



सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

Guidelines for Providing Arrangements for Bridge Inspection

BS - 113
November, 2014

ISSUED BY

B&S DIRECTORATE

RESEARCH DESIGNS AND STANDARDS ORGANISATION

LUCKNOW-226011

Foreword

Inspection arrangement for bridges is a very important subject to which Indian Railways need to pay more attention. Recognizing the need for the same, Railway Board, vide their letter no 2014/CE-III/BR/Bridge Policy Dated 09.10.2014 have laid down that while constructing a new bridge, suitable arrangements for facilitating proper inspection as per Indian Railways Bridge Manual (IRBM) shall be planned and executed before handing over the bridge to open line for regular train operations.

The inspections as per IRBM require comfortable access to all parts of the bridge. The access can be provided in many ways – by deploying machinery to take the inspectors near all parts of the bridge or providing permanent/ temporary arrangements which can facilitate inspections. To provide guidance to field engineers regarding various approaches/ options available for this important aspect, B & S Directorate decided to bring out a BS report. I am happy that Sh V B Sood, Director/B & S/SB-II and his team have taken lead to compile this document.

The main purpose of this document was, as stated above, to compile the work already done in this field to provide guidance to the field engineers. However, there is no limitation to the imagination and further different types of arrangements can be designed which might even be able to serve the railway's needs in an even more efficient manner. It is requested that while guidance may be taken from this document, all initiatives at innovation shall be encouraged (ensuring safety at all times) and the results shall be conveyed to RDSO for incorporation of success stories in future versions of this document. Feedback may be provided edbsrdso@gmail.com or directorsteel2@gmail.com.

There are some advanced methods for inspections, such as remote operated vehicles and cameras etc but these are very complicated techniques about which there is very limited experience on Indian Railways as yet. These are, therefore, not covered in these guidelines. Some special type of bridges like long span arches, pylons of cable stayed bridges etc have not been included as special arrangements need to be designed/ envisaged for these during design.

17th November 2014

Lucknow

A K Dadarya
Executive Director

**Government of India
Ministry of Railways
Railway Board**

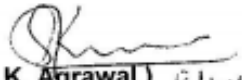
No.2014/CE-III/BR/Bridge Policy

New Delhi, Dated : 09-10-2014

**PCEs / CAO/Cs
All Zonal Railways.**

Sub : Providing necessary inspection arrangements for new bridges.

It is imperative that while constructing a new bridge suitable arrangements for facilitating proper inspection as per IRBM is to be planned and executed before the section is handed over to the open line for regular operation. For every major / important bridge, the executing agency (construction wing of Zonal Railway, RVNL) should provide inspection cum maintenance system for all major / important bridges at the time of handing over the section. PCEs / CBEs are also requested to see that the inspection system arrangements for bridge are in place before taking over the section. For example, in case for tall pier there should be suitable arrangements for reaching every point of the pier for inspection from inside in case of hollow as well as from outside. There should be suitable provision for ventilation for inspection from inside in case of hollow piers. Another example is providing the ladder on both side from top of the girder to the bed lock for inspectors / officers to reach at the bearing level for inspection. This is not exhaustive. PCEs/CBEs should satisfy themselves that the system provided for inspection and maintenance for newly constructed bridge as per IRBM is in place for all new bridges being constructed either from construction wing or by RVNL. This issue was discussed in the CBEs' conference held at Pune on 11th & 12th September, 2014.


(S.K. Agrawal) 9/10/14
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Copy to :

CMD / RVNL, New Delhi for information & necessary action.

BS – 113: Guidelines for Provision of Arrangements for Bridge Inspection and Maintenance

- 1) **Introduction:** Inspections are a key activity to ensure due performance of assets. In case of bridges, proper inspections are even more important, since the problems in the bridges have severe impact on safety and train running. Since Indian Railways still relies on visual inspections to a considerable extent, the issue of arrangements which can enable the inspecting officials to gain access to all parts of bridge assumes greater significance. These guidelines discuss the various types of arrangements possible for to enable inspections of bridges to be carried out safely and conveniently.
- 2) **Types of Inspection:** Various types of inspections being done on Indian Railways are as follows:
 - a) General inspection of bridges by open line Assistant Engineer after monsoons every year (Para 102 of IRBM).
 - b) Once a year inspection of bridge, prior to monsoons, by open line SE(Works)/SE(P Way) covering the protection works, foundation and superstructure of bridges <12.2m span. (Para 117 of IRBM).
 - c) Inspection of bridge superstructure for spans more than 12.2m once in five years by SE(Bridge) (Para 107(d) of IRBM).
 - d) Test check on the inspections by ADEN(Br) and checks on referred/ distressed/ important bridges by DyCE(Br)/ SrDEN (Para 105 (2), 1105 and 1106 of IRBM).
 - e) Special inspections during monsoons for studying the scour pattern by SE(W).
 - f) Special structural inspections after earthquake or accidents involving bridges.
- 3) **Why Inspection Arrangements Are Required?:** The various inspections listed above have to be done periodically either visually, using NDT or using other equipment. Proper inspections require good access to the structure. *It is experienced in field that for carrying out proper inspections, the inspecting official shall be **comfortably stationed at a location not more than 3-4 m away from any structure**.* As the distance from the surface increases or the discomfort of the official increases, the quality of inspection and the ability to detect the potentially harmful defects at nascent stage diminish disproportionately. **To meet this objective, some structures/arrangements may have to be provided on bridges, which are called inspection arrangements.**
- 4) **Inspection arrangements currently in use and drawbacks of the same:** Currently, the arrangements for inspection generally available on most bridges of Indian Railways include ladders to reach the pier top and steps on approaches to reach the riverbed. These are elementary arrangements which are often inadequate to serve the needs of proper inspections. Inspections often have to be got done by inspecting personnel climbing on bridge without any arrangements and without adequate protection. If the inspecting official does not feel comfortable and safe, it will affect the quality of inspections to some extent. Due to this realization, some railways have worked proactively to provide inspection arrangements in most bridges. West Central Railway is a note-worthy example in this respect.



Figure 1: Bridge official climbing end raker of girder without inspection arrangement.

The obvious drawbacks of lack of proper inspection arrangements are as follows:

- 4.1 The present system relies on inspection by the bridge personnel who are adept at walking on thin girder members and even outside flanges of girders without any protection.
 - 4.2 If the inspectors and officers are not able to access the various parts of girders in the absence of inspection arrangements, the inspections may be got done through artisans and other staff.
 - 4.3 The quality of inspections is generally poor due to lack of availability of good secure place for the inspecting official to stand.
 - 4.4 Due to lack of inspection arrangements for substructure, proper inspections are not always possible.
 - 4.5 Attempts to carry out inspections without proper arrangements are unsafe for the personnel involved.
- 5) **Various approaches to Inspection arrangements:** Different approaches to providing inspection arrangements may be followed depending on the population and type of bridges and other site specific factors. These approaches can be:
- (a) **Permanent arrangement:** In this approach, access to the bridge for inspections is provided through permanent arrangement fixed to the bridge. Inspections on the bridge can be done at any time.
 - (b) **Temporary Arrangement:** In this case, the access is provided through temporary arrangements which are to be installed every time any inspection/repair activity is to be done on the bridge. The inspection arrangement is designed as light weight modules which can be separated/ folded and carried by personnel even in passenger trains. For special works, heavier temporary arrangements are also designed.
 - (c) **Mobile Arrangement:** The inspection arrangement can also be provided in the form of inspection capsule which can be on track mounted or boat mounted or on road vehicle. This arrangement is not sturdy but mobile and need not be transported to bridge using other means.
- 6) **Different inspection arrangements:** The inspection arrangements required to be provided/ procured for the bridge shall be chosen as discussed below:
- 6.1 **No inspection arrangements required:** The above list of choices of inspection arrangement is not exhaustive. There are many cases where there is no need for any type of arrangement to be provided except, may be, steps to reach the river bed. Such bridges include:
- **Minor Bridges such as pipes, arches, small BOXes etc:** These bridges have limited heights and extent and can be easily inspected from any one point near the opening. If the dimensions of the span are such as to allow a person to go inside when the waterway is dry, inspections can be done. If the bridge is too narrow for inspecting officials to go inside, then the condition of the bridge shall be assessed from tell-tale signs from areas adjoining the bridge.
 - **Bridges having accessible river bed and less height:** The bridges having height less than 4 m can be inspected and maintained from the river bed itself without any inspection arrangements. It is not required that the river bed be accessible throughout the year. Even if the bridge is accessible for inspections for part of a year, the same will suffice as the bridges are not required to be frequently inspected.

6.2 Mobile inspection arrangements: Bridges can be inspected easily if a special vehicle is available for inspection. This vehicle shall have buckets at the end of flexible arms which can manoeuvre through the girder components and the inspecting officials in the buckets can safely reach various parts of the bridge and carry out inspections. Same vehicle can move from bridge to bridge and provide access to the inspecting official. This is a cheap option as the cost of vehicle is shared by a large number of bridges. If an inspection plan is drawn up, the vehicle can be deployed for fixed times in different sections. The vehicle provides several advantages as it can take heavy testing/ inspection equipment to bridge site and the deployment of vehicle for inspections is quite fast. The person sitting in bucket is quite secure and consequently the inspections are of good quality. The 'mobile' part of the arrangement can be of two types:

- i) **Rail mounted mobile arrangement:** A rail mounted vehicle is very good means for carrying out inspections but a major drawback in Indian scenario is the requirement of traffic blocks for carrying out inspections. The vehicle will also require OHE shutdown and earthed in electrified areas. A couple of such vehicles have being procured by Indian Railways.



Figure 2: A track mounted vehicle used for inspection of underside of girder.

This vehicle can be used where:

- Number of bridges having river bed inaccessible is very high e.g. in hilly areas.
 - Traffic is very less and blocks can be easily granted e.g. in branch lines.
 - Where the problems in a bridge have to be analyzed/ using equipment transported in the vehicle.
- ii) **Road/Boat mounted mobile vehicle:** Except in case of through or semi through type of girders, most of inspections are to be done below the track. A very good approach, therefore, is to have the mobile inspection arrangement travel on road instead of rails. The arrangement is similar to the rail mounted one and can be quite light weight also as can be seen in figure 3 below. Same vehicle can be mounted on boat/ barge to inspect bridges having adequate depth of water. These types of vehicles are commonly used for inspection/ maintenance work by civic bodies also. These vehicles, thus, can be got repaired/ maintained more comfortably.



Figure 3: A road mobile vehicle being used for inspections.

This type of vehicles can be used in:

- Bridges located in such a terrain that river bed is easily accessible for road vehicles and the height of bridges is not more than 15-20m above ground.
- Spans on major rivers such as Ganga having large no of spans and sufficient depth of water to allow boats to ply.
- Bridges over reservoirs etc which have lot of water throughout the year.
- Where the problems in a bridge have to be analyzed/ using equipment transported in the vehicle.

Care needs to be exercised in properly securing and propping the mobile inspection vehicles on stable non-yielding locations so that the vehicle can take all loads during inspections. Other safety precautions in operation of the vehicles shall also be diligently exercised.

6.3 Permanent inspection arrangements: Permanent inspection arrangements include permanently fixed ladders, cradles, pathways, rungs etc supported on bridge itself. The permanent inspection arrangements are generally made of steel (these can be made of concrete also but it may be kept in mind that concrete adds extra superimposed dead load on the structure and may render inspection of some bridge components difficult), and supported on the girders or the sub-structure.

i) **Mandatory Permanent Inspection Arrangements:** There are few permanent arrangements which are mandatory for all bridges. These include:

- Concrete, masonry or kutchra steps on bridge approach for providing access to the river bed.
- Ladder to descend onto the pier/ abutment top where girder depth is more than 0.75m.
- Trolley refuges and man refuges in longer bridges/ open web girders etc as per extant instructions/ codal provisions.

- ii) **Arrangement for inspection of bearings in plate/PSC/Composite girders:** For inspection of bearings, bed blocks and for gaining access to the inside of the girders, cradles can be provided on piers and abutments in case of plate/PSC/Composite girders. These cradles can have permanent or temporary flooring as per site conditions. This type of cradles are not feasible for the underslung girders and not required for open web girders with roller-rocker bearings.

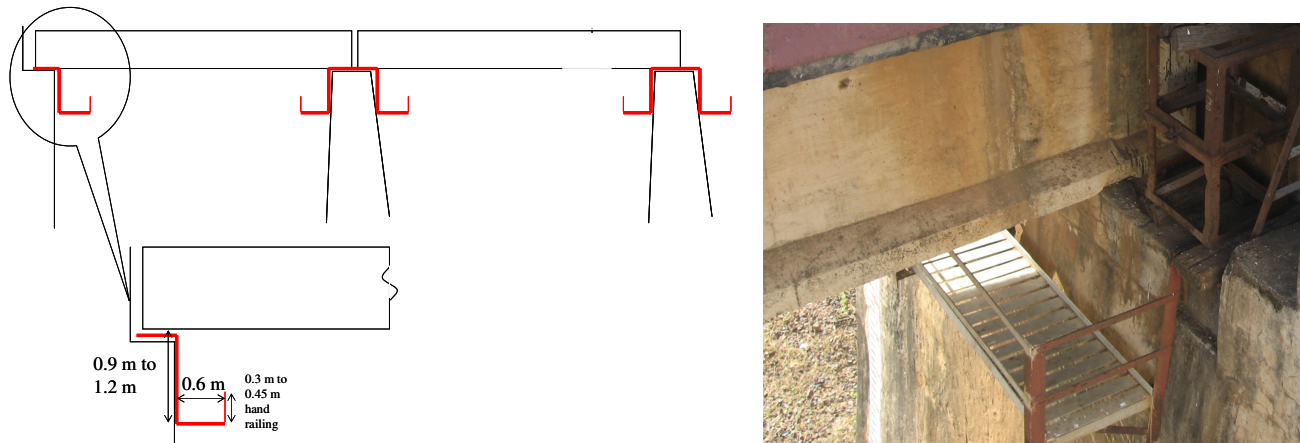


Figure 4: Schematic arrangement of cradles at piers/ abutments, and actual site photograph of same.

- iii) **Arrangement for inspection from inside the plate/ underslung girders:** To provide means to the bridge officials to comfortably inspect the inside of the girders, pathway can be provided in underslung and plate girders. This pathway in underslung girders is supported on the bottom bracing and has railing on either side. The inspection of top chord can be done using ladders or other temporary arrangement for deeper girders. The ladders from pier top to the pathway can be used for inspection of bearings also. In plate girders, the pathway is feasible only if the girder depth is more. The pathway can be supported on gussets of cross frames in this case. Railing is optional in this case as support of girder top flange can be taken by inspecting official.

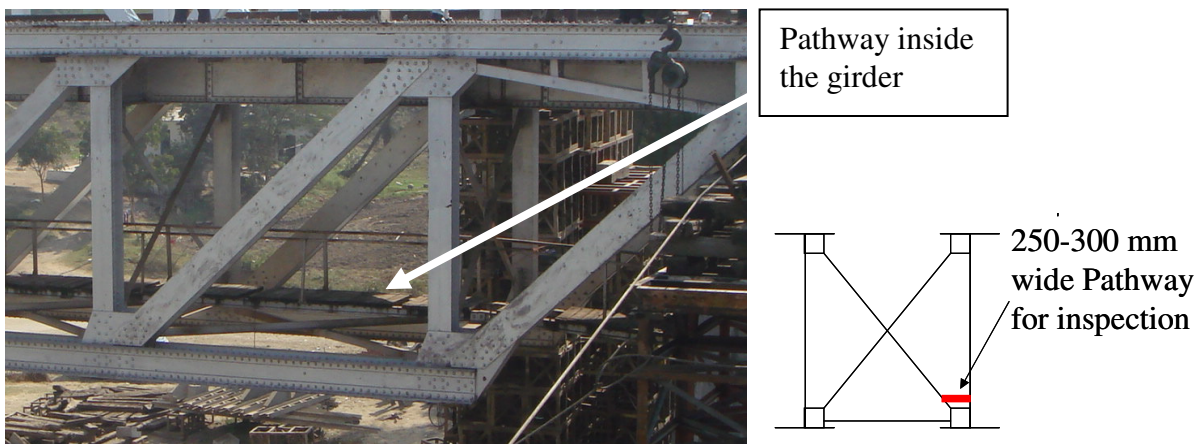


Figure 5: Pathway inside an underslung girders and a plate girder

- iv) **Arrangement To Access Top Boom Of Open Web Through Type Girders:** The open web through type girders can be provided with ladders on the end rakers to access the top boom as shown below:



Figure 6: Ladder with railing on end raker of through type girder

- v) **Arrangement for Inspection of Top Chord Node Points:** For close inspection of the node points in top chord, either through walkway or cradles at the node points can be provided. These cradles can be used for inspection of underside of members also as the nodes are at spacing of 5m to 8m only.



Figure 7: Long and close-up view of cradle provided at node of open web girder.

- vi) **Arrangement for Inspection of in small span PSC/Composite girders:** For smaller span PSC/Composite girders, intermediate cradles can be provided at regular intervals for inspection of the complete girders. For 12.2 m spans, one intermediate cradle in the center of span can meet the requirement of providing access to the inspecting official with 3-4 m of all parts of girder. For 18.3 m spans, three intermediate cradles are required. The intermediate cradles shall be provided such that these are 0.75 m to 0.90 m below the bottom of girder, allowing the bottom of girder to be inspected. The obstruction to waterway may be checked in this case keeping in view the fact that the area of obstruction is very less and that the steel cradles have open construction which does not trap debris.



Figure 8: Front and side views of Inspection cradle at intermediate point of a PSC I-girder



Figure 9: Arrangement for descending onto the inspection cradle from track



Figure 10: Cradles at intermediate point and abutment in a PSC I girder seen from underside

vii) **Arrangement for Inspection of longer PSC girders:** As the number of cradles described above increases, the number of time an inspecting official has to descend the ladders for and climb back increases. This is extremely fatigue inducing and affects the quality of inspections and the officials may be inclined to skip a few arrangements out of fatigue. For longer spans, depth of girder also increases and a better method for inspection can be by providing a side

pathway which runs parallel to the girder. The flooring of the side pathway can be permanent or temporary as per site requirements.

The pathway can be provided 0.75 m to 0.90 m below the bottom of girder, if allowed from waterway considerations. However, if the HFL is too high and sufficient clearance is not available, the pathway shall not project below bottom of girder. In such a case, a light weight temporary cradle made of aluminum can be used for inspection of the underside of girders. This temporary cradle shall be supported on the permanent side walkway arrangement by simple methods of bolting/ clamping at certain fixed locations where openings shall be provided for access to the temporary cradle.



Figure 11: Side pathway in a PSC BOX girder (Not projecting below bottom of girder)

For composite girders, side pathway is not required as the pathway at bottom flange indicated for the plate girders in para 6.4(i) above shall be used for the same. In the case of composite girders, however, hand railing is required to be provided so that the bridge staff can hold onto the same.

- viii) **Travelling Platform Arrangement for Inspection of Underside of long span girders:**
Where the HFL is high and waterway is inadequate as to allow the permanent inspection cradles or pathway to be provided below the bottom of girder, another option for the inspection of underside of long span girders is to provide a moveable platform. This platform can be mobile, moving on side pathway provided as above in girder or on rails fixed to the girder. Southern Railway had designed and demonstrated such an arrangement some years back.

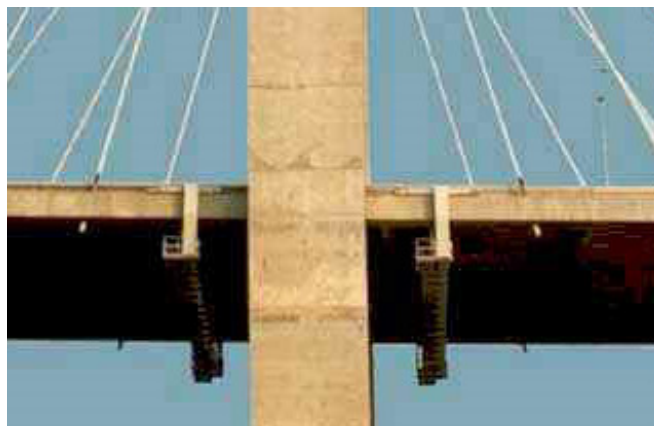


Figure 12: Travelling platform for inspection underside of a cable-stayed bridge.

- ix) **Door arrangement in BOX type girders:** The BOX type PSC/ composite girders have the facility for accessing the inside of girder through the end opening. This opening can be designed to serve as inspection arrangement from inside. For this purpose, the end opening shall not be less than 0.75m x 0.75m, preferably more than 0.9 m size. However, this opening provides a good space for anti-social elements also for their activities, so it is preferable to provide doors with locks to control access on the inside.



Figure 13: Door in a PSC Box Girder, and inspection in progress inside the girder

- x) **Arrangements for Inspections of Road Over bridges/ Flyovers:** Normally the Road over bridges/ Flyovers are in the range of 6-7 m above the ground. These require cradles to be provided for inspection of bearings if SOD permits the same. If not, inspection of bearings shall be done using ladders and other arrangements. The girders and/ or slab etc can be inspected using ladders from the ground itself, supplemented by binocular inspection near center of track. For close inspections, traffic and OHE blocks may be required to be taken. Tower wagons belonging to the OHE department can also be requested for special inspections/ repairs. However, if the road over bridge/ flyover is having open web/Bow string girders or these are having more than 6-7 m height above ground, proper inspection arrangement has to be planned for these also.



Figure 14: A typical Road Over Bridge in electrified territory

xi) Arrangements for inspection of sub structure from river bed: These arrangements are feasible only if river bed is accessible.

- (a) **Road mounted inspection vehicle:** For sub structure having height between 8m to 20 m from river bed, road mounted inspection vehicle is ideal as it does not require track occupation and OHE shutdown. However, there must be a certain minimum number of bridges for inspections to justify the investment in the vehicle.
- (b) **Permanent Arrangement On outside of sub-structure:** If the sub structure is more than 20 m height or if the number of bridges to be inspected is too less to justify the investment on road mounted inspection vehicle, permanent arrangement in the form of steel rungs embedded in the concrete at regular intervals to help the inspecting officials descend/ climb the sub structure can be provided. The steel rungs can be provided on the periphery of sub structure at interval of about 4-5 m.



Figure 15: Steel rungs provided in sub structure

xii) Arrangements for inspection of sub structure from top: These arrangements may be required if the river bed is not accessible.

- (a) **Rail mounted inspection vehicle:** If the sub structure height is between 8m and 20 m and river bed is not accessible, rail mounted inspection vehicle can be an option. There is requirement of traffic/OHE blocks for inspections, which need to be planned and provided. However, there must be a certain minimum number of bridges for inspections to justify the investment in the vehicle.
- (b) **Permanent Arrangement:** If the sub structure is more than 12 m height or if the number of bridges is less and the investment on the rail mounted inspection vehicle is not justified or if the blocks cannot be granted to rail mounted vehicle, permanent arrangement shall be provided. The permanent inspection arrangement shall be in the form of steel rungs embedded in the concrete at regular intervals to help the inspecting officials descend/ climb the sub structure shown in figure 15 above.
- (c) **Arrangement for Flood records:** In certain bridges, the scour readings and the flood levels are recorded for gauging purposes. Suitable cradles supported on the girders or piers shall be provided for this purpose.

6.4 Temporary inspection arrangements: Some bridges require temporary arrangements for carrying out inspections. Also, the inspection vehicles and permanent arrangements may have

to be supplemented by temporary inspection arrangements like ladders, scaffolds, challis etc, which are removable. Temporary arrangements are also required where some defect has been identified for further diagnostic and repair works. The temporary arrangements are made of light weight material and in small lengths for ease of transportation. These are transported to the bridge site, erected in position and removed after the inspection work is over. Aluminum and bamboo are best suited material for temporary inspection arrangements. Ropes and bolts are generally used for erection/ tying purposes. These structures offer absolute flexibility at site and if the basic material is available, any part of the bridge can be inspected/ accessed. However, erecting these structures is a specialized job requiring lots of time and physical efforts. Sometimes, labour erecting the temporary arrangement needs to be sent in advance of the inspecting officials, so that the time of inspecting officials is not wasted. These arrangements suffer wear and tear with repeated use and require regular maintenance. Different types of temporary arrangements are:



Figure 16: Rope and bamboo ladders



Figure 17: Steel/ bamboo scaffolding hung from the girder



Figure 18: Scaffolding erected from ground/sub structure



Figure 19: Aluminium Ladders of Folding and non-folding type

These arrangements are suitable in the following conditions:

- **Bridges having accessible river bed and moderate height:** For bridges having girder bottom to river bed distance in the range of 7-8 m, ladders and temporary scaffolds can be conveniently used. Beyond this height, the ladders become too unwieldy and unsafe for the inspecting officials.
- **Inspection of Specific areas:** Defects are sometimes seen in bridge members and these are required to be inspected more closely for taking the detailed observations, drawing sketches and marking the defects. For such specific areas, scaffolds/ ladders may be used. The temporary arrangements thus supplement all other type of arrangements.
- **Isolated Bridges located in sections** where other inspection system such as rail/ road mounted vehicle are too costly, temporary arrangements may be the only feasible option.

Suitable materials for temporary Inspection Arrangement: Ropes are used to secure temporary arrangements to the bridge. The ropes can be normal Manila type or polypropylene type. Manila ropes have lesser life and require to be replaced frequently, especially if they get wet. Polypropylene ropes are durable and don't get affected by water easily. Other type of ropes/ tying materials can be used as found suitable. The materials for temporary arrangement shall be light weight and materials like

bamboo, aluminium etc are quite suitable. Bamboo is cheap and strong but not so durable. Aluminium is sturdy and durable and gives good confidence to the inspecting officials.

Care needs to be exercised in erecting the temporary inspection arrangement to ensure that the knots in the ropes are made properly and don't open out easily. Also the ropes shall also not be loose as the swinging arrangements might lead to rubbing of ropes with the structure and can lead to breakage. Before erecting any temporary arrangement, the condition of all components shall be closely examined to ensure safety of the personnel involved.

7) Action to be taken if inspection arrangements are not possible/ not available: If the inspection arrangements have not been provided, or provision of inspection arrangement is not possible due to any reason, one of the options available for inspection of inaccessible areas is to use binoculars. This solution is acceptable for small inaccessible areas, however the use of binoculars for inspecting large areas is very tedious for the inspecting officials. The inspecting official loses perspective of the bridge component when inspecting with binoculars, and consequently, the quality of inspection suffers. The use of binoculars for inspection, therefore, is recommended for small areas or as an interim measure only.

8) Comparison of Different Approaches to Inspection Arrangements: The comparison of the three approaches in respect of various variables is as follows:

	Variable concerned	Permanent Arrangement	Temporary Arrangement	Mobile arrangement on	
				Track	Road/Boat mounted
1)	Initial Cost (Capital)	Moderate	Low	High	High
2)	Initial Cost (Per Bridge)	Highest	Average	Low	Very Low
3)	Labour Required	Least	Highest	Moderate	Moderate
4)	Wastage of labor	Least	Moderate	High	Least
5)	Ease of Use	Most Convenient	Inconvenient. If care is not taken during installation, may infringe moving dimensions.	Inspection is convenient, however the movement of vehicle, availing of block, and other logistics are very inconvenient and time wasting.	Convenient
6)	Maintenance of arrangements	Low	High	Very High	High
7)	Public Nuisance due to arrangement (including security concerns).	High especially in city and other vulnerable areas. Chances of theft are also there.	Nil.	Nil	Nil
8)	Feasibility	Feasible at all bridges. Need to be designed to be away from Maximum Moving Dimensions.	Mostly feasible, efforts for erection vary from bridge to bridge. More problematic in concrete bridges.	Feasible. Accessibility is not an issue as the vehicle can go anywhere if track is there.	Feasible only if road access is there or sufficient water is there for boats to ply
9)	Time taken for Inspection	Least	Moderate	High	Moderate

	Variable concerned	Permanent Arrangement	Temporary Arrangement	Mobile arrangement on	
				Track	Road/Boat mounted
10)	Traffic block requirement	Nil	Low	High	Low or Nil
11)	Confidence of Inspecting officials	High	Low	High	Moderate
12)	Other Issues	a) Cannot cover the entire area but only critical areas, which is adequate for most of the bridges b) Are required to be supplemented by temporary arrangements and binoculars etc. c) Helps in maintenance activities such as painting repairs also.	a) Can be erected anywhere, especially where problems have been detected and these are to be studied in detail/ close up. b) Labour required is high for setting up, shifting etc and leads to wastage of time. c) With wear and tear due to repeated use, the arrangements are required to be repaired/ replaced regularly. Care needed in maintenance.	a) Equipment for inspection/ testing can be carried in the vehicle and this will help in better inspections b) Track occupation will be required for inspection and will severely restrict the time available for inspections.	a) Equipment for inspection/ testing can be carried in the vehicle and this will help in better inspections b) Cannot be used for very large heights c) Cannot be used if boats cannot ply due to fast/ rough current or low water depth.

9) Recommendations on Inspection arrangement to be Chosen:

As seen above, all the approaches to providing the inspection arrangements have their own advantages and disadvantages. One approach cannot be specified as solution for all the circumstances and decisions have to be taken for each section/bridge separately. The suitability of inspection arrangement shall be decided after taking holistic view for **each section** based on various factors enumerated above. In each section a predominant method of inspection shall be specified. However, individual bridges in a section may have different arrangements as per local site conditions. The main guiding factors shall be good quality of inspections and economy. The arrangements shall be provided at the optimum level.

As guidance, the broad recommendations for providing the inspection arrangements shall be as follows:

- 9.1 Sections having bridges with **low to moderate heights**, only **temporary arrangements** are sufficient for inspection purposes.
- 9.2 If section has **few bridges with abnormal heights** or inaccessible river beds, the **permanent arrangements** shall be provided in these bridges.
- 9.3 The sections where **traffic is more and/or the bridges are more in number**, the arranging of blocks for the rail mounted inspection vehicle shall be very difficult. In such sections, the **on road inspection vehicle or permanent arrangements** shall be provided depending on whether

road access is available or not. The choice between vehicle and permanent arrangement shall be governed by whether the investment on the vehicle is justified or not looking at the workload.

9.4 The **rail mounted inspection vehicle** shall be provided in sections where the **traffic block is easy** to be granted, where **the river bed is not accessible** or the bridges are high.

9.5 If the traffic is high, and the river bed is inaccessible, permanent arrangements shall be planned. The choice between vehicle and permanent arrangement shall be governed by trade off between the cost and the feasibility of blocks being granted.

9.6 **Other issues:** There are some bridges where side pathways are demanded by the locals for crossing the river and have been provided by the railways. These pathways, and other arrangements like trolley refuges/ man refuges etc, shall be dovetailed into inspection arrangements required for the bridge inspections.

10) Design of inspection arrangements:

10.1 The inspection arrangement shall be so planned as to provide access to all parts of bridge within 3-4 m of eye and shall not obstruct the inspection of bridge components.

10.2 The quality of inspections depends on sturdiness of the inspection arrangement provided. Therefore, temporary or permanent inspection arrangements shall be properly designed and there shall be no undue vibrations or sagging of the members under normal loads. At least 2-3 persons with some tools are expected to use a typical inspection arrangement. The connections of inspection arrangements shall be sturdy enough to withstand these loads.

10.3 While using temporary, permanent or mobile inspection arrangements, the protection gear such as helmets, anti-skid protective shoes etc and use of safety belts shall be mandatory. Safety of the personnel shall be of paramount importance.



Figure 20: Temporary cradle erected from the hand railing. The hand railing shall be properly designed if such arrangement is to be used.

10.4 The stresses on bridge components due to erection of the temporary or permanent inspection arrangements shall be computed and checked (See Figure 19). Also, there shall be

no local damage to the members such as abrasion of edges of the elements during repeated use.

10.5 While designing/ planning the inspection arrangements, the maintainability aspects must be kept in mind.

10.6 For new bridges/rebuilding works inspection arrangements shall be planned in advance, at the GAD stage and provision for the hooks, rungs etc to fix temporary and permanent inspection arrangements on the girders/substructure shall be made while casting/fabrication itself.

11) Maintenance of the inspection arrangements shall be the responsibility of the bridge officials using that component. For example if superstructure of a bridge is under the SE(Br), the ladders, cradles etc on the same shall be the responsibility of the SSE(Br) and any arrangement on the sub structure shall be the responsibility of the SSE(W)/ SSE (P Way) who maintains the sub structure.

12) Tackling anti-social elements: There is genuine fear that the permanent inspection arrangements on bridges can be misused by anti-social elements. These can be misused to gain access to various parts of bridges and can be used for sleeping, anti-social tasks such as gambling or may even be used for sabotage of the traffic. The permanent arrangement shall be planned with care in areas known to be prone to such activities. To enable the permanent arrangements to be used for the railways' use but not for the antisocial elements, the innovative local solutions shall be adopted. Some of these are:

- **No ladder** within 4 m of the pier/ ground level policy can be adopted. The inspecting officials can bring a folding ladder of 4 m length and use the same to access the inspection arrangements. The folding ladder can be of bamboo or aluminum. Folding ladders can be such as to be carried in trains easily by the staff.



Figure 21: Folding aluminium ladder

- **No flooring** in the walkways can be adopted so that nobody can sit on these. The inspecting officials shall bring portable flooring members made of bamboo or aluminum and, fix them on the walkway supports before start of inspection.
- **Anti- theft measures:** Another threat to the permanent arrangements is from theft. Any structure fixed to the structure shall be secured properly by welding/ nuts with damaged threads etc. These anti- theft measures shall be strong enough to withstand the normal efforts at theft.

13) Conclusion: The planning of inspection arrangements is a vital area which requires careful thought and planning. With better inspection arrangements, the inspection results are likely to be more reliable. This can lead to a more proactive approach to bridge health management on Indian Railways.

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