

Chapter 1 - Review on 'Maintenance of Bridges in Indian Railways'

Executive Summary

Across Indian Railways, there were over 1.36 lakh railway bridges, which constitute an essential part of the Railway network. The existence of a large number of very old bridges identified as due for rehabilitation/ reconstruction is a concern for safe train operations. The Corporate Safety Plan (CSP) of IR (2003-2013) envisaged progressive rehabilitation/ rebuilding of bridges over IR on condition basis by providing funds through normal plan outlay. The CSP also focused on the need for modernizing bridge management system – modernization of inspection, and maintenance of bridges.

The review was conducted to see whether the mechanism for identification and planning for rehabilitation/ reconstruction of railway bridges was effective and efficient; and rehabilitation of bridges was carried out as envisaged in the Corporate Safety Plan. It was also seen whether inspections for maintenance of bridges were adequate and efficient.

Some of the key audit findings discussed in this review are mentioned below:

- During test check of 102 bridgeworks pertaining to 150 bridges, Audit noticed that in 31 bridgeworks, Railway Board took on an average 43 months to sanction the bridgeworks after its identification for rehabilitation.
- Railway Board fixes targets for rehabilitation of bridges based on the proposal and monetary limit provided for the Zone. During the last four years (2010-11 to 2013-14), as against the target of 3433 bridges for rehabilitation, Audit noticed shortfall in achievement of target (245 bridges) in nine zones ranging between 2 bridges in WR and 80 bridges in NR.
- While across IR, bridgeworks for rehabilitation of all the three bridges of category I and 45 bridges of category II¹ were sanctioned by Railway Board during 1999-2000 to 2012-13, in respect of other category (where bridges are marked for major/special repair or routine maintenance during inspection), bridgeworks of 598 bridges (13.20 per cent) out of 4529 bridges, were yet to be sanctioned by Railway Board (March 2014).
- Out of the bridgeworks of 3979 bridges, sanctioned by Railway Board, bridgeworks of 710 bridges (three of category I, four of category II and 703 of other category) remained to be completed as on March 2014 after expiry of prescribed period of one/four years (one year in case of Category I and four years in case of Category II and others). In test check of 102 bridgeworks (150 bridges), average delay of 41 months, ranging between 8 months (SECR) and 105 months (ECR), was noticed.
- Delays in sanctioning of bridgeworks and completion of sanctioned bridgeworks resulted in operation of train services with speed restriction.

¹ Category I and II are assigned during the inspection of bridges based on the condition of bridges. Category I bridges required to be rehabilitated within one year and category II bridges should be rehabilitated in programmed basis.

Instances of continued operation of speed restriction were noticed on 87 bridges of 13 Zones ranging between four to 591 months. Audit assessed an extra expenditure of ₹103.40 crore on account of operational cost due to continuation of speed restrictions.

- Bridges made of Early Steel/ Crew pile/ Cast Iron were considered to be prone to brittleness and hence had to be phased out by end of 2013 as per CSP projections. The review revealed that as on March 2014, out of 147 bridges due to be phased out, 96 bridges of these types still existed over five Zonal Railways.
- Budget Grant for bridgeworks was provided to Zonal Railways annually under Plan Head 32 of Major works. Review revealed that Budget Grant provided to Zonal Railways for bridgeworks was less (average shortfall ₹213.69 crore per year) than that of Budget demanded by Zonal Railways. Review further revealed that even Budget provided was not fully utilized. Average under utilization of ₹60.95 crore per year was noticed in the review.
- The objective of conducting bridge inspection is to assess the condition of bridges and take corrective remedial measures such as maintenance, rehabilitation, rebuilding etc. Review revealed shortfall in adherence to scheduled inspection of bridges by various levels of inspection authority to the extent of 32.19 per cent. This shortfall may result in a serious bridge condition going unnoticed.
- In its recommendations, CSP envisaged use of modern techniques during inspection of bridges. As such, Railway Board prescribed use of 20 different modern equipments during inspection. Review revealed that over IR, though 290 equipments have been procured in different Zones, utilization of these equipments during inspection of bridges was only 7.07 per cent which defeated the purpose of strengthening of inspection techniques.

The above demonstrates the casual approach on part of Railways in sanctioning/executing and monitoring of bridgeworks. This resulted in delay in execution of bridgeworks that were identified for rehabilitation leaving the possibility of compromising passenger safety during operation of train services on these bridges. Railways need to ensure an effective monitoring system to be in place for timely execution and completion of bridgeworks.

1.1 Introduction

Across Indian Railways (IR), there were over 1.36 lakh bridges out of which, 741 were classified as important, 10,944 as major and 1,25,035 as minor bridges².

As per Indian Railway Bridge Sub-structure and Foundation Code, important bridges are those which have a linear waterway of 300 meters or a total waterway of 1000 sqm. Major bridges have a total waterway of more than 18 m. or which have a clear opening of more than 12 m or more in any span. The rest are minor bridges.

² Source – Indian Railway Yearbook 2012-13.

Out of 1,36,728 bridges over IR network, 36,470 (26.67 per cent) were over 100 years old of which 6,680 bridges located in eight zones³ were over 140 years, 14,324 bridges were 81 to 100 years old, while 15,637 bridges were 61 to 80 years old. The balance 70,297 bridges were less than 60 years old.

The Corporate Safety Plan (CSP) of IR (2003-2013), inter-alia envisaged planned rehabilitation of bridges duly providing funds through normal outlay. The CSP also focused on the need for creating a bridge management system, modernization of inspection and maintenance of bridges etc.

A High Level Safety Review Committee headed by Shri Anil Kakodkar recommended (February 2012) instrumentation of all bridges and use of advanced scientific measurements and inspection for condition assessment. In this backdrop, a review was conducted on maintenance of bridges in IR.

1.2 Previous Audit Report

A review on Rehabilitation/ Rebuilding/ strengthening of Railway Bridges was printed as Chapter IV in Comptroller and Auditor General of India (C&AG's) Report (No.9 of 2003), wherein Audit commented on substantial delays in rehabilitation of bridges identified for rehabilitation for both categories of bridges (Category I & II)⁴. Shortfall in scheduled inspections was also noticed in audit. In its Action Taken Note, Railway Board stated (June 2008) that rehabilitation of distressed bridges other than category I would normally require three to four years for completion after sanctioning bridgeworks. All bridgeworks of over four years after sanction are specially monitored upto highest level. Audit again reviewed the status of maintenance of bridges over IR with the following audit objectives.

1.3 Audit objectives

The review on 'Maintenance of Bridges on IR' was conducted to see whether-

- the mechanism for identification and planning for rehabilitation/ reconstruction of railway bridges was effective and efficient
- rehabilitation of bridges was carried out and completed as envisaged in the Corporate Safety Plan 2003-2013
- inspection and maintenance of bridges was adequate and efficient

1.4 Audit criteria

Following were used as criteria for conducting audit:

- Provisions in Indian Railway Bridge Manual (IRBM) regarding maintenance/ rehabilitation/ reconstruction of distressed bridges
- Action Taken Note on Audit Para on 'Rehabilitation/ rebuilding/strengthening of Railway Bridges in Indian Railways' (Railway Audit Report No.9 of 2003).
- Indian Railway Finance code Vol.I (Para No.219).
- Underwater Inspection (UWI) Booklet issued by Indian Railway Institute of Civil Engineering (IRICEN) in regard to UWI.

³ ECR, ER, NCR, NR, SER, SR, WCR and WR

⁴ Categorization of bridges was done on the basis of ORN number marked for the bridge during inspection as discussed in Para 1.7.1.1. ORN No. 1 belong to Category I, No.2 belong to Category II bridges

- Projections made in Corporate Safety Plan (CSP) and Indian Railway Modernization Plan (IRMP) regarding rehabilitation/ rebuilding of identified bridges and modernization of repairs and rehabilitation activities.
- Recommendations of High Level Safety Review Committee headed by Anil Kakodkar in its report published in February 2012.
- Instructions issued by RB from time to time in relation to maintenance/ rehabilitation/ reconstruction of railway bridges

1.5 Audit scope, methodology and sample

Records of Railway Board, Civil Engineering department of Zonal Railway and of the Construction Organization of 16 Zonal Railways relating to reconstruction/ rehabilitation of bridges, inspection and maintenance etc. were reviewed. Records available in the offices of Deputy Chief Engineer/Construction, Assistant Divisional Engineer, Senior Section Engineer/ Permanent Way, Senior Section Engineer/ Bridges and Senior Section Engineer /Works of all the Zonal Railways were also reviewed by Audit. In the context of maintenance of bridges, identification is carried out in terms of bridges, whereas the proposals and sanctions for the rehabilitation/ reconstruction are given in terms of bridgeworks. One bridgework may contain one or more bridges.

For conducting audit, all the new bridgeworks sanctioned as well as bridgeworks in progress during the review period were taken into account. The total population of bridgeworks across the 16 zones was 225 and these pertained to 476 bridges. The details of sample selection are as under:

- For review of bridgeworks including system of identification for rehabilitation/ reconstruction over IR, 102 bridgeworks comprising 150 bridges were selected;
- For adherence to inspection/ maintenance schedule, two divisions in each zone were selected to review the inspection done by one Sr. Section Engineer (Bridges), one Sr. Section Engineer (works), one Sr. Section Engineer (P.Way) and one Assistant Divisional Engineer in each division;
- For adherence to Underwater Inspection schedule, audit selected two Sr. Section Engineers (Bridges) in each zone

The Review was issued to Railway Board on 27-01-2015. Railway Board's response has been received on 27-04-2015 and suitably incorporated in the review. Responses of Zonal Railway Administration have also been incorporated in the Para. Exit conferences were conducted with respective Zonal Railway Administrations between September 2014 and January 2015. An Exit conference was also conducted with officers of Railway Board on 16 April 2015.

1.6 Audit findings

1.6.1 System of identification and planning for rehabilitation/ reconstruction of bridges

The process of identification of bridges for rehabilitation /reconstruction is specified in the Indian Railway Bridge Manual, which is as under:

Bridges are subjected to Inspection by various levels of officials in the Civil Engineering department of Zonal Railway. Any Railway Bridge has seven components viz.,

- (i) foundation and flooring,
- (ii) substructure,
- (iii) training and protective works,
- (iv) bed blocks,
- (v) bearing and expansion arrangements,
- (vi) super structure and
- (vii) track structure.

In a bridge, one or more of these components may be many in number. On assessing the condition of each member of these components during inspection, the inspecting official assigns CRN (Condition Rating Number) for each member of these seven components of the bridge. The CRN number ranges from 0 to 6 where,

- 1 denotes condition warranting immediate rehabilitation/ reconstruction;
- 2 denotes condition requiring rehabilitation/ reconstruction on programmed basis;
- 3 denotes condition requiring major/ special repairs;
- 4 denotes condition that requires routine maintenance;
- 5 denotes sound condition;
- 6 denotes not applicable; and
- 0 denotes component not inspected.

- For example, if a bridge had two Piers, three spans and two bed blocks, 7 CRNs are assigned, like 4,0,4,3,5,3,4. The ORN (Overall Rating Number) of the Bridge is the least of the 7 CRNs except 0 which in this case is 3 which denotes that bridge requires major/ special repairs. (Para No.1103 of IRBM)
- If the ORN of a bridge is 1, the Bridge would be classified as “Distressed Category-I” which, in terms of Para 504 of IRBM requires to be rehabilitated within a year’s time.
- If the ORN of a bridge is 2, the bridge would be notified as “Distressed Category-II” in which case, the bridge has to be taken up for rehabilitation on programmed basis.
- Other bridges assigned a rating of ORN 3 or 4 during inspection by the Railway officials are marked for major/ special repairs or routine maintenance respectively.

Further, as per Para 504 of IRBM for rehabilitation / reconstruction, the bridges were classified⁵ as:

1. Distressed bridges – Category-I – required to be rehabilitated within a period of one year.
2. Distressed bridges – Category-II – required to be rehabilitated within a period of four years on a programmed basis.

⁵ Source – Indian Railway Bridge Manual.

3. Bridges other than distressed bridges requiring rehabilitation / reconstruction on condition basis.

Railway Board informed (November 2014) that vide advance correction slip No.30 issued by Railway Board, the above Para was deleted, where provision existed for categorization of bridges as distressed bridges as I, II and others. However, in the revised Para 503, it was stated that rehabilitation of bridges would be done on the basis of ORN number assigned during the inspection giving the priority of the condition of the bridges.

For rehabilitation/ reconstruction works of bridges, the following officers are charged with the responsibilities from identification of bridges for rehabilitation/ reconstruction to final approval as shown in the following diagram.

Table 1.1

Responsibility level	Responsibility assigned
Field Level	
Sr. Section Engineer (SSE) (Bridges) Sr. Section Engineer (Works) Sr. Section Engineer (Permanent Way)	Inspection of bridges and recording of condition rating as 1,2,3,4 etc. by SSE/ ADEN
Divisional Level	
Assistant Divisional Engineer (ADEN)	Inspection of bridges with condition rating 1 or 2 or 3 to revise or confirm the rating by the Divisional Engineer.
Divisional Engineer (DEN)	Prioritization of bridge rehabilitation works by Divisional Administration based on severity of distress.
Sr. Divisional Engineer (Sr. DEN) (Co-ordination)	Preparation of plans by the Divisional Administration for rehabilitation and submitting the same to zonal HQ for approval by competent authority.
Zonal Level	
Chief Bridge Engineer (CBE)	Shortlisting of proposals by CBE in consultation with PCE and forwarding the same to RB based on condition of bridges but limiting to monetary cap fixed by RB.
Principal Chief Engineer (PCE)	
Railway Board Level	
Executive Director (Bridges & Structures)	Approval of bridgeworks by RB based on priority-listing by zones but limiting to resource available.
Member Engineer	Communication of approval by RB to the zones for execution of the rehabilitation work.
Chairman Railway Board	

From the records of RB (Annual Works programme issued by RB), Audit observed that RB pruned down proposals of bridgeworks submitted by Zonal Railways

keeping in view the monetary resources available for a particular year for bridgeworks over IR.

Audit reviewed the records of Zonal Railways pertaining to proposals submitted by Zonal Railways and sanction of bridgeworks by RB and it was noticed that, during the period from 2010-11 to 2013-14, the ZRs shortlisted recommendations received from field offices and forwarded proposal for 2694 works at an estimated cost of ₹3559.10 crore to RB for approval. As against this, RB approved 1953 bridgeworks (72.49 per cent) estimated to cost ₹2195.85 crore (61.70 per cent).

Audit further observed that-

- The system of identification of bridges for rehabilitation provides that bridges are identified for rehabilitation based on condition assessed during inspection at field level (SSE/ ADEN) and further confirmation by next higher level officials (DEN/ Sr. DEN). Despite this, restricting the proposals (at CBE i.e. zonal level and RB level) on monetary considerations defeats the very purpose of the system of identification. This led to compromising the safety of train services on the bridges, identified for rehabilitation due to sanction not being accorded or delayed sanction.
- A sample check by Audit on 102 bridgeworks pertaining to 150 bridges revealed that, in case of 31 bridgeworks (which included category-I and category-II bridges also), on an average, RB took 43 months to sanction the bridgeworks after identification by the zonal railways.
- The average time taken for sanction of a bridgework was as high as 131 months in NCR followed by CR (57 months), ECoR (55 months), SER (54 months) and average delay of 30 months each in SR and WCR.
- Delay in completion of bridgeworks also caused continuation of speed restrictions on the bridges that led to extra operational cost as discussed in Para 1.6.2.5).

In reply, Railway Board stated that the works proposed for RB's sanction (more than ₹one crore) are examined based on the information furnished by respective zonal railways such as justification of the work, cost of work, existing throw forward, likely bridge allotment, available time allowance etc. They also stated that depending upon the availability of funds and resources, the works required from safety considerations are given topmost priority. The safety of train operations is never compromised. If the corrective/ remedial measures are expected to take a long duration due to complexity of the site situation, etc., suitable safety measure like imposing speed restrictions and keeping such bridge under close watch are taken till the rehabilitation of the bridge.

The above replies cannot be acceptable as Zonal Railways themselves prioritise bridgeworks at CBE/PCE level based on safety considerations identified during the inspection and proposals are submitted to RB accordingly. Further, the works pertaining to the bridges categorised as distressed category-I & II (ORN rating 1 and 2 respectively) took substantial time for sanction and delayed the execution as discussed in Para 1.7.2.2. Imposition of speed restriction has been termed as a remedial measure to ensure safety. But it involves huge additional expenditure on

account of extra operational cost as noticed during a study conducted in SCR. As such, delay in sanctioning of bridgeworks and limiting the proposals of bridgeworks based on financial constraints not only compromise the safe train operations but also result in extra financial burden.

1.6.2 Status of Rehabilitation/ Reconstruction of Railway Bridges

Audit examined the overall position of achievement of targets for rehabilitation/ reconstruction of bridges over IR, the overall status of execution of rehabilitation/ reconstruction of bridges and in detail reviewed the execution of 102 selected bridgeworks (involving 150 bridges). Audit findings in this regard are given in the following sub-paragraphs-

1.6.2.1 Achievement of target for rehabilitation/ reconstruction of bridges

Audit observed that, annual targets were fixed by RB for rehabilitation/ reconstruction of railway bridges for each zone based on the sanction given for bridgeworks and also keeping in view the Budget Grant provided for bridgeworks for the particular year.

Scrutiny of records relating to rehabilitation works carried out over IR as against targets fixed by RB during the years from 2010-11 to 2013-14 as elaborated in **Annexure I** and noticed that-

- Against the overall target of rehabilitation works of 3433 bridges in 16 Zones over IR, 3292 bridges were rehabilitated leaving shortfall of 141 bridges. While in nine zones⁶, shortfall in achievement of target (245 bridges) was noticed, in the remaining seven Zones⁷, no shortfall was noticed. In five Zones ((CR, ECoR, ER, NFR and NWR), bridges were rehabilitated in excess of the target set for these Zones.
- The shortfall in achievement of target was highest in NER (52.63 per cent) followed by NR (42.78 per cent), WR (23.17 per cent), ECR (22.88 per cent), SR (21.51 per cent).
- The reasons attributed by Zonal Railway Administrations for the shortfall in achievement of targets were, paucity of funds, non-availability of line block, encroachment/ eviction problems involved etc.

In reply RB stated that for the period from 2010-11 to 2013-14, against overall target of 3310 bridges, 3666 bridges have been rehabilitated. However, in the table given in the reply, it was given as progressed against the stated target. As such it is not clear whether all the bridgeworks progressed, as shown in the table, were completed or not. Moreover, the figure calculated by Audit regarding shortfall in achievement of target was based on the data given by the Zonal Railway Administrations during audit.

(a) Overall position of pending bridgeworks

Across IR, three distressed category-I bridges were identified (one in 2002 and other two in July 2009) and all the three bridges were pending to be rehabilitated/

⁶ NER, NR, WR, ECR, SR, NCR, SECR, SER and WCR

⁷ CR, ECoR, ER, NFR, NWR, SCR, SWR

reconstructed as on 31 March 2014 though as per IRBM provision the works should have been completed within a year of sanction.

In regard to distressed category-II bridges, out of 45 bridges identified⁸, four bridges (one each in ER, ECoR, ECR and SECR) remained to be rehabilitated (March 2014) beyond the period of four years after sanction (between 1999 and 2005).

In other than distressed category I- & II category (ORN rating 1 and 2 respectively), there were 4529 bridges over IR. Out of these 4529 bridges, in respect of 3931 bridges, sanction for rehabilitation was accorded by RB as on March 2014. Out of these 3931 bridges for which sanction was accorded, in case of 703 bridges, rehabilitation works were not completed even after four years of sanction as of March 2014.

1.6.2.2 Review of execution of 102 bridgeworks relating to rehabilitation/reconstruction

The total population of new as well as ongoing bridgeworks relating to the review period was arrived at as 225 which included 476 bridges. Out of this, Audit reviewed 102 bridgeworks (relating to 150 bridges).

Out of 150 bridges included in the 102 bridgeworks selected for check, there was one distressed category-I bridge, eight distressed category-II bridges and 141 bridges in 'others' category.

Out of 102 bridgeworks selected for check, 19 works had not even commenced as of 31 March 2014. These 19 works included eight works, for which sanction was given during 2003-04 to 2011-12 and four works were sanctioned during 2012-13. Execution of the remaining 83 bridgeworks are discussed in the succeeding sub-paragraphs-

(a) Execution of works relating to distressed Category-I Bridges

In terms of Para 504 of IRBM, distressed bridges category-I, which were assigned URN number 1 during the inspection, are to be rehabilitated within one year.

A bridge of category I located in Ernakulam – Cochin Harbour Terminus section of SR was identified in 2002 for rehabilitation and the work was sanctioned in 2002-03. However, the execution of rehabilitation work remained to be completed (March 2014) even after expiry of more than ten years of sanctioning.

Audit noticed that, error in preparation of estimate in the initial stages, problems in acquisition of land from Defence authorities, termination/ foreclosure of two contracts, delay in shifting of service lines etc. caused the delay.

The delay in execution at various stages were as under-

- ❖ there was delay of five months due to delay in the finalisation of tender and award of contract,
- ❖ change of scope of work after award of contract caused a delay of six months,

⁸ Identified during the review period as well as during earlier periods.

- ❖ delay in handing over of site free from encumbrances accounted for 22 months time over-run,
- ❖ termination and re-award of contracts took 24 months, and
- ❖ for various other reasons, there was time loss of 46 months.

Additionally, Audit also reviewed the other two category I bridges, located in Bhavnagar division (Botad –Sabarmati Section) of WR.

These two bridges were identified as distressed category-I in July 2009 by WR officials. RB however accorded sanction for rehabilitation only in 2012-13 i.e., after more than two years of identification. Audit further noticed that works in respect of these bridges were completed in May 2014 and August 2014 i.e. Railway took more than one year to complete the works. Speed restriction was, however, imposed on these bridges in July 2009, which had to be continued till the completion of works in May/ August 2014.

Audit also noticed that on the section (Botad –Sabarmati Section) where these two bridge existed, 10 passenger trains (five Up and five Down direction) were operated daily. As such, delayed sanction and completion of works in case of these bridges clearly indicates non-prioritization which might endanger safety of travelling passengers in addition to the extra operation cost due to imposition of speed restriction.

In case of bridgeworks in SR, RB itself accepted that the said bridge is an important bridge and stated that during execution of work, lot of complications arose such as land acquisition, shifting of utilities, contractual issues which could not be foreseen and were beyond the control of railway administration. RB further stated that depending upon the scope of work and other activities involved, the time required for rehabilitation can range from one year upto several years and in the instant case bridge construction has been completed and will be commissioned shortly. In case of WR, it was contended that the bridgeworks were planned to be taken up in anticipation of gauge conversion work to avoid the duplicity of work and wastage of public money. In view of delay in sanction of gauge conversion project and deteriorating condition of slab, the work was sanctioned in 2012-13 and completed subsequently.

Railway Board's contention that the problems associated with land acquisition, shifting of utilities etc. could not be foreseen and were beyond the control of Railway Administration seem to be an afterthought as RB itself instructed (1972, and from time to time) that all pre-requisites for a work have to be completed before commencing execution of a work. Specifically, land free from encumbrances should be ensured before commencing the work. Further, in case of WR, Railway took more than two years in sanctioning of bridgework of category I bridge i.e. where ORN 1 was assigned during inspection. The response of RB that rehabilitation was delayed due to gauge conversion work only confirms that critical condition of the bridges impacting the safety of the passengers was not given due importance in spite of the fact that 10 passenger trains are running daily on the section.

Moreover, RB's contention that "time required for rehabilitation can be ranging from one year up to several years" is a clear indication that RB has not fixed any specific time frame for execution of such safety related works in the absence of which, accountability at execution level cannot be ensured. With better planning and effective monitoring in execution, the works could be executed within specific time frame.

(b) Execution of works relating to distressed Category-II and "other than distressed category-I & II" bridges

As per para 504 of IRBM, Distressed bridges other than category-I & II are required to be rehabilitated on a programmed basis. RB stated (June 2008) in its Action Taken Note on Audit Para on 'Rehabilitation/ rebuilding/ strengthening of Railway Bridges in Indian Railways' printed in C&AG's Report (No.9 of 2003) that, the rehabilitation/ reconstruction of these category of bridges would be completed within a period of four years after sanctioning of works.

Execution of 82 bridgeworks pertaining to rehabilitation/ reconstruction of eight distressed category-II bridges and 141 bridges of "other than distressed category-I & II" category was reviewed by Audit in detail. In absence of any benchmark mentioned in the IRBM or elsewhere in respect of time to be taken for each activity/ stage of execution of bridgeworks, audit assessed the time taken by Railway Administration in completion of each stage of execution of bridgework. Details of time taken at each stage are elaborated in **Annexure II**. Audit noticed that -

- The average time taken per work in the commencement of work was assessed by Audit as 33 months. Average time taken per work for commencement was highest in ECR (82 months) followed by SR (55 months), NCR (51 months), CR (41 months), WR (37 months), SER (36 months), ER (30 months), WCR (15 months), NR (11 months) and so on.
- Average time taken per work for finalization/ approval of plans and drawings was seven months per work (NWR, ECoR, WCR, NR and NCR).
- Average time per work taken in the finalization of tenders and award of contract was 12 months in CR, NWR, NCR, SWR, ECoR, NR, ER and WCR.
- Average time lost per work was assessed by Audit as three months due to award of contract without properly assessing the capability of contractor (SR and SER). Termination and re-award of contract led to average loss of five months per work in ECR, NR, ER, SR and WCR.
- Change in the scope of work after award of contract resulted in an average time loss of 9 months per work in NCR and NR and two months per work in NFR.
- Failure to hand over site free from encumbrances to contractor caused average delay of one month per work in NR.
- Paucity of funds led to average delay of two months per work in NWR, ECoR and WCR.

- Non-availability of line block caused an average delay of two months per work in SR and SER.
- In all, in the 82 bridgeworks commenced and in-progress during the review period, execution suffered an average delay of 41 months per work on various counts. The cost overrun in these 82 works was assessed at ₹192.69 crore.

The above findings clearly showed that, poor planning and improper contract management on the part of Zonal Railway Administrations caused inordinate delay in execution of rehabilitation/ reconstruction of bridges at various stages of execution culminating in the overall delay in execution of rehabilitation works.

Railway Board contended that the rehabilitation/ rebuilding may take several years and it cannot be generalized. Some isolated cases may take more than four years also because of reasons beyond control of the railway administration.

Railway Board's contention that bridge rebuilding /rehabilitation may take several years is a general reply and is not acceptable. For any work there should be a specific time frame and executive in charge should be accountable for the delay. Moreover, bridgeworks are important works and delay in execution of bridgeworks pertaining to bridges identified for rehabilitation are threats to loss human lives and railway assets. Further, "Reasons beyond the control of Railway administration" is not an acceptable statement, as Railways are sole responsible for timely completion for bridge rehabilitation works, identified solely during the inspection at field level. With better planning and effective monitoring during execution of bridgeworks, Railways should be able to complete works within specific time frame.

RB should fix specific time frame for each milestone in the execution of bridgeworks and also for completion of the bridgework as a whole so as not to compromise on the safety of human life and railway assets.

1.6.2.3 Rehabilitation/ reconstruction of bridges within their codal life

It was noticed in Audit that, during conduct of inspection by zonal Railways during 2010-11 to 2013-14, 42 bridges were found to have become due for rehabilitation within their codal life. Out of these 42 bridges, 37 were located in SWR alone and

As many as 42 bridges were identified for rehabilitation/ reconstruction within their codal life over IR.

in other five zones (NR, ECoR, SER, SR and WR) there was one bridge in each zone. This pointed to premature rehabilitation

necessitated due to poor maintenance.

In the case of SR, Railway Administration admitted (July 2014) that more frequent painting of girders was necessary considering the adverse environmental condition to avoid heavy corrosion. This implies that, there was inadequacy in maintenance of the bridge which resulted in premature rehabilitation.

In regard to SWR, Audit observed on review of zonal Railway records that, rehabilitation works were carried out to strengthen the bridges by re-girding and replacement of steel girders to meet RDSO standards. Audit noticed that out of 37 bridges identified for rehabilitation within codal life, rehabilitation works in respect of 11 bridges were completed by March 2015 and works in respect of 26 bridges

were in progress. From the review of records of SWR Administration, it was noticed that delay in completion of bridgeworks in these cases was mainly due to delay in fabrication of girders and non-supply of girders by Civil Engineering Workshop at Arakkonam of SR.

In respect of NR, ECoR, SER and WR, increased water flow, washing away of bridge girders in one case, use of old girders during gauge conversion etc. were stated by the zonal Railways as reasons for premature rehabilitation.

Railway Board stated that these cases of rehabilitation within the codal life are not due to poor maintenance but other reasons such as increased loading standards, inadequate water way due to change of pattern of flow in the catchment area, excessive corrosive conditions etc.

The above reply is contradictory in itself as on one hand it was stated that premature rehabilitation was not due to poor maintenance, on other hand one of the reasons stated was excessive corrosion. Continuous excessive corrosion needs to be tackled by effective measures of maintenance. In IR, there are 42 bridges in the system, identified for premature rehabilitation. These bridges need to be rehabilitated as existence of such bridges is a threat to safe train operation on these bridges.

1.6.2.4 Replacement of Early Steel/ Cast Iron/ Screw Pile Bridges

Bridges constructed prior to 1905 were of Early Steel and stated to contain higher proportion of sulphur, making it prone to brittleness. These bridges were referred to as 'technically obsolete bridges'. The Corporate Safety Plan (CSP) envisaged that, all Early Steel/ Cast Iron Pile bridges would be phased out of the system by the end of the CSP viz., by 2013 duly prioritizing these bridges during rehabilitation/ reconstruction. The Commissioner of Railway Safety in October 2006 required that, all Early Steel/ Cast Iron/ Screw Pile Bridges be phased out of the system. Audit, however, observed that no specific time frame was fixed by the RB to phase out the obsolete bridges.

Audit noticed that, out of 147 technically obsolescent bridges identified in five zones (NFR, NR, WR, ER and NWR) during the review period or before, 96 remained to be rehabilitated as of March 2014. Audit further noticed that -

- NFR alone had as many as 69 technically obsolete bridges identified for rehabilitation as on March 2014, which remained to be rehabilitated.
- In ER, out of the 11 such bridges identified for rehabilitation, only four have been sanctioned whereas rehabilitation of one bridge could be completed as on March 2014.
- In WR, during the review period, out of 23 such bridges, works in respect of 14 bridges were sanctioned (three in 2010-11 and 11 in 2013-14). Rehabilitation of three works, sanctioned in 2010-11 was completed in June 2014 and works sanctioned in 2013-14 were targeted to be completed during 2014-15.

CSP emphasized the need for phasing out of these bridges by 2013. But even at the end of 31st March 2014, 96 bridges still remained to be reconstructed which is a threat to the safety of lives of Railway users and Railway property.

Railway Board stated that the work of technically obsolete bridges has been executed keeping in view the availability of funds, the condition of the bridge. They further stated that the obsolete bridges, falling on Broad Gauge route in five Railways (NR, WR, ER, NFR and WCR) would be replaced by March 2017 and other bridges, falling in Meter Gauge route of NFR would be replaced in gauge conversion work.

The target fixed by Railway Board for replacement of technically obsolete bridges, falling on Broad Gauge route as March 2017 was not as per the recommendations of CSP, wherein it was envisaged that these bridges would be phased out by 2013. Moreover, Railway Board has not fixed any target for replacement of 69 such bridges on Meter Gauge route in NFR. Further, it is pertinent to mention here that at the time of inspection, these bridges were declared technically obsolete bridges, containing higher proportion of sulphur, making bridges prone to brittleness. As such, keeping in view, the safety of bridges, these need to be replaced in a time bound manner.

1.6.2.5 Extra expenditure due to continued operation of Speed Restriction

In the Corporate Safety Plan (CSP), it was mentioned that, in the rehabilitation/reconstruction of bridges, priority would be assigned to bridges on which permanent speed restriction was imposed. Para 505 of IRBM narrates in detail, the circumstances under which permanent speed restriction could be ordered by zonal Railways subsequent to inspection of bridges. Permanent speed restriction is speed restriction expected to last for long duration compared to temporary speed restriction which is normally operated for few days or weeks.

Continued operation of services with permanent speed restriction results in extra expenditure on account of high operation cost. Besides, running of services on technically obsolete bridges is a safety hazard.

Audit assessed the impact of imposition of permanent speed restriction on bridges in all cases over IR and noticed that -

- Instances of continued operation of speed restriction were noticed on 87 bridges of 13 zones⁹. Of which, 31 bridges were located in important (A, B, C) routes. Out of these 31, three bridges were distressed category-II and 28 bridges were other than distressed category-I & II.
- In these bridges, Permanent speed restriction was continued to be operated for periods ranging from four to 591 months beyond the admissible period of 12 months in case of distressed category-I bridges and 48 months in case of other bridges.
- Out of these 87 bridges, 75 bridges remained to be rehabilitated as on 31 March 2014.

⁹ ECoR, ECR, ER, NCR, NER, NFR, NR, SCR, SECR, SER, SR, SWR and WR

- The extra expenditure due to continued operation of speed restriction on these bridges, located on important routes (A, B and C) alone¹⁰, worked out to ₹ 103.40 crore¹¹ during 2010-11 to 2013-14.

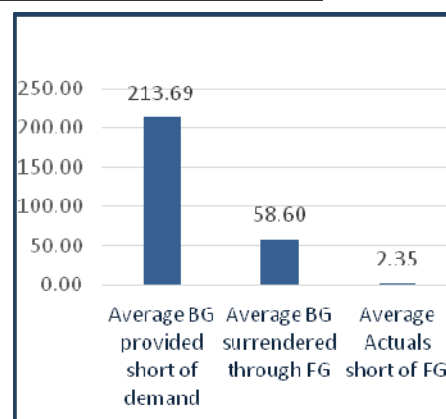
Railway Board stated that the speed restrictions on bridges are being imposed within available engineering time allowance. The extra expenditure due to continued operation of speed restriction is notional in nature.

The above reply is general, as Railway Board did not frame any specified time frame for continuation of speed restriction. Audit assessed continuation of speed restrictions as long as 591 months due to delay in execution of bridgeworks. Further, the argument that “the figure arrived at as extra expenditure is notional” is not acceptable. It is a known fact that running of trains with speed restriction affects line capacity, turn-round of rolling stock etc. and thus results in extra expenditure besides the line congestion which could be avoided if execution of works is completed in time bound manner. Audit assessment for extra expenditure was based on the study conducted in SCR in 1989-90.

1.6.2.6 Allotment and Utilisation of Funds for Bridge works

While paucity of funds can affect the momentum of execution of important safety works, poor planning and bad contract management on the other hand could lead to under/ non-utilisation of budget allotment.

The CSP proposed rehabilitation/ rebuilding of about 600 bridges annually on condition basis. CSP also aimed at rehabilitation of about 19,000 bridges on technical obsolescence basis during the CSP period (2003-2013). Provision of funds for rehabilitation was to be through normal plan outlay.



In regard to bridgeworks, Budget Grant is made through the Railway Budget under Grant Number 16 – Plan Head 32 for each zonal Railway. The BG so made can be modified through demand for Final Grant (FG) made subsequent to conduct of ‘August Review’ by the zonal Railways.

The BG allotted to individual zonal Railways is related to the works programme approved for the particular zonal Railway. Audit assessed allotment and utilization of fund over IR as per details given in **Annexure III**. As against 2432 works proposed by all zonal Railways at a cost of ₹ 3453.52 crore during the review period, RB sanctioned 1691 works for a value of ₹ 2090.27 crore.

During the review period, the average Budget Grant (BG) provided per year was short of average BG demanded per year, to an extent of ₹ 213.69 crore (38.65 per cent) in IR¹². Provision of less Budget Grant than that demanded ranged from

¹⁰ 31 bridges (12 in SER, nine in SCR, four in WR, three in SR, two in ECR and one each in ECoR, ER, NCR)

¹¹ Calculation of extra expenditure was based on figures assessed in a Cost Study conducted in August 1991 by SCR Railway Administration.

¹² Position in respect of SER was awaited.

₹0.73 crore (in respect of WCR) to ₹53.41 crore (in respect of ECR). The magnitude of short provision of BG has the effect of slowing down the momentum of progress of bridge works.

While BG provided was short of demand, on the other hand, the total average BG surrendered per year through the process of demand for less Final Grant (FG) across zones was ₹ 58.60 crore (17.28 per cent). The average surrender per year through less demand for FG was highest at ₹10.47 crore in SER followed by ER at ₹ 7.29 crore, WR at ₹7.19 crore, SCR at ₹6.36 crore and so on. This apart, average under-utilisation of funds per year by way of less actual expenditure was ₹ 2.35 crore ranging from ₹0.08 crore by NFR to ₹ 4.95 crore by ECR.

It is evident from the above that, on one hand paucity of funds was quoted as one of the main reasons for slow progress of bridgeworks and shortfall in achievement of target for rehabilitation/ reconstruction of bridges, on the other hand, BG provided was not utilised to the tune of ₹ 60.95 crore per annum.

Railway Board stated that funds have been allotted in bridgeworks based on overall availability of funds. They further stated that the funds have been almost fully utilised. During the last four years (2010-11 to 2013-14), against the Revised Estimates (RE) of ₹1388.31 crore, FG of ₹1402.85 crore was demanded and ₹1385.16 crore was actually utilised.

The above contention is not acceptable as the figures arrived at by Audit have been collected from various zonal railways from the certified appropriation accounts. Further, Railway Board has not given the data about BG provided to Zones, making a demand for less FG compared to BG allotted amounts to surrender and utilization of less funds. As per the details given in **Annexure III**, audit noticed that there were large scale surrenders/ under-utilization of funds in several zonal railways.

The quantum of surrender/ under-utilisation of funds provided through the budgetary processes indicate improper planning/ execution of bridgeworks.

1.6.2.7 Fabrication of girders for bridgeworks by Civil Engineering Workshops (CEWs)

There were 10 Civil Engineering Workshops (CEWs)¹³ over Indian Railways to cater to the need of zonal railways of girders for railway bridges. These workshops fabricated girders of various types¹⁴ for use in construction of bridges.

Audit examined the position of compliance to indents placed by zonal Railways for supply of bridge girders by these CEWs for the period from 2010-11 to 2013-14. It was noticed that, as against the indent placed for

There was shortfall to an extent of 66.09 per cent in the supply of steel girders by CEWs in CR, ECR, NR, SCR and SR during 2011-12 to 2013-14.

¹³ One each in SR, CR, SER, ECR, NER, NFR, WR, SCR and two in NR.

¹⁴ Riveted type plate girders, welded type plate girders, shallow type girders, semi-through girders and open web girders.

fabrication of 45847.630 MT of steel girders meant for use in the rehabilitation/reconstruction of steel bridges, the Workshops turned out 12359.891 MT of steel girders. i.e. a shortfall of 73.67 per cent.

During review, a case of defective fabrication of bridge girders by the CWE at Arakkonam of SR was noticed. The CEW of SR accepted (May 2008) an order from NER for fabrication and supply of ten spans of riveted type open web girder for use in the construction of a bridge (Bridge number 409) across Yamuna river as part of gauge conversion of Bareilly- Kasganj section of NER. The fabricated girders supplied (by March 2012) by the CEW/SR could not be used by NER in the construction of the bridge due to mismatch of the holes of gusset and connecting members in the fabricated girders. Based on the directives of RB, RDSO inspected (February 2013) the girders at bridge site and found that fabrication of girders was carried out by CEW/ SR in a most casual way without following any specification and procedure as laid down in IRS B1-2001. RDSO also concluded that, these girders cannot be used for erection of the bridge girder without sacrificing the safety of bridge. The failure was attributed to inadequate infrastructure and technical knowhow of the CEW of SR. An expenditure of ₹22.31 crore incurred by SR in the fabrication of girders became largely unfruitful. Subsequently, RB directed (April 2013) SR Administration to stop the work of fabrication of open web girders in the workshop. The CWE of SR was permitted by RB to fabricate only welded plate girders used normally for use in Foot Over Bridges, from December 2013.

In SWR, out of 37 technically obsolete bridges taken up for rehabilitation, the rehabilitation work of 12 bridges got delayed due to delay in supply of bridge girders by the CWE at Arakkonam/SR. Progress of work in these cases ranged from 0 to 14 per cent as on March 2015.

Railway Board stated the work orders/ indents placed on the workshops are always in excess of the production capacity of the workshops. It was also stated that lot of time is required for procurement of raw material such as steel etc. after work order placed on the workshop.

It is a fact that delays in supply of girders by the Bridge Workshops affect execution of the relevant bridgeworks. As such, Railway needs to enhance the capacity of the workshops to avoid the delay in supply as it ultimately impacts the safety aspects on account of delay in execution of bridgeworks identified for rehabilitation.

1.6.3 Inspection and Maintenance of Bridges

1.6.3.1 Use of Modern Equipment for bridge inspection

The Corporate Safety Plan (CSP) 2003-13 observed that the present system of inspection and assessment of bridges is based on visual inspection and is subjective. Hence the same would be modernized and a modern bridge management system would be introduced.

The CSP listed a number of plans for modernization of inspection of bridges. In January 2005, an Integrated Railway Modernization Plan (IRMP) 2005-10 was

released by the Minister of Railways which proposed setting up of a number of technologies as part of modernization of inspection, as listed below:

- a. Testing and Remote Monitoring of bridges using modern technologies - (in collaboration with IIT/Mumbai)
 - i. Vibration Signature Testing and
 - ii. Remote Monitoring of Bridges;
- b. Adopting Seismic Isolation Techniques and Earthquake Protection of Bridges (in collaboration with IIT/Kanpur);
- c. Development and use of Advanced Corrosion Protection System for bridges (in collaboration with IIT/Mumbai);
- d. Scour assessment, real time monitoring and protection of bridges (in collaboration with IIT/Kharagpur);
- e. Use of high performance concrete in Railway Bridges;
- f. Residual Life estimation of Concrete Bridges in collaboration with IIT/Kanpur;
- g. Underwater Inspection of bridges;
- h. Inspection and maintenance of Railway Bridges by Mobile Bridge Inspection Units;
- i. Laying Long Welded Rails over Bridges taking in to account track bridge interaction; and
- j. Adopting modern technologies for building bridges, rehabilitation of old bridges and use of Advanced Composite materials in Bridges in collaboration with IIT/Mumbai.

However, review of RB records (2010-11 to 2013-14) as well as of zonal HQ offices over IR revealed that none of the above projects/ activities was completed (as on March 2014) so as to apply the modern technology in the field except for issue of a booklet containing guidelines for conduct of UWI by Indian Railway Institute of Civil Engineering (IRICEN).

From Railway Board's reply (April 2015), it was noticed that only three activities mentioned above (g, h and i) were completed and rest are under trial stage. Two projects (a and f) were dropped, as these were found not be feasible to deploy. IR need to complete the remaining projects to improve the inspection techniques by utilizing modern techniques.

Further, the High Level Safety Review Committee headed by Shri. Anil Kakodkar in its Report (February 2012) also stressed the need for use of modern methods for inspection of bridges such as capturing images and posting thereof in MIS or sending it through internet to all concerned senior engineers having vast experience to visualize the impending bridge failure. The Report also recommended that vulnerable bridges should be fitted with water level gauges and turbine flow meters to measure the water flow which should be interlocked in a way to warn the driver of the approaching train.

Audit observed that though photographic images of weaknesses noticed during inspection of bridges were taken and sent to higher officials for study, the second recommendation in regard to fitting of water level gauges and turbine flow meters and a system to warn the driver of an approaching train, was not implemented in IR (except NR) as on March 2014.

For conducting objective inspection of bridges, RB prescribed use of about 20 different modern equipment, referred to as Non-destructive Testing Equipment (NDT) such as Liquid Die Penetration Equipment, Rebound Hammer, Structural Scan Equipment etc.¹⁵

Audit noticed that 290 equipment of five types (on an average) have been procured in different Zones over IR. Utilization of these equipment during inspection of bridges was only 7.07 per cent. Some of the equipment were not used even once as ascertained from the log book maintained by the zonal Railways.

In reply, Zonal Railway Administrations stated that the reasons for non/ under utilization of (Non-destructive Testing) NDT equipment in the inspection of bridges were absence of trained staff, vacancy in Group D category staff, lack of skills and logistics etc. However, in reply Railway Board stated (April 2015) that the NDT equipments available in Zonal Railways are being used regularly to assess various parameters related to condition of bridge. However, the response given by RB is not factual in view of the constraints mentioned by the Zonal Railways in utilisation of NDT equipment.

The reply of Railway Board is also incorrect as based on the data collected by Audit from the log books relating to use of NDT equipment, overall average utilisation at 7.07 per cent only was noticed.

In a particular case of SR, Railway Administration stated (July 2014) that the NDT equipment were being used wherever necessary based on instructions from the competent authority. The log book entries however showed that the utilization of various NDT equipment was insignificant since their procurement.

The NDT equipment procured at an approximate cost of ₹12.99 crore over IR remained grossly underutilized, defeating the purpose of strengthening of inspection techniques.

1.6.3.2 Adherence to Inspection/Maintenance Schedule

Inspection by officials of the Civil Engineering department of Zonal Railway

The Indian Railway Bridge Manual (IRBM), Chapter –XI prescribes the manner and periodicity of inspection of bridges by different level of officials of the Civil Engineering Department of the Zone.

¹⁵ The Liquid Die Penetration Equipment helps in the assessment of depth of crack on the surface of the bridge span/ pier, Rebound Hammer is useful in the assessment of compressive strength of concrete etc.

For scrutiny of adherence to inspection schedule, Audit selected the records of inspection carried out by two SSE/SE -Bridges, two SSE/SE - Permanent Way, two SSE/SE-Works and two ADEN of each zone. Audit noticed that -

Inspection of bridges by SSE/SE - Bridges:

As per prescribed schedule, the SSE/SE Bridges should inspect Superstructure and Steel works and bearings of all girders of 12.2 m clear span and above of all bridges once in five years.

Audit checked the position in 31 offices over IR and found that, 4379 inspections due during the four year period were conducted without any shortfall. On completion of inspection, the inspecting official has to record a certificate with observations and remedial action needed to be taken if any. Subsequently, compliance to remedial action suggested has also to be recorded in the bridge inspection register. In case of 110 inspections in NR, certificate of inspection has not been recorded and in five cases in SER, compliance thereon has not been mentioned.

Inspection by SSE/SE – Works:

The SSE/SE Works is expected to inspect Superstructure and Steel works and bearings of all girders less than 12.2 m clear span once in five years. In addition, Foundation, Sub-structure and Bed block of all bridges should be inspected once in a year prior to monsoon.

Audit checked 32 offices over IR. Against 10391 inspections due as per schedule, 6710 inspections were carried out leaving a shortfall of 3681 inspections (35.42 per cent) during the review period. The shortfall (1356 inspections) was highest in NWR followed by NR (1104) and SECR (687). In 2907 cases, 2092 in NR, 499 in SECR, 272 in ER and 44 in NFR certificates on inspection were not recorded. In 915 cases, 400 in SECR, 333 in NR, 138 in ER and 44 in NFR compliance indicating action taken on observations made were not recorded. In SR, SWR, WR, NWR and ECR either inspections due by SSE/SE – Works were not at all conducted or no records were maintained by the concerned officials in support of conduct of inspection. The SSE/SE – Works generally had not carried out inspections, stated to be due to non-availability of trained manpower and infrastructure.

Bridge inspections to be carried out by SSE/Works were not carried out in many zones, citing non-availability of staff and infrastructure as reasons.

Inspections by SSE/SE – Permanent Way:

As per schedule, SSE/Permanent Way should carry out inspection of Track and approaches of all bridges at least once a year prior to monsoon etc.

Audit checked 32 offices over IR and found that, as against 8962 inspections due during the review period, 6367 inspections were carried out leaving a shortfall of 2595 inspections (28.96 per cent). Highest shortfall was noticed in WR at 863 inspections followed by NR (792 inspections) and SECR with a shortfall of 608 inspections. Subsequent to inspection, in 1596 cases in NR and in 260 inspections carried out in NFR, certificate of inspection were not recorded. In 240 cases relating to NR, compliance to remedial action suggested has not been recorded.

Inspection by ADENs:

As per schedule ADEN/AEN has to inspect Foundation, Sub-structure and Bed block etc. of all bridges once a year after monsoon.

Audit checked the position in 32 offices in IR and found that, there was no shortfall in conduct of inspection. In 3536 cases pertaining to NR, certificate of inspection has not been recorded. In regard to recording of compliance to remedial measures suggested, in 1283 cases in NR and in 280 cases in NWR the same has not been complied with.

The objective of conducting bridge inspection is to assess the condition of bridges and to take corrective remedial measures needed if any. Shortfall in conduct of inspection at the level of SSE/Works (35.42 per cent) and SSE/ Permanent Way (28.96 per cent) as pointed out above may result in shortfall in the timely identification of defects in bridges and this may lead to serious consequences.

In regard to recording of certificate by the inspecting officials and for recording of remedial action taken as recommended also, compliance should be ensured.

In regard to adherence of inspection schedule, Railway Board stated (April 2015) that by and large, the inspection schedules are being adhered to by the designated officials and remedial actions are being taken. However, the instructions have been reiterated by the Zonal Railways to the field officials for adhering to the inspection schedule, making good the shortfall if any, and also recording the observations/ furnishing certificates.

Special Inspection of Distressed Bridges

In terms of Para 509 of IRBM, special Inspection of distressed bridges category-I and II have to be carried out by SSE/SE-Bridges, ADEN and DEN/Sr.DEN once in a month, once in two months and once in three months respectively.

Records of zonal Railways revealed that, in seven¹⁶ Railways where special inspections were due on 10 distressed category-II bridges (out of the total of 45 distressed category-II bridges on IR as of 31st March 2014), inspections were carried out as per schedule except in case of ECoR where there was a shortfall of 32 inspections at SSE level and 16 at ADEN level on two distressed category-II bridges during the three year period viz., 2011-12 to 2013-14.

Underwater Inspection (UWI) of Bridges

Bridges, substructure/ foundation/ bed block of which are submerged under water throughout the year, are to be subjected to UWI. The UWI is conducted either departmentally by the trained divers or outsourced. As UWI is an area which was not fully covered in the IRBM or in any other codes, Indian Railway Institute of Civil Engineering (IRICEN) issued guidelines (July 2008) for conduct of UWI. As per the guidelines, all bridges identified should be subjected to UWI at least once in five years.

There was a shortfall of 44 UWI during the review period over CR, ER, SER, NFR and SCR.

¹⁶ ECoR, ECR, ER, NCR, SCR, SR, WR

Audit examined the position of conduct of UWI by 28 SSE/Bridges over IR during the period from 2010-11 to 2013-14 and noticed that-

- Against 156 bridges due for UWI during the review period, UWI was carried out on 112 bridges leaving a shortfall of UWI on 44 bridges. In CR, not a single bridge on which UWI was due, was conducted during the review period as against 31 bridges due for UWI.
- During conduct of UWI in the years 2011-12 to 2013-14, the inspecting agency noticed defects in the bridges and the observations were recorded in their report in case of 27 bridges (ER, NCR, NFR, NR, SER, SR, SWR and WR). Out of these 27 bridges, in respect of 12 bridges follow up action was yet to be taken as at the end of 31 March 2014.

In a particular case of a bridge in Ernakulum– Alleppey section of SR, there were serious findings during UWI following which, speed restriction was imposed on the bridge in December 2011. However, work for rehabilitation of the bridge was not processed for sanction even after 27 months of identification of the problem and train services were continued to be run on the bridge with speed restriction.

In reply to the Audit observation, the SR Administration stated (July 2014) that, the delay was due to turbidity/ tidal action of back water and time taken in the assessment of quantity of piers required for strengthening etc.

The reasons stated are not tenable as, the delay of 27 months indicates that priority was not accorded in the rehabilitation of the bridge though speed restriction was imposed on the bridge which is indicative of vulnerability of the bridge. Besides, tidal action of back water is a perennial phenomenon which cannot be stated as reason for delay in assessing the quantum of work to be carried out.

In case of other zonal Railways, the reasons stated for not taking follow up action were as under-

- In NFR, in case of one bridge where UWI was done during 2012-13, follow up action has not been taken up till July 2014. The reason stated by NFR Administration was high flood level in river Brahmaputra for conduct of a test for assessment of depth of crack in the piers.
- In WR, out of the seven cases of UWI, in one case, follow up action was not taken by WR Administration. It was noticed that though the bridge was identified in 2010-11 during UWI, the work has not been sanctioned till March 2014.
- In case of SER, the zonal Railway Administrations stated that no follow up action was required based on the observations made in UWI.

1.6.4 Other issues

Apart from the above findings discussed in Para 1.6.1 to 1.6.3, audit also examined other important issues related to maintenance of bridges such as instrumentation of bridges, bridge cell, Bridge Management System, provision of anemometer, maintenance of flood records etc. These are discussed in subsequent paragraphs:

1.6.4.1 Instrumentation of bridges

RB took a decision in May 2005, to permit running of wagons loaded up to CC+8+2¹⁷/ CC+6+2¹⁸ on identified Iron Ore routes listed in the letter ibid, as a pilot project. In the same letter in which the above decision was communicated, RB instructed zonal Railways to check the impact of running of high axle load services through a number of measures which included assessing the fatigue life and residual life of bridges. For this purpose, RB instructed ZRs to take up Instrumentation of bridges¹⁹ in the identified CC+8+2/ CC+6+2 routes.

Instrumentation had to be done on sample bridges representing all types in the route and results of the study were to be reported to RDSO for further action.

The Anil Kakodkar Committee also recommended (February 2012) that, instrumentation of all bridges should be undertaken in terms of deflections/ displacements, water level and flow velocity, on a continuous basis and data should be communicated to the concerned CBE for monitoring. The Report considered that, advanced scientific measurement and inspection for the condition assessment of the under-side of the bridges using mobile and articulating platform was essential.

In IR, 66 bridges in the notified CC+8+2 routes and 32 in the CC+6+2 routes were selected in the year 2006 as sample bridges for instrumentation. Out of these 98 bridges, Instrumentation was done in four cycles over the period from 2006 to 2014 on 77 bridges (61 in the CC+8+2 routes and 16 in the CC+6+2 routes) at a cost of ₹ 23.11 crore leaving a shortfall of 21 bridges. Audit scrutiny of records relating to instrumentation of bridges revealed that –

Instrumentation on bridges in CC+8+2 routes

- In NR, on none of the five bridges identified on the CC+8+2 routes instrumentation was carried out during the review period. On these five bridges, speed restriction was imposed and restriction on movement of heavy axle load traffic was ordered.

Instrumentation on bridges in CC+6+2 routes

- In the CC+6+2 routes, out of 32 bridges planned, instrumentation was conducted on 18 bridges leaving a shortfall of 14 bridges (nine in WR and five in NR). In respect of WR, as there was no major finding during Instrumentation of one Bridge (Bridge No. 65), no further Instrumentation was stated to have been carried out. In case of NR, reasons for non-instrumentation have not been found on record during audit.
- The overall cost of instrumentation in the CC+8+2 and CC+6+2 routes in the above cases was ₹ 28.42 crore.
- In WR, based on instrumentation, one bridge in the CC+6+2 route was marked for rehabilitation but sanction for the work was not accorded till end of 31 March 2014. Speed restriction was imposed on this bridge and restriction on movement of 25 T axle load traffic was also ordered.

¹⁷ CC (carrying capacity of wagon)+8 tons (additionally loadable) + 2 tons (tolerance limit).

¹⁸ CC (carrying capacity of wagon)+6 tons (additionally loadable) + 2 tons (tolerance limit).

¹⁹ Instrumentation is a process of assessing the longitudinal axle load bearing capacity of bridges.

1.6.4.2 Bridge cell

Railway Board instructed (July 2007) Zonal Railways to implement Centralised Bridge Organisation at the zonal level under the Chief Bridges Engineer (CBE). Creation of separate Bridge Cell was intended to provide specialized attention on inspection and maintenance of bridges and also in the effective monitoring of bridgeworks.

Audit noticed that policy guidelines for implementation of centralized bridge organisation at zonal level were prepared in April 2009. However, out of 16 zones, only in ten zones²⁰ separate bridge cell has been formed.

Existence of a separate Bridge Cell at zonal level was expected to help in the better monitoring of inspection and maintenance of bridges. Audit observed that where Bridge Cells were established, details of inspection and identified bridges due for rehabilitation were recorded in the Bridge Cell for better monitoring of bridgework. As such, Railways need to establish the Bridge Cell in the remaining six Railways for better monitoring of inspections and execution of bridgeworks over IR.

In reply, Railway Board stated that the bridge organization in all the zonal railways is working under CBE. However, Railway Board is silent about non-formation for separate bridge cell in remaining six zones.

1.6.4.3 Bridge Management System (BMS)

The CSP listed BMS as one of the thrust areas in technology improvement in regard to modernisation of bridge inspection and maintenance. The Centre for Railway Information System (CRIS) was entrusted with the development of the system as part of the Track Management System (TMS). Development of BMS was conceived with 20 modules which inter-alia, included the following:

- creation of central structured Bridge Data Base;
- digitization and uploading of all bridge drawings and its management;
- bridge inspection management;
- bridge rehabilitation/ strengthening/ rebuilding management;
- distressed/ weak/ identified bridges health monitoring and management;
- flood control management; etc.

The Safety Action Plan in the CSP relating to Civil Engineering Department specified (August 2003) the time frame for completion of the BMS as 2006-07. But, the committee for development of bridge specific proforma for recording observations of bridge inspection officials was formed only in March 2011, which submitted its Report in June 2011. Bridge Modules were developed in Track Management System (TMS) as per the proforma approved by RB for filling up of bridge details (static master data). The RB instructed the zonal Railways in February 2012 to complete feeding of bridge data in to the TMS module within three months (i.e., by May 2012). The bridge data in the static master data would contain complete information about a bridge such as type of bridge, foundation

²⁰ ECoR, ECR, NCR, NER, NR, SCR, SECR, SER, SWR and WCR

type, drawing relating to foundation, substructure and superstructure, year of construction, specification of bridge structures etc.

During the review, Audit observed that, data relating to 73,699 bridges (65.50 per cent) out of 1,12,517 bridges (in 14 zones) have been fed in to the system as on March 2014. In respect of NR and NWR bridge data module in TMS was not commissioned and data feeding was not carried out by these zonal Railways. Further, the proforma for recording of observations made during inspections for various types of bridges was yet to be developed.

Thus, the BMS, which was mentioned in CSP as one of the thrust areas in technology improvement in regard to bridge inspection and maintenance, targeted to be completed by 2006-07, was still in nascent stage. Out of the 20 modules proposed, only one module relating to creation of central structured Bridge Data Base was finalized and in that too, feeding of data relating to bridges was completed to an extent of 61.38 per cent only across 14 zones.

Railway Board stated that the feeding of master data for bridges is in advanced stage and is planned to be completed during 2015-16. Bridge inspection proforma is under development and will be available to railways by May 2015.

The fact remains that in its recommendations, CSP envisaged that the BMS had to be fully functional by 2006-07. But even after expiry of seven years, the same is yet to be implemented completely.

1.6.4.4 Installation of Anemometer in case of bridges located in high wind zones

Para 717 of IRBM provided that Anemometer²¹ has to be fixed in railway stations adjacent to a bridge located in high wind zone. The purpose of the Anemometer is to enable Station Master to control or stop trains in the section if the wind velocity exceeds 72 kmph to protect against the danger of capsizing of vehicle.

The position of provision of Anemometer over IR is discussed in the sub-para below-In IR, there were 61 bridges located in the high wind zone and the nearest railway station/ location to the bridges were not fitted with Anemometer in 13 cases (10 in SCR and three in ECoR). In the other 14 zones, Anemometer was fitted at the nearest railway stations in respect of bridges located in wind zones, wherever necessary.

The SCR Railway Administration stated that, in the absence of anemometer, Station Masters regulate the section based on experience gained in the past. In ECoR, there was nothing on record to show how the Railway Administration managed in the absence of Anemometer.

Railway Board stated that in SCR, anemometer has been installed for three bridges and for remaining 7 bridges in SCR and for three bridges in ECoR, procurement of anemometer is underway.

1.6.4.5 Maintenance of flood records in case of bridges over flood prone rivers

As per para 701 of IRBM, flood records are to be collected and kept in prescribed format by the concerned Divisional Engineer/ Assistant Divisional Engineer to

²¹ Anemometer is a device used for measuring wind speed.

acquaint themselves with the behaviour of rivers in their jurisdiction in order to ensure safety of railway structures during floods. Para 702 of IRBM specifies the manner in which flood details have to be collected during monsoon and records kept.

Audit noticed that, out of 246 bridges over the flood prone rivers, in 73 cases (61 in NFR and 12 in CR) flood records were not maintained. The reason for non-maintenance of flood records in these two zonal Railways was not found on record.

Railway Board accepted the audit comments and stated that it will be ensured that the flood records are maintained for the identified bridges as per the codal provisions.

1.6.4.6 Adequacy of manpower for inspection and maintenance of bridges

Though bridge maintenance staff are not classified as belonging to 'safety category', the need for having adequate manpower for inspection and maintenance to ensure safe passage of trains over bridges, cannot be overemphasized. Audit observed that, as inspection and maintenance of bridges is largely labour oriented activity, substantial vacancy in Group 'C' and 'D' cadres has the potential of affecting the quality of inspection and maintenance. Details of sanctioned post and actual strength are given in **Annexure IV**.

Audit examined the position over IR and noticed that-

- The overall vacancy in the skilled category (Group 'C') was 40.84 per cent and in the unskilled category (Group 'D'), the vacancy was 28.91 per cent.
- The vacancy percentage in skilled category was highest in SWR (60.38) and in SECR, NR, NCR, ER, SER, SR, WR, ECoR and ECR, it was more than 40 per cent. In the unskilled category, SR had highest vacancy per cent (75.23) followed by ECoR and WR with over 40 per cent vacancy.
- The overall vacancy in Group C and D cadres was 33.28 per cent with SR registering the highest percentage at 54.26 per cent and NR, SECR, WR and ECoR having over 40 per cent vacancy.

This clearly indicates that sufficient and suitable manpower required to carry out the important safety function viz., inspection and maintenance of bridges was not available in most of the Zonal Railways.

Railway Board accepted the audit comments and stated that the bridge staff works in safety related circumstances and efforts are being made to put bridge staff in safety category. The vacancies are being filled through departmental promotions, direct recruitment etc.

1.6.4.7 Training of staff in Bridge Maintenance

CSP (2003-2013) laid special emphasis on training of bridge engineers and supervisors on regular and continuous basis with a view to enable them to adapt to technologies appropriately. Para 1304 and 1305 of IRBM also provides instructions for conduct of refresher course to SSE/Bridges and other

In ER, SWR, NER, WR, ECR and SR the percentage of shortfall in conduct of training to bridge staff, was very high.

bridge staff once in five years and conduct of special course to SSE/Bridges on specific aspects to increase sense of awareness on specific issues relating to bridge inspection.

Audit examined the records of Zonal Railways relating to conduct of training as per details given in **Annexure V** and noticed that-

- Over IR, during the review period, training was imparted to 194 bridge engineers/ supervisors as against 402 bridge staff due as per requirements of CSP listed above for the training i.e., there was a shortfall of 52.24 per cent.
- In ER and SWR, the shortfall in training was 100 per cent i.e., none of the bridge staff was trained during the review period.
- In three Railways (ECR, NER and WR), there was shortfall of more than 90 per cent in the conduct of training.
- In five Railways (CR, NR, NWR, NCR and WCR) all staff due for training were imparted training.

From the reply of Railway Board (April 2015), it was noticed that after the audit comment regarding shortfall in conduct of appropriate training, Railway improved the system. In ER, nine bridge engineers have taken training in November-December 2014. Training programme for 2015 has been finalized and bridge engineers and other staff will be sent for training in 2015 as per programme.

1.7 Conclusion

The IR network had 36470 bridges that were over 100 years old. The system of rehabilitation/ reconstruction of identified bridges was based on monetary limits and on condition of bridges. Proposals forwarded by zones were pruned down at RB level and considered in the light of monetary caps imposed and constrained to that extent. Over the review period, RB's sanction was not accorded in respect of 27.51 per cent bridgeworks proposed by Zonal Railways. Moreover, where RB's sanction was accorded, bridgeworks pertaining to 710 bridges could not be completed by the prescribed time period. Audit came across instances of delay in rehabilitation of bridges under distressed category-I and II, technically obsolete bridges, bridges with long periods of speed restriction etc.

During the period covered in audit, target for rehabilitation/ reconstruction was not achieved in nine zones and the overall shortfall was 13.53 per cent. While analyzing the reasons for under-achievement of targets, audit observed that delay in preparation of drawings, finalisation of tenders, shifting of service lines, paucity of funds, non-availability of line block etc. caused overall delay in completion of works within target periods. Rehabilitation/ reconstruction works were not prioritized in respect of bridges where permanent speed restriction was imposed, which resulted in continued operation of speed restriction leading to avoidable extra expenditure of ₹ 103.40 crore in case of 31 bridges on important routes alone.

Audit noticed that less budget allotment compared to budget demanded for programmed works was one of the major reasons for shortfall in achievement of target. However, on the other hand, there was substantial surrender of funds (through the process of demand for less Final Grant as against the Budget Grant

provided during the year), due to improper planning of works and poor contract management. The 290 numbers of five types of NDT equipment procured across zonal Railways for use during inspection remained grossly underutilized. Though Bridge Management System was mentioned in the Corporate Safety Plan (2003-2013) as a thrust area in technology improvement, only one module relating to “Central structured Bridge Data Base” was approved by RB in 2012 and even in this, the feeding of data was not completed as of 31 March 2014. Inspection of bridges to be carried out by SSE/Works was either not carried out as per schedule or there was large scale shortfall. There was acute shortage of manpower which may impact the quality of bridge maintenance/ inspection and there was shortfall in the conduct of training of the bridge staff.

Recommendations

- *While there was a system of identification of bridges for rehabilitation/ reconstruction, the process of sanctioning bridgeworks did not take into cognizance the same. It was primarily based on the monetary limits fixed for each zone. IR should ensure that bridgeworks should be sanctioned keeping in view the conditions noticed at the time of identification of bridges for rehabilitation to ensure prompt rehabilitation in time bound manner.*
- *During review, Audit noticed substantial delays in execution of bridgeworks. IR should fix responsibility for timely execution of bridgeworks at zonal level as well as at RB level. There should be effective monitoring of execution of bridgeworks at both Zonal and RB level in view of the safety of human lives and assets.*
- *Bridge inspection at various levels is required to assess the condition of bridges and to take corrective remedial measures needed if any. As such, complete adherence to inspection schedule at each level should be ensured by Zonal Administrations.*
- *Though paucity of funds was cited as reason for shortfall in achievement of targets for bridgeworks, substantial surrender of funds was noticed. Effective monitoring should be ensured at both zonal and RB level to ensure optimum utilization of funds provided for bridgeworks.*