gummy base which attaches to the surface of the substance and solidifies there.

(2) PIGMENT – These are solid material suspended in the binder and add colour, abrasion-resistance and anti-corrosive property to the paint.

(3) SOLVENT – This is a solution which evaporates after application of paint. This adjusts consistency of paint.

5.3.3 Paints

Although paints are tested as per the IS 101 before acceptance the bridge inspector can carry out the various tests in the field on receipt of the supply. Separate painting scheme is adopted depending upon the severity of environment condition.

5.3.4 Surface Preparation

(a) Rust, being porous, permits corrosion. Grease dirt oil etc do not allow the paint to adhere to the steel surface. Basic purpose of surface preparation is to clean the steel of oil and grease. This is the most important single factor to increase the life of, paint on steel structure. Surface is cleaned by the following methods:

(i) Sand or girt blasting

(ii) Scrapping, wire brushing and chipping manually or power operated tools.

(iii) Flame cleaning.

5.3.5 Painting procedure

5.3.5.1 Environmental Conditions

(a) On sand blasted surface the first coat of primer paint should be applied immediately after surface preparation.

(b) On flame cleaned surface, first coat of primer paint should be applied when the surface is slightly warm.

(c) Painting should not be done in rainy season.

(d) Painting during early mornings in winter season should be avoided.

(e) Painting during extremely windy and dusty conditions should be avoided.

(f) In summer afternoons, areas which are directly, exposed to sun-light should not be painted.

5.3.5.2 Precautions in carrying out Painting

(a) Thorough mixing of paint should ensured

(b) Paint should be applied with several light vertical/lateral strokes of the brush.

(c) Tendency to add thinners frequently must be curbed.

(d) Subsequent coat of paint should be applied only after allowing adequate drying time for the previous coat.

5.3.5.3 Quality of Work

(a) Coat of paint applied, shall be uniform, free from brush marks, sags, blemishes and pinholes.

(b) Thickness of paint coating should be checked with an "Elcometer".

6.0 Watch Man on Bridges

During the monsoon period particularly at important bridges watchman should be posted. The watchman selected should be intelligent, reliable, experienced and who can read, write and communicate on phone. In addition he should be aware of the safety rules, protection measures and know about signaling.

Main equipments available with the bridge watchman are given as below:

(i) Two red flags, One green flag, Two hand signal lamps, 10 detonators, & Flair signals (where prescribed)

(ii) Whistle & Matchbox

(iii) Keying and spiking hammer as well as a fish bolt spanner

(iv) A gauge cum level

(v) A staff to exhibit flag lamp

(vi) A powerful torch

(vii) A probing rod if required.

He is supposed to walk over the bridge where possible inspecting every portion of the bridge for any sign or failure.

His main duties are as under:

1. To watch the flood whether the same is exceeding the danger level.
2. Any type of crack or seepage in approach bank/embankment/various types of bunds.
3. Whether any type of obstruction is there to the waterway or not.

In case of any danger, he has to stop the traffic and communicate the same to appropriate authority for further necessary action.

7. Railway Affecting Works

There are so many works near to Railway track, which may effect to safety of the Railway track if not maintained properly or in case of failure of the same. All such works are categorized as Railway Affecting Works. Brief lists of the Railway Affecting Works are given as below:

1. Irrigation and water supply tank or reservoir.
2. Canal embankment and river bund.
3. Road embankment with adequate waterway for drainage situated upstream and down stream of the Railway line.
4. Temporary channel cut for irrigation or other purposes from bed of active rivers.
5. Other works or operations which might alter or impede the natural course of flood flow or cause an increase in volume of such flow. These may be new irrigation projects, new township, new forest belt, large scale deforestation etc.

Authority to declare a work as Railway Affecting Work rests with an Officer not below the rank of Executive Engineer of the State Government or Divisional Engineer of the Railway. In case of dispute, the matter will be referred to Chief Engineer of the Railway. :

List of Railway Affecting Works should be maintained in the AEN Office as well as DEN Office. Well before time all Railway Affecting Works should be jointly inspected by the Railway Engineers as well as by Engineer of the concerned department under whose jurisdiction of that particular Railway Affecting Work is falling. Discrepancies, if any pointed out should be attended to in time, much before the onset of monsoon to ensure safety of the Railway Track and Bridges.

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