सत्यमेव जयते

भारत सरकार – रेल मंत्रालय

GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

3 एवं 4 फरवरी – 2011 में
सिकन्दराबाद में होने वाली
पुल एवं संरचना मानक समिति की
अस्सीवीं बैठक की
कार्यसूची

Agenda
Of
Eightieth Meeting
Of
Bridge & Structures Standards Committee
(3rd & 4th February - 2011)
At
Secunderabad

अनुसंधान अभिकल्प और मानक संगठन

लखनऊ–226011

RESEARCH DESIGNS AND STANDARDS ORGANISATION

LUCKNOW-226011

SUBJECT INDEX

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80th MEETING OF BRIDGE AND STRUCTURES STANDARDS COMMITTEE (February, 2011)

ITEM NO. 1021

Subject : Provision of Shut-off valves for pipe line crossings under railway track conveying inflammable substances like petroleum oil and gases etc.

BSC Reference : Item No. 863 of 72nd BSC.

RDSO File No. : CBS/DCP/1.

Agenda : To make provisions for Shut-off valves in pipelines crossing railway track conveying inflammable substances.

NOTES BY SECRETARY

1. CBE/NR vide letter No. 33-W/O/RDSO/W.BR./Pt.-1 dated 19.11.10 has raised the following issue:

   "Para 5.5 of RDSO guidelines (Report No. BS: 105, October'2009) mentions that 'Shut off valves on either side of railway crossing is not recommended. Installation of these valves introduce hazards not consistent with good pipeline operating practices'. The rational of this provision is to avoid near vicinity of shut off valves installations (being hazardous) to Railway track. However, no minimum distance has been specified.

   It has been found that on an average, gases are being carried under pressure of 70 kg with provision of shut off valves at a distance of about 25 km. Thus in case of any eventuality of pipeline bursting, a huge quantity of gas within the pipeline between shut off valves will come out and may cause fire leading to high temperatures. Thus it calls for provision of shut-off valve at a closer distance to keep the quantity available for burning to the minimum.
   It is suggested that:-

   (i) Shut off valves should be provided on either side at about 500m from Railway Boundary.
   (ii) The inter-se distance between two shut off valves on either side of Railway track should not exceed 2000m".

2. Based on the literature study undertaken by RDSO, the existing provisions of Shut-off valves for pipe line crossings under Railway Track conveying inflammable substances are given below:

   (i) Para 5.5 of BS-105 (October'2009):Guidelines on pipe line crossings under Railway Track

   Shut off valves on either side of railway crossing is not recommended. Installation of these valves introduce hazards not consistent with good pipeline operating practices.

Item No. 1021 continued….

(ii) Para 5.1.6.6 of AREMA (American Railway Engineering and Maintenance-of–Way Association) Guidelines 2002

Accessible emergency shut off valves shall be installed within effective distance each side of the railway as mutually agreed to by the engineer and the pipeline company. These valves should be marked with sign for identification. Where pipelines are provided with automatic control stations at locations and within distances approved by the engineer, no additional valves shall be required.

(iii) Clause 4.4.11of Standards Respecting Pipeline Crossings under Railways (Railway Association of Canada), June 21, 2000

For oil and gas pipelines, accessible emergency shut off valves shall be located each side of the railway within effective distances as mutually agreed to by the Engineer and the pipeline company. These valves shall be marked with signs for identification. Where pipelines are provided with automatic control stations and/or valves that are remotely operated, no emergency shut off valves are required at the crossing.

(iv) Metra Guidelines for Utility Installations (Part-2 Pipelines: Flammable and Non-Flammable Materials), September, 2007

(North East Illinois Regional Commuter Rail Road Corporation)

The Utility Owner shall install accessible emergency shut-off valves within effective distances on each side of the railroad. Where pipelines are provided with automatic control stations, no additional valves will be required.

Valves shall not be located within the railroad right of way.

(v) Burlington Northern Santa Fe (BNSF) Railways Utility Accommodation Policy of April 16, 2004, Revised May 5, 2007

i. The Utility Owner shall install accessible emergency shut-off valves within effective distance on each side of the railroad. Where pipelines are provided with automatic control stations, no additional valves will be required.

ii. Locating a shut-off valve on railroad property should be avoided. If approval is acquired, a guardrail must protect the shut-off valve.

iii. When a guardrail is required, its height shall be four (4) feet above the ground line. All four corner posts shall be driven to minimum depth of four (4) feet below ground line. There shall be minimum clearance of two (2) feet from the valve to the guardrail. The steel pipes for the four corner posts and guardrail shall have a minimum diameter of four (4) inches. All joints will be welded with a one-quarter (1/4) inch fillet weld all around.

Item No. 1021 continued….

3. (i) As per provisions of Para 5.0 of Guidelines on pipeline crossing under railway track (Report No. BS-105) of RDSO the pipelines conveying inflammable substance under pressure should be through a casing pipe able to withstand a pressure equal to that of the main carrier pipe with a safety factor of 3. Casing pipe and joints should also be capable of withstanding latest approved railway loading as per Bridge Rules. Corrosion protection system has also been specified. Further, the casing pipe shall have to be underground. In such a scenario, the likelihood of leakage of carried substance within railway area is remote. However, in rare exigencies involving breakage of casing as well as carrier pipe due to accident in Railway boundary and its close vicinity, there is likelihood of effect on railways on account of discharge of excessive quantity of material when shut-off valves are located far apart.

(ii) While it is accepted that inter shut-off valves distance should be minimum to have least consequences, prescribing limits in the guidelines may be deliberated keeping in view factors such as width of railway land at the location of crossing, land use pattern and geographical features of area around railway land etc.

(iii) To cater for such situation, RDSO is of the view that provision similar to para 5.1.6.6 of AREMA (American Railway Engineering and Maintenance-of–Way Association) Guidelines 2002 may be incorporated by amending para 5.5 of BS-105 as under:

"5.5 Accessible emergency shut off valves shall be installed within effective distance each side of the railway as mutually agreed to by the engineer and the pipeline company. These valves should be marked with sign for identification. Where pipelines are provided with automatic control stations at locations and within distances approved by the engineer, no additional valves shall be required.

Valves shall not be located within the railway boundary".

4. Committee may deliberate and make recommendations.

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80th MEETING OF BRIDGE AND STRUCTURES STANDARDS COMMITTEE (February, 2011)

ITEM NO. 1022

Subject : Modification in para 1104 of IRBM on account of Abolition of THOD System.

BSC Reference : Nil.

RDSO File No. : CBS/IRBM.

Agenda : To consider the role and duties of SAG Officers of Engineering Department working on open line of Zonal Railways.

NOTES BY SECRETARY

Railway Board has specified the role and duties of SAG Officers of Engineering Department working in open line of Zonal Railways vide their letter no. 2010/EDCE/G/Misc./8 dated 14-09-2010. After implementation of this order SAG Officers of Engineering department will no longer work as THOD and they will only be acting as functional HOD. With the implementation of above, para 1104 of Bridge Manual needs to be reviewed & modified.

Bridge Manual para 1104 states that-

By Divisional Engineers And Territorial HODs

1. Details of inspection:

   a) The Divisional Engineer shall carefully scrutinize the Assistant Engineer's Bridge Inspection Register and inspect all important bridges and such bridges as called for his inspection. He shall record his orders regarding the points which require as decision by him and initial against every bridge in token of scrutiny.

   b) He will complete his inspections and scrutiny by a specified date.

2. Certificate by Divisional Engineer.

   He should endorse on each register, below the Assistant Engineer's certificate as follows:

   "I have personally scrutinized this register and inspected all important bridge and bridges referred to me and have issued orders regarding all essential points requiring a decision by me. The following points are submitted to the Territorial Head of the Department for orders.

   Bridge No. (s) ---------- require rehabilitation.

   Bridge No. (s) ---------- have ORN 1 or 2.

   Bridge No. (s) ---------- have one or more CRN as 0 for more than one consecutive inspection."

Item No. 1022 continued….

3. The Divisional Engineer shall inspect all those bridges for which the ORN is 1, 2 or 3 and revise/confirm the rating given by the AEN. Bridges which have, after review, an ORN of 1 shall be placed in the distressed category.

4. Action by Divisional Engineer:

   He should then send the register to the Assistant Engineer for noting his orders with instructions to return them within ten days. The Assistant Engineer should then extract the orders issued by the Divisional Engineer, intimate the same to the Inspectors concerned and ensure expeditious compliance.

5. Scrutiny by Territorial HOD and action thereon:

   The registers should then be forwarded by the Divisional Engineer to the Territorial HOD by a specified date, who will examine each register, issue orders regarding matters referred to him duly endorsing the registers to the effect and return them to the Divisional Engineer latest by a specified date. Subsequent action taken on the Territorial HOD's orders should be entered in the register by the Assistant Engineers.

Since the item is related to policy matter and is purely administrative issue, the committee may deliberate and make recommendations for modification in para 1104 of IRBM.

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80th MEETING OF BRIDGE AND STRUCTURES STANDARDS COMMITTEE (February, 2011)

ITEM NO. 1023

Review of action taken on pending items

1. Item No. **884**/73rd/2001/CBS/PSBC
Depth of scour in clayey soil.

COMMITTEE'S RECOMMENDATIONS:

Committee recommends to add a new Clause 4.6.5.1 and new Appendix-VI in IRS Bridge Substructure and Foundation Code based on Clause 703.2.2.2 and Appendix-I of IRC:78-2000 regarding calculation of silt factor 'f' for gravels, boulders and clayey beds, as following:

1) **Clause 4.6.5.1** No rational formula or data for determining scour depth for bed material consisting of gravels and boulders (normally having weighted diameter more than 2.00 mm) and clayey bed is available. In absence of any data on scour for such material, the mean scour depth may be calculated following the guidelines given in *Appendix-VI.*

2) **Appendix-VI:**

Guidelines for Calculating silt factor for bed material consisting of gravels, boulders and clayey beds.

(Refer Clause 4.6.5.1)

In absence of any formula silt factor '*f* ' may be determined as per Clause 4.6.5 and may be adopted based on site information and behaviour history of any existing structures. The clayey bed having weighted diameter normally less than 0.04 mm offers more resistance to scour than sand, though mean depth of scour as per the formula given in Clause 4.6.3 & 4.6.4 indicates more scour. In absence of any accepted rational formula or any data of scour at the site of the proposed bridge, the following theoretical calculation may be adopted for clayey beds to calculate silt factor 'f ':

i) In case of soil having, angle of internal friction, $\emptyset < 15^o$ and cohesion of soil, c > 0.2 kg/cm^2.

$$f = F(1+\sqrt{c})$$

where, '*c*' is in kg/cm^2
and *F* = 1.50 for $\emptyset > 10^o$ and $< 15^o$
= 1.75 for $\emptyset > 5^o$ and $< 10^o$
= 2.00 for $\emptyset < 5^o$

ii) Soil having $\emptyset > 15^o$ will be treated as sandy soil even if *c* is more than 0.20 kg/cm^2 and silt factor will be calculated as per provisions of Clause 4.6.5.

RAILWAY BOARD'S ORDER: BSC recommendations approved. RDSO to send draft correction slip to IRS Bridge Substructure and Foundation Code for approval of Railway Board.

Item No. 1023 continued….

PRESENT STATUS: In compliance to BSC recommendation and Board's orders, Draft A&C Slip No.30 to "IRS Bridge Substructure and Foundation Code" was sent to Railway Board for approval vide letter No.CBS/PSBC dated 03.08.2010. Railway Board vide their letter No. 2009/CE-I/BR/Seminar(BSC)/1 dated 10.08.2010 directed RDSO to modify the description/wordings to make the provisions explicit. In response, revised draft A&C Slip was submitted by RDSO to Railway Board vide letter dated 14.09.2010 duly segregating the provision of silt factor for bed material consisting of gravels and boulders and clayey beds in proposed Appendix-VI. Railway Board vide their letter No. 2009/CE-I/BR/Seminar(BSC)/1 dated 10.11.2010 has further directed that '*RDSO should study few real cases on Indian Railways to firm up Correction Slip No. 30'.*

In view of the Board's above mentioned directives, CBEs of Zonal Railways were requested by RDSO vide letter No. CBS/PSBC dated 01.12.2010 for identifying few bridges on clayey beds and to collect the scour data and send to RDSO in the prescribed format for validation of formulae recommended by 79th BSC.

2. Item No. **898**/74th/2003/CBS/WRJ
Design of new bridges for LWR/CWR forces.

COMMITTEE'S RECOMMENDATIONS:

The Report of the committee to be finalized early.

RAILWAY BOARD'S ORDER: BSC recommendations accepted.

PRESENT STATUS: Committee's 3rd meeting held at IRICEN/PUNE on 04-07-2009. Draft report circulated by Director IRICEN to committee members. ED Track has some reservations about the additional rail stress due to LWR. Last meeting was held on 01-10-2010 at Railway Board and issues discussed. ED/Track suggested to use special rails for this purpose. Next meeting will be held after issue of specification of rails by ED/Track/RDSO. Now Board has decided to take up project with UIC. In view of above it is proposed that this item may be closed from here.

3. Item No. **905**/75th/2004/CBS/PSBC
Passing of service cables through bridges in parallel to track.

COMMITTEE'S RECOMMENDATIONS:

Committee recommends RDSO should issue General Arrangement drawing for passing of cables in consultation with S&T & Electrical Dte.

RAILWAY BOARD'S ORDER: RDSO should finalize and issue GAD for passing of cables in consultation with S&T and Electrical Directorate/RDSO.

Item No. 1023 continued….

PRESENT STATUS: The subject was studied and it has been observed that the requirement for passing service cable will be different for different bridge depending upon location, type of bridge and number of cables to be passed. So it is not feasible to issue a single drawing covering all the possible combinations. As the issue is site specific, it is proposed that the concerned department whose cable are to be passed through bridge in parallel to track should make a drawing and get it approved from the CBE before executing the work. In view of above, item may be closed.

4. Item No. **928**/76th/2007/CBS/Tour/ME
Technical instruction No.6 of ME - River training and Protection.

COMMITTEE'S RECOMMENDATIONS:

After discussions committee recommends that following modifications are suggested in the Sub-committee's Report for revision of chapter-VIII of IRBM (Indian Railway Bridge Manual) which had been submitted to Railway Board vide RDSO's letter No. EDBS/Proj/Committee dated 31/03/2008:

(I) New para 808 in Sub-committee's Report:

Provisions of return period is proposed to be modified as indicated below, as per Clause 4.2.2. of IRS Substructure Code:

Provision as per Report in the second paragraph (page 4) :

"For very important structures, return period is taken as 200 years and for other cases, return period of 50-60 years is generally adequate."

The above sentence may be replaced with the following :

"All bridges shall be designed with adequate waterway for design discharge. This shall normally be the computed flood with a probable recurrence interval of 50 years. However, at the discretion of Chief Engineer/Chief Bridge Engineer, bridges, damage to which is likely to have severe consequences may be designed for floods with a probable recurrence interval of more than 50 years*."*

(II) In proposed Para 809 (page 6) of Sub-committee report the following sentence modification may be made:

Provision as per Report:

The following types of river training works are generally adopted on Indian Railways:

The above sentence may be replaced with the following :

"The following types of river training works and bank protection measures are generally adopted on Indian Railways:"

Item No. 1023 continued….

(III) **Following typographical errors in the Report, may be corrected.**

(i) In para - 810 (2) (e) Add "radius of" in the second sentence which should read as under -

"The radius of downstream curved tail may be kept as 0.32 to 0.5 times the radius of upstream curved head."

(ii) Add "the top of drop" and "match" in 8th sentence of Para 820 of subcommittee report which should be read as under-

"The slope of floor should match the bed slope and also the top of drop wall should match the slope and also the top of drop wall should match the slope."

(iii) In the new para 820 proposed in sub-committee in the 3rd sentence of the paragraph titled "Major / Important Bridges", replace "for well/pipe foundation" with "well and pile foundation which should read as under –

"For well and pile foundation, they are designed for the scour and hence no protection is necessary even in case of a local scour."

(iv) In para 810 (2)(i) IS:10751-1983 and IRC:89-1985 should be replaced with IS:10751-1994 and IRC:89-1997 respectively.

(v) In para 810(2)(e) modify the last sentence to read as under "For important rivers multi radii may be selected generally after model studies for smoother flows.

(vi) In para 817, (i) IS:8408-1979 should be replace with IS:8408-1994 and (ii) relationship V=4.893d1/2 should be corrected as $V=4.893d^{1/2}$, (iii) In last sentence, replace "300 mm kg stone" with "300 kg stone".

With the above modifications, the sub-committee report may be approved by Railway Board for replacement of chapter-VIII of IRBM by means of an advance A&C slip and this item may be closed.

RAILWAY BOARDS ORDERS: BSC recommendations approved.

PRESENT STATUS: Railway Board vide their letter No. 2009/CE-I/BR/Seminar(BSC)/1 dated 11.11.2010 directed RDSO to submit Draft Correction Slip to IRBM and advised RDSO to go through entire proposed revision and to suggest any further improvement/discrepancies. In response, RDSO has reviewed the proposed revision and submitted Draft Correction Slip to IRBM for consideration of Railway Board vide letter No. CBS/PSBC dated 13.12.2010.

Item No. 1023 continued….

5. Item No. **934**/76th/2007/CBS/DAB
Criteria for safe load on arch bridge.

COMMITTEE'S RECOMMENDATIONS:

Committee to expedite and enhance scope to include retrofitting of old arch bridges in the report. Eastern Railway should carryout load test on representative arch bridge. The effect of retrofitting techniques like helifix, centac can also be considered. The result may be advised to committee for finalizing the report.

RAILWAY BOARD'S ORDER: BSC recommendations approved.

PRESENT STATUS: Committee is yet to finalize its report. Information from Eastern Railway is awaited.

6. Item No. **936**/76th/2007/CBS/PSBC
Adoption of ME's Technical Instruction No. 1, 2 & 3.

COMMITTEE'S RECOMMENDATIONS:

After discussion committee recommends that RDSO should study the reinforcement provided in Railway Bridge wells and compare the percentage steel with the provision of IRC and discuss the result in next BSC.

RAILWAY BOARD'S ORDER: BSC recommendations approved.

PRESENT STATUS: Zonal Railways were requested to furnish details of vertical and hoop reinforcement provided in plain cement concrete well foundations adopted in their Railways vide letter dated 25/26.03.2010 & 29/30.11.2010. Details from Zonal Railways except ECoR are awaited. Information received from ECoR is furnished below:

Bridge No.	Span & Type	Location	% vertical reinforcement	% hoop steel	Remarks
539	16x30.75m PSC Box Girder	NRG-KNPR	0.12% of gross area for steining of all abutments and piers	0.04% of volume per unit length of steining	Reinforce-ment provided is in conformity with the proposed provisions in agenda item of 79th BSC.
Rly. Fly Over	1x61.0m	SKND-JKPR	0.12% of gross area for steining of both abutments	0.04% of volume per unit length of steining	
7	8x45.7m steel through girder	BXQ-LPG	0.12% of gross area for steining of all abutments and piers	0.04% of volume per unit length of steining	

7. Item No. **955**/77th/2008/CBS/NIL
Inspection of PSC Girders.

COMMITTEE'S RECOMMENDATIONS:

The proposed modification to IRBM is accepted. Correction Slip to IRBM as submitted to Railway Board may be considered for approval.

Item No. 1023 continued….

RAILWAY BOARD'S ORDER: Add new Para 1107(15)(i) in IRBM as below:

1107(15)(i) – In case of PSC girders, measurement of loss of deflection should be done. Deflection measurement should be at centre upto 20m span and at centre & Quarter points for spans more than 20m. Deflection measurements would be entered in column 8 of Annexure 11/9 of IRBM. Correction Slip to IRBM to be issued.

PRESENT STATUS: The Advance Correction Slip No. 21 to Indian Railways Bridge Manual (IRBM) inserting para 1107(15)(i) was issued vide Board's letter no. 2009/CE-I/BR/Seminar (BSC)/1 dated 2.7.2010. The provisions of para 1107(15)(i) were discussed in CBE seminar held in Oct. 10 at IRICEN, Pune. The issue has been further studied in RDSO and it is considered that it would be more appropriate to use word "Camber" in place of word "Deflection" in para1107(15)(i) so that provision of IRBM conveys its proper meaning.

It is, therefore, proposed that para 1107(15)(i) be corrected as under :-

"Replace existing Para 1107(15)(i) in IRBM with following :

1107(15)(i) in case of PSC girders, measurement of loss of camber should be done. Camber measurement should be at centre upto 20m span and at centre and quarter points for spans more than 20m. Camber measurements would be entered in column 8 of Annexure 11/9."

Railway Board has been requested to consider the above and issue further orders vide RDSO's letter no. CBS/C-76 IRBM dated 29.12.2010.

8. Item No. **978**/16th Extra Ordinary/2008/CBS/Codes/A&C
Clause no.11 of IRS:CBC regarding Loads, Load combinations and Partial load factors.

COMMITTEE'S RECOMMENDATIONS:

(i) BTDG recommendations are accepted by incorporating following changes.

(ii) In load combination II & III the temporary erection loads should be removed.

(iii) RDSO to give a sample calculation for design of super structure and sub structure. Comparing the same with working stress method.

(iv) Note to be added that earth work load on bridges should be considered as dead load.

(v) Note to be added that the earthquake forces or construction stage should be taken for 5 years return period and values can be taken from relevant IS code.

(vi) In note 4 of table forces due to eccentricity to be added and separate mention of braking force may be deleted as it is covered in longitudinal force mentioned in the note.

Item No. 1023 continued….

RAILWAY BOARD'S ORDER:

(i) Y_{fl} factors given in table 12 of IRS Concrete Bridge Code be replaced by factors suggested by BTDG.

(ii) Notes below table 12 of IRS Concrete Bridge Code be replaced as suggested by BTDG except that note 4 would be as below:

Note 4: Live load shall also include dynamic effect, forces due to curvature exerted on track, longitudinal forces, forces due to eccentricity and forces on parapet.

PRESENT STATUS: A&C 13 to IRS CBC 1997 has been issued vide RDSO letter no. CBS/Codes/A&C dated 25/29.11.2010. Item may be closed.

9. Item No. **989**/16th Extra Ordinary/2008/CBS/Codes/A&C

*Clause no.16.8.3.3 (Friction in the Duct due to Unintentional variation form the Specified Profile**)** and clause no.16.8.3.4 (Friction in the Duct due to Curvature of the Tendon) of IRS:CBC.*

COMMITTEE'S RECOMMENDATIONS:

The following changes in Para 16.8.3 of IRS Concrete Bridge Code may be done.

a. The value of μ & K given in IRS Concrete Bridge Code to be replaced by values given in IRC -18 as per the recommendation of BTDG in existing clauses 16.8.3.3 and 16.8.3.4.

b. The clause No. 16.8.3.5 regarding Friction in Circular construction to be deleted.

c. The term 'x' is the actual length of tendon between jacking point and the point where we are calculating pre-stressing force after loss, which is to be mentioned in clause 16.8.3.3.

d. In existing clause 16.8.3.1.1, re-number clause reference '16.8.3.5' with '16.8.3.4'.

e. In existing clause 16.8.3.6, delete clause No. reference '16.8.3.5' and re-number existing clause 16.8.3.6 as '16.8.3.5'.

RDSO should process the necessary A&C Slip to IRS Concrete Bridge Code.

RAILWAY BOARD'S ORDER: BSC recommendations accepted. RDSO to send draft correction slip.

PRESENT STATUS: A&C 13 to IRS CBC 1997 has been issued vide RDSO letter no. CBS/Codes/A&C dated 25/29.11.2010. Item may be closed.

10. Item No. **995**/78th/2009/ CBS/PSB

Revision of fatigue provisions in IRS Steel Bridge Code.

COMMITTEE'S RECOMMENDATIONS:

Correction Slip to IRS Steel Bridge Code to be issued.

Item No. 1023 continued….

RAILWAY BOARD'S ORDER: Vide Railway Board's letter no. 2008/CE-I/BR/Seminar (BSC) 2 dated 23-06-2009, RDSO was required to fully ascertain the workability, suitability etc. of proposed revisions for design of new bridges. RDSO should apprise the result of above exercise before a decision is taken on correction slip.

PRESENT STATUS: Draft provisions have been discussed as agenda item in 78th BSC. λ values for 25t loading–2008 and DFC loading have also been received from IIT, Roorkee. Project completed in all respect. Draft correction slip to IRS Steel Bridge Code sent to Railway Board for approval vide RDSO letter No. CBS/PBR dated 30-04-2010. Further clarifications as desired by Rly. Bd. have also been submitted. Final approval of A&C Slip No. 18 to be given by Rly. Board.

11. Item No. **999**/78th/2009/ CBS/DPG-1
Design of 12.2m span Welded Plate Girder for "25t Loading-2008" (10 Million Cycle).

COMMITTEE'S RECOMMENDATIONS:

Committee recommends drawing to remain provisional and to be discussed in next BSC.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS: The above drawing was issued in September 2008. These drawing are also suitable for use in all seismic zones. In this reference letters are written to Chief Bridge Engineer of Zonal Railways, but no comments have been received till date.

12. Item No. **1000**/78th/2009/ CBS/DPG-1
Design of 18.3m span Welded Plate Girder for "25t Loading-2008" (10 Million Cycle).

COMMITTEE'S RECOMMENDATIONS:

Committee recommends drawing to remain provisional and to be discussed in next BSC.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS: The above drawing was issued in October 2008. These drawing are also suitable for use in all seismic zones. In this reference letters are written to Chief Bridge Engineer of Zonal Railways, but no comments have been received till date.

Item No. 1023 continued….

13. Item No. **1001**/78th/2009/ CBS/DPG-1
Design of 24.4m span Welded Plate Girder for "25t Loading-2008" (10 Million Cycle).

COMMITTEE'S RECOMMENDATIONS:

Committee recommends drawing to remain provisional and to be discussed in next BSC.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS: The above drawing was issued in November 2008. These drawing are also suitable for use in all seismic zones. In this reference letters are written to Chief Bridge Engineer of Zonal Railways, but no comments have been received till date.

14. Item No. **1003**/78th/2009/ CBS/DWF
Socket Resistance of Piles anchored in Rock.

COMMITTEE'S RECOMMENDATIONS:

Committee recommends to include new para no. 2.4.3.3 in "Manual on Design of Well and Pile Foundations" as-

"**2.4.3.3 Piles in rocks**

A pile socketed into rock derives its capacity from end bearing and socket side resistance. The ultimate load carrying capacity may be calculated from:

$Q_u = R_p + R_s = K_{sp} . q_c . d_f . A_p + A_s \ q_s$

Where

Q_u = Ultimate capacity of pile socketed into rock.

R_p = Ultimate end bearing

R_s = Ultimate side socket shear

K_{sp} = An empirical co-efficient whose value ranges from 0.1-0.4

q_c = Average uniaxial compressive strength of rock at tip level

A_p = Cross sectional area of base of pile

d_f = Depth factor= $1+0.4 \times \frac{length of socket}{Dia. of socket}$

length of socket may be limited to 0.5 x dia. of socket.

A_s = Surface area of socket

q_s = Ultimate shear along the socket. Value of q_s may be taken as 50kg/cm^2 for normal rock which may be reduced to 20 kg/cm^2 for weathered rocks.

Item No. 1023 continued….

Note:

1. For piles in rock, factor of safety shall be 5 on the end bearing component and 10 on socket side resistance component.
2. The maximum allowable end bearing pressure should be limited to 30 kg/cm^2 after applying factor of safety."

RAILWAY BOARD'S ORDER: BSC recommendations accepted. RDSO to send draft correction slip.

PRESENT STATUS: In compliance to BSC recommendations and Board's orders, Draft A&C slip No.3 to "Manual on Design and Construction of Well and Pile Foundations" was sent to Railway Board for approval vide letter No.CBS/DWF dated 12/16-07-2010. Railway Board directed to have a relook at the values given for q_s and the values given in the Note vide their letter No. 2009/CE-I/BR/Seminar(BSC)/1 dated 17.08.2010. In response, details were submitted by RDSO to Railway Board vide letter dt.07/08-09-2010. Railway Board vide their letter No. 2009/CE-I/BR/Seminar(BSC)/1 dt.10.11.2010 has further directed that:

"1) RDSO should incorporate the factors to be considered for deciding the values of K_{sp}. RDSO should also incorporate, how the value of q_c has to be adopted.

2) RDSO should also study certain real cases involving rocks on Indian Railways to firm up Correction slip No.3".

In view of the Board's above mentioned directives, CAOs and CBEs of Zonal Railways were requested to provide the design details and parameters adopted in design for bridges provided with pile foundations on rocks on their railways vide letter dated 02.12.2010. So far no information has been received by RDSO.

15. Item No. **1005**/78th/2009/CBS/Codes/A&C

Clause no.16.8.3.5 titled "Friction in Circular Construction" and clause No.16.8.3.6 titled "Lubricants" in IRS: Concrete Bridge Code.

COMMITTEE'S RECOMMENDATIONS:

Modification to Para 16.8.3 of IRS Concrete Bridge Code to be done as recommended in item No. 989.

RAILWAY BOARD'S ORDER: BSC recommendations accepted. RDSO to send draft correction slip as directed under item No. 989.

PRESENT STATUS: A&C 13 to IRS CBC 1997 has been issued vide RDSO letter no. CBS/Codes/A&C dated 25/29.11.2010. Item may be closed.

Item No. 1023 continued….

16. Item No. **1006**/79th/2010/CBS/Project Seismic/I&P
Guidelines on Seismic Design of Railway Bridges .

COMMITTEE'S RECOMMENDATIONS:

1. The guidelines may be issued to Zonal Railways for their comments and suggestions for improvement.
2. Amendment to IRS Bridge Rules may be proposed based on the feedback received from Zonal Railways, and discussed in next BSC.

RAILWAY BOARD'S ORDER: Recommendations of BSC are accepted.

PRESENT STATUS: Draft of "Guidelines for seismic design of railway bridges" has been submitted by IIT/Kanpur and comments of RDSO and other agencies sent to IIT/Kanpur. No comments were received from any Zonal Railway. Modified Draft Guidelines were received from IIT/Kanpur. After receiving the comments the same were discussed with IIT/Kanpur in a Series of meetings and guidelines have now been finalized and circulated to Zonal Railways. The document is under printing. Now training to Railway Engineers is being arranged at IIT/Kanpur.

17. Item No. **1008**/79th/2010/CBS/……..
Provision of Pathways on long girder bridge for inspection and maintenance.

COMMITTEE'S RECOMMENDATIONS:

Following recommendations are made:

(A) Indian Railway Schedule of dimension Item 15 (i) and (ii) is recommended for amendment as under:

Maximum distance apart of trolley refuges:

(i) On bridges with main spans of less than 50m = 50m

(ii) On bridges with main spans of 50m or more = A refuge over each pier

(B) A pathway of minimum 0.75m be provided on all major bridges.

RDSO should develop GAD for provision of pathway. Zonal railways should send their practices and drawings on the subject for study and development of drawing.

RAILWAY BOARD'S ORDER:

(i) Recommendations be discussed in TSC.

(ii) RDSO to develop GAD for provision of pathway.

Item No. 1023 continued….

PRESENT STATUS: The recommendations have been sent to Track Directorate for discussion in TSC for amendment in SOD of Item No. 15 (i) & (ii). The item has been discussed in TSC and recommendation have been submitted to Railway Board. RDSO has developed the drawing of man refuge on open web girders for span 30.5m and above and the Drg. No. CBS/0028 has been circulated to all railways on 24-8-2010. The same has been discussed in CBE's Seminar also.

18. Item No. **1009**/79th/2010/CBS/DCS

Standard drawing of Precast RC Bridge Slabs of standard spans 0.61, 0.915, 1.22, 1.83 & 2.44m for 25t Loading-2008, (Concrete Grade M-25).

COMMITTEE'S RECOMMENDATIONS:

RDSO to modify existing drawing to cover extreme environment condition and grade of concrete to be kept as M-35.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS:

(i) Provisional Drawing No. RDSO/B-10063 of Precast RC Bridge Slabs for standard spans was issued for 25t loading- 2008 (with Concrete Grade M-25) conforming to moderate environment conditions i.e. crack width not exceeding 0.20mm.

(ii) In order to cover extreme environment condition in the existing drawing, design crack width as calculated in accordance with Clause: 15.9.8.2 of IRS Concrete Bridge Code 1997 shall not exceed the value of 0.10mm given in Table 10 [Clause:10.2.1(a)] of IRS Concrete Bridge Code 1997.

(iii) RDSO studied effect of designing RC slab for 0.1mm crack width in order to evaluate if the designs with 0.1mm crack width can be universally adopted. The results of study are as under:

(a) The design crack width, calculated in accordance with Clause: 15.9.8.2 of IRS Concrete Bridge Code, depends mainly on depth of slab, spacing of main bars (keeping dia. of bars same) and clear cover to reinforcement. Crack width is independent of the grade of reinforcement steel and effect of increase in grade of concrete is marginal. Minimum clear cover of 50mm is prescribed for extreme environment conditions and as such clear cover of 50mm provided in provisional drawing cannot be reduced further.

(b) The design for standard span of 2.44m of precast RC Bridge slab for 25t loading- 2008 has been analysed to cover extreme environment condition with M-35 concrete grade as recommended by BSC for following cases:

Case (a): Keeping same overall depth and diameter of main bar.

Case(b): Keeping same overall depth and increasing diameter of main bar.

Item No. 1023 continued….

Case (c): Increasing the depth and diameter of main bar.

The results of the analysis carried out for 2.44m span are given below for consideration of BSC:

S. No.	Description of item	Provisional Drawing values	Results of Analysis for severe environment condition		
			Case (a)	Case (b)	Case (c)
1	Overall depth of slab (mm)	370	370	370	400
2	Diameter of main bar (mm)	16	16	20	20
3	c/c spacing of main bar (mm)	80	50	85	90
4	Remarks				
4(a)	% increase in steel		59	47	39
4(b)	% increase in concrete		-	-	8
4(c)	Feasibility	Clear spacing being **64mm**	Not feasible as clear spacing becomes **34mm**	Feasible with 47% increase in steel with clear spacing of **65mm**	Feasible with 39% increase in steel & 8% increase in concrete and clear spacing being **70mm**

The above table summarizes impact in adopting 0.1mm crack width universally.

(iv) In view of the above, BSC may deliberate and decide on following:

a) Limits to which depth of slab can be increased considering aspects of approach raising for economizing design and adopt the same universally.

b) Considering limited population of bridges in moderate condition, limiting inventory of slab types etc., issue of standard drawings for severe/extreme environment condition only for universal adoption by RDSO in due course.

19. Item No. **1010**/79th/2010/CBS/DCS

Standard drawing of Precast RC Bridge Slabs of standard spans 0.61, 0.915, 1.22, 1.83 & 2.44m for DFC Loading (32.5t Axle Load), (Concrete Grade M-30).

COMMITTEE'S RECOMMENDATIONS:

RDSO to modify existing drawing to cover extreme environment condition and grade of concrete to be kept as M-35.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

Item No. 1023 continued….

PRESENT STATUS:

(i) Provisional Drawing No. RDSO/B-10062 of Precast RC Bridge Slabs for standard spans was issued for DFC loading (with Concrete Grade M-30) conforming to moderate environment conditions i.e. crack width not exceeding 0.20mm.

(ii) In order to cover extreme environment condition in the existing drawing, design crack width as calculated in accordance with Clause: 15.9.8.2 of IRS Concrete Bridge Code 1997 shall not exceed the value of 0.10mm given in Table 10 [Clause: 10.2.1(a)] of IRS Concrete Bridge Code 1997.

(iii) RDSO studied effect of designing RC slab for 0.1mm crack width in order to evaluate if the designs with 0.1mm crack width can be universally adopted. The results of study are as under:

(a) The design crack width, calculated in accordance with Clause: 15.9.8.2 of IRS Concrete Bridge Code, depends mainly on depth of slab, spacing of main bars (keeping dia. of bars same) and clear cover to reinforcement. Crack width is independent of the grade of reinforcement steel and effect of increase in grade of concrete is marginal. Minimum clear cover of 50mm is prescribed for extreme environment conditions and as such clear cover of 50mm provided in provisional drawing cannot be reduced further.

(b) The design for standard span of 2.44m of precast RC Bridge slab for 25t loading- 2008 has been analysed to cover extreme environment condition with M-35 concrete grade as recommended by BSC for following cases:

Case (a): Keeping same overall depth and diameter of main bar.

Case(b): Keeping same overall depth and increasing diameter of main bar.

Case (c): Increasing the depth and diameter of main bar.

The results of the analysis carried out for 2.44m span are given below for consideration of BSC:

S. No.	Description of item	Provisional drawing details	Results of Analysis for severe environment condition		
			Case (a)	Case (b)	Case (c)
1	Overall depth of slab (mm)	375	375	375	400
2	Diameter of main bar (mm)	20	20	25	25
3	c/c spacing of main bar (mm)	85	60	95	100
4	Remarks				
4(a)	% increase in steel	-	43	40	33
4(b)	% increase in concrete	-	-	-	7

Item No. 1023 continued….

4(c)	Feasibility	Clear spacing being **65mm**	Not feasible as clear spacing becomes **40mm**	Feasible with 40% increase in steel with clear spacing of **70mm**	Feasible with 33% increase in steel & 7% increase in concrete and clear spacing being **75mm**

The above table summarizes impact in adopting 0.1mm crack width universally.

(iv) In view of the above, BSC may deliberate and decide on following:

a) Limits to which depth of slab can be increased considering aspects of approach raising for economizing design and adopt the same universally.

b) Considering limited population of bridges in moderate condition, limiting inventory of slab types etc., issue of standard drawings for severe/extreme environment condition only for universal adoption by RDSO in due course.

20. Item No. **1011**/79th/2010/CBS/DPA

Design of substructure i.e. Pier and Abutment suitable for span 6.1m precast PSC slab (2 units) conforming to 25t Loading-2008.

COMMITTEE'S RECOMMENDATIONS:

Committee recommends that RDSO should revise drawings suitable for Zone V.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS:

(i) Provisional Drawing No. RDSO/B-10339 & RDSO/B-10340 for design mass concrete pier and abutment suitable for span 6.1m precast PSC slab (2 units) conforming to 25t Loading-2008 (Concrete Grade M-25) is issued for seismic zones II & III.

(ii) As per Note to Clause 5.12.1.1 of IRS Bridge Substructure and Foundation Code:

"In Zones IV & V, suitably designed reinforced concrete piers and abutments shall be used and where use of mass concrete/masonry substructures becomes unavoidable, a minimum surface reinforcement as per formula given below may be provided vertically on each face of the pier/abutment to improve the ductility of the substructure and surface reinforcement not less than 5Kg/m2 may be provided horizontally. Spacing of such reinforcement shall not exceed 500mm center to center.

$$P_s = \frac{0.2F_r}{F_y} \times 100\%$$

Item No. 1023 continued….

Where,

Ps = percentage steel area on each face of masonry/mass concrete.

Fr= modulus of rupture of masonry/mass concrete.

Fy= yield strength of steel."

The provision indicates that provision of mass concrete substructures should be avoided in seismic zones IV & V.

(iii) Computation of seismic force depends upon several local factors like soil parameters, type of foundations provided, soil foundation interaction, importance of the bridge, type of seismic zone etc. as per clause 2.12 of IRS Bridge Rules. These parameters are site specific and generalization of these parameters on safer side shall be uneconomical. In view of this, it is considered that Zonal Railways continue to undertake design of substructure for seismic zones IV & V keeping prevailing site conditions in view.

(iv) In view of the above, BSC may consider to standardize the provisional Drawing No. RDSO/B-10337 & RDSO/B-10338 for seismic zones II & III (for overall bridge length less than 60m) where seismic forces are not required to be considered in design as per provision of clause 2.12.5.2 of IRS Bridge Rules.

21. Item No. **1012**/79th/2010/CBS/DPA

Design of substructure i.e. Pier and Abutment suitable for span 9.15m precast pre-tensioned PSC slab (3 units) conforming to 25t Loading-2008.

COMMITTEE'S RECOMMENDATIONS:

Committee recommends that RDSO should revise drawings suitable for Zone V.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS:

(i) Provisional Drawing No. RDSO/B-10339 & RDSO/B-10340 for design mass concrete pier and abutment suitable for span 6.1m precast PSC slab (2 units) conforming to 25t Loading-2008 (Concrete Grade M-25) is issued for seismic zones II & III.

Item No. 1023 continued….

(ii) As per Note to Clause 5.12.1.1 of IRS Bridge Substructure and Foundation Code:

"In Zones IV & V, suitably designed reinforced concrete piers and abutments shall be used and where use of mass concrete/masonry substructures becomes unavoidable, a minimum surface reinforcement as per formula given below may be provided vertically on each face of the pier/abutment to improve the ductility of the substructure and surface reinforcement not less than 5Kg/m2 may be provided horizontally. Spacing of such reinforcement shall not exceed 500mm center to center.

$$P_s = \frac{0.2F_r}{F_y} \times 100\%$$

Where,

Ps = percentage steel area on each face of masonry/mass concrete.

Fr= modulus of rupture of masonry/mass concrete.

Fy= yield strength of steel."

The provision indicates that provision of mass concrete substructures should be avoided in seismic zones IV & V.

(iii) Computation of seismic force depends upon several local factors like soil parameters, type of foundations provided, soil foundation interaction, importance of the bridge, type of seismic zone etc. as per clause 2.12 of IRS Bridge Rules. These parameters are site specific and generalization of these parameters on safer side shall be uneconomical. In view of this, it is considered that Zonal Railways continue to undertake design of substructure for seismic zones IV & V keeping prevailing site conditions in view.

(iv) In view of the above, BSC may consider to standardize the provisional Drawing No. RDSO/B-10337 & RDSO/B-10338 for seismic zones II & III (for overall bridge length less than 60m) where seismic forces are not required to be considered in design as per provision of clause 2.12.5.2 of IRS Bridge Rules.

22. Item No. **1013**/79th/2010/CBS/DPS

Standard drawing of 3.05m PSC Pre-tensioned slab (2-unit) for 25t Loading-2008.

COMMITTEE'S RECOMMENDATIONS:

The drawing should be revised for:

1. The R.C.C. Retainer should of M-35.
2. The drawings should be suitable for severe environmental condition.
3. The drawings should be suitable for all seismic zones.

Item No. 1023 continued….

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS: The drawing is suitable for all seismic zone. The design of ballast retainers with M-35 for severe environment is in progress.

23. Item No. **1014**/79th/2010/CBS/DPS
Standard drawing of 3.66m PSC Pre-tensioned slab (2-unit) for 25t Loading-2008.

COMMITTEE'S RECOMMENDATIONS:

The drawing should be revised for:

1. The R.C.C. Retainer should of M-35.
2. The drawings should be suitable for severe environmental condition.
3. The drawings should be suitable for all seismic zones.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS: The drawing is suitable for all seismic zone. The design of ballast retainers with M-35 for severe environment is in progress.

24. Item No. **1015**/79th/2010/CBS/DPS
Standard drawing of 4.57m PSC Pre-tensioned slab (2-unit) for 25t Loading-2008.

COMMITTEE'S RECOMMENDATIONS:

The drawing should be revised for:

1. The R.C.C. Retainer should of M-35.
2. The drawings should be suitable for severe environmental condition.
3. The drawings should be suitable for all seismic zones.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS: The drawing is suitable for all seismic zone. The design of ballast retainers with M-35 for severe environment is in progress.

25. Item No. **1016**/79th/2010/CBS/DPS
Standard drawing of 6.1m PSC Pre-tensioned slab (2 unit) for 25t Loading-2008.

COMMITTEE'S RECOMMENDATIONS:

RDSO to revise drawing for:

1. The concrete mix for PSC slabs should be M-45.
2. The concrete mix of RCC retainer should be M-35.
3. The drawings should be suitable for all seismic zones.

Item No. 1023 continued….

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS: The design of slabs with M-45 and ballast retainers with M-35 for severe environment is in progress.

26. Item No. **1017**/79th/2010/CBS/DPS

Standard drawings of 9.15m PSC Pre-tensioned slab (3 unit) for 25t Loading-2008.

COMMITTEE'S RECOMMENDATIONS:

RDSO to review drawing for:

1. The drawings should be suitable for severe environmental condition.
2. Lifting arrangement should be reviewed.

RAILWAY BOARD'S ORDER: Railway Board Orders are not required in terms of Board's letter no. 2005/CE-I/BR-II/8 dated 04-08-2009.

PRESENT STATUS: The design of ballast retainer with M-35 and sever environment is in progress. Lifting hooks are already provided in RDSO design.

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80th MEETING OF BRIDGE AND STRUCTURES STANDARDS COMMITTEE (February, 2011)

ITEM NO. 1024

Subject : Inclusion of provision of HSFG Bolt in IRS Steel Bridge Code.

BSC Reference : Item No. 589 of 51st BSC, Item No. 701 of 59th BSC and Item No. 749 of 62nd BSC.

RDSO File No. : CBS/DFP.

Agenda : Deliberations on Inclusion of Provision of HSFG Bolt In IRS Steel Bridge Code.

NOTES BY SECRETARY

Comments of CBE/S.R. on Provisions for HSFG Bolts:

At present, no provisions are available in the IRS Steel Bridge Code for use of HSFG bolts nor have any separate guidelines been issued by RDSO. HSFG bolts are now being universally adopted for all types of steel structures in lieu of riveting which is a difficult task. Quality of riveting is also poor due to site conditions, especially in case of replacement of loose/corroded rivets at site.

The use of HSFG bolts is being demanded regularly by various agencies, particularly in ROBs with composite construction. Hence, there is need for making codal provision and guidelines for use of HSFG bolts in Railway Bridge Construction.

General:

The joining of various part of any bridge girder can be done using welding, hot driven rivet, Black Bolt or HSFG Bolt connections.

Present IRS Codes provide for welded, riveted and normal Black Bolt connections.

On Indian Railways, the HSFG Bolts have been used in Ajnikhand Bridge in Udhampur-Srinagar Project, use on Chenab Bridge is also planned apart from a number of ROB's where HSFG Bolts have been used.

It is also observed that now days Quality of Rivets & workmanship is becoming an issue. Also at some locations, due to site constraints, location of joint is such that Riveting is not possible, here HSFG Bolts comes as a handy solution.

The use of HSFG Bolts on Bridges was first discussed by BSC vide Item 589 of 51st BSC (1971) and Committees Recommendation are given as under:-

Item No. 1024 continued….

Committees Recommendations of 51th BSC Item No. 589 (1971)

(I) High strength friction grip bolts should be tried by the railways as detailed below:

(a) Bracing 12.2m BGML girders on Northern and Western Railways, and of 12.2m MGML girders on North Eastern Railway.

(b) Splices and bracings of turn-table girders on North Eastern Railway.

(c) Connections of steel channel sleepers to the rail bearers in open web girders on South Eastern Railway.

(d) Connections in floor systems of open web girders where the deck is fully covered on South Eastern Railway.

(II) Anti-sabotage measures should be developed by RDSO to enable further use of these bolts in bridge girders.

Railway Board Orders of 51th BSC Item No. 589

(I) High strength friction grip bolts should be tried by the railways as detailed below:

(a) Bracing of 12.2m BGML girders on Northern and Western Railways and of 12.2m MGML girders on North Eastern Railway.

(b) Slices and bracings of turn-table girders on North Eastern Railway.

(c) Connections of steel channel sleepers to the rail bearers in open web girders on South Eastern Railway.

(d) Connections of steel trough floorings with girders where the troughings rest on the girders, on Western and Eastern Railway.

(II) RDSO should take necessary action to develop anti-sabotage measures essential for the use of friction grip fasteners with safety in railway bridge girders and put up proposals for the consideration of the Bridge and Structures Standards Committee.

(III) RDSO should also keep track of the investigations being carried out by the ORE with regard to the behavior of high strength bolted connections with protected faying surfaces under dynamic loads and advise the railways accordingly as soon as final Report is published by ORE on Question No. D-90.

The subject for the use of HSFG Bolts was further reviewed by BSC vide Item 644 of 55th BSC and the Committee Recommendations as noted by the Railway Board are as under:

Item No. 1024 continued….

Committee's Recommendations:

"Northern Railway procured 40 high strength friction grip bolts and used on bridge No. 222-A on Moradabad-Ghaziabad section. South Eastern Railway have procured 500 such bolts for trials, a part of which will be supplied by them to North Eastern and Western Railways. The Railways may send reports of the trials to RDSO periodically."

While discussing the draft specifications for fabrication and erection of steel work and draft manual of instructions for maintenance of steel work of microwave towers-self supporting type, the BSC, vide item 661 of the extraordinary meeting held in Nov. 1977, observed that although riveting of the joints would be preferable to bolted connections but since this is not practicable in structures like microwave towers, high strength friction grip bolts give superior quality of connections and better service. Moreover, in tall tower structures such as multistoried buildings and towers where wind induced vibrations are an important factor, the American Institute of Steel Construction prohibits use of black bolts in important connections. BSC therefore recommend that.

COMMITTEE'S RECOMMENDATIONS (Item 661 – Extraordinary BSC 1977):

"Use of high tensile friction grip bolts for some critical connections and splices in microwave structures will be conducive to better retention of shape and geometry of structures and easier maintenance."

The subject of HSFG fasteners was again discussed vide item 701 of the 59th meeting of the BSC held in July 1980. The Committee's observations, recommendations and Board's Orders thereon are appended below:

Committee's Observations of 59th BSC

The committee discussed the use of high strength friction grip bolts in bridges and other structures and discussed the benefits in use of these as also their design and installation procedures such as slip factor applicable to different surfaces; the method of tightening to be adopted; the use of bolts in replacement of loose rivets in riveted joints, etc. The Committee also discussed the possibility of sabotage by removal of HSFG Bolts from bridge girders and noted that removal of these bolts is quite difficult. It was agreed that procurement of bolts may be made to IS, BS or ASTM specifications as can be indigenously procured. The Committee noted that the trials carried out so far were neither with bolts of proper quality nor installed under proper supervision.

Committees Recommendations of 59th BSC Item No. 701

HSFG bolts be used as a trial measure in main joints of a few bridge girders, and in other structures such as gantry girders, turntables, etc.

Item No. 1024 continued….

Railway Board's Orders of 59th BSC Item No. 701

Recommendation(1): Approved.

(a) Eastern and Central Railways may carry out trials of high strength friction grip bolts in splice joints on 18.3m span girders.

(b) All Railways may use high strength friction grip bolts as a trial measure in structures such as gantry girders and furnish reports to RDSO on these performance.

Committees Recommendations of 61st BSC Item No. 739

The specifications and special conditions be approved and used by al Zonal Railways for procurement of HSFG Bolts nuts and washers.

Railway Board's Orders of 61st BSC Item No. 739

Approved.

Committees Observations of 62nd BSC Item No. 749

As the specification has been issued to Zonal Railways, the Committee Recommend that the item may be closed.

Committees Recommendations of 62nd BSC Item No. 749

This item may be closed.

Railway Board's Orders of 62nd BSC Item No. 749

Closure of item is approved. (Specification issued are placed at Annexure-A).

Efforts Made by RDSO:

(I) As per Railway Board Order in 51st BSC, RDSO kept track of the investigations carried out by the ORE with regard to the behavior of HSFG connections with protected faying surfaces under dynamic loads and accordingly prepared the detailed report C-258. The report also has detailed test plans to conduct the (1) static (2) Sustained and (3) Dynamic Load Tests on HSFG Bolts of 16, 20 & 24mm dia confirming to different IS & BS specifications under different faying conditions to obtain (1) slip factor and (2) Loss in pre-stress (3) effect of corrosion on slip factor through accelerated corrosion.

(II) In continuation of above, the Static Load Tests were conducted on 16mm, 20mm & 24mm HSFG Bolts for different faying conditions and slip factor obtained for different conditions.

Item No. 1024 continued….

(a) Condition 'a' – Both bolts and faying surfaces are hot dipped-galvanized and faying surfaces cleaned by wire brush.

(b) Condition 'b' – Both bolts and faying surfaces are left unprotected & faying surfaces cleaned by wire brush.

(c) Condition 'c' – Faying surfaces protected with hot dipped galvanizing and bolts remaining un-protected & faying surfaces cleaned by wire brush.

(d) Condition 'd' – Faying surfaces unprotected and bolts protected with Phosphate coating & faying surfaces cleaned by wire brush.

(e) Condition 'e' – Both bolts and faying surfaces are left unprotected & faying surfaces cleaned by grit or sand blast.

The slip factor was found maximum for condition (e) i.e. faying surfaces cleared by grit or sand ballasting.

Application of the required torque to the bolts was given during 2-3 hrs of the cleaning of the surface and thereafter period of 18 hrs was allowed to be elapsed between the tightening of the bolts & the testing of the specimens. Although no appreciable loss of prestress was observed during this period, However, a study reveal that the loss of pretension occurred only in the initial stages of the about 72 hours and therefore retightening will have to be thought of after the first stage of the application of torque.

The Report C-246 was issued, however conclusion could not be drawn for want of dynamic & Fatigue Tests.

(iii) Subsequently tests for Sustained Loads for the above mentioned faying conditions and effect of corrosion were conducted to ascertain.

(i) The effect of permanent/sustained loads in the performance of high strength bolted connection under different surface conditions rendered to bolt and faying surfaces.

(ii) To ascertain the loss in pretension during the period the loads are allowed to sustain on the specimen.

It was found that accelerated corrosion does not bring deterioration in the performance of the joints using HSFG Bolts, though conclusion was not drawn as results of only limited tests was available. Fatigue Loads Testing facility was not available & same could not be carried out. Under sustained loads no detrimental effect on slip factor was found, but since limited tests were carried out, conclusions remained inconclusive.

Item No. 1024 continued….

Fresh Literature Survey:

Use of HSFG Bolts for Bridges have been recommended by all advanced countries and provisions exist in various important codes as follows:

(i) IRC 24-2001

(ii) Euro Code

(iii) ISO

(iv) Japanese Specifications for Highway Bridges

(v) AASHTO

(vi) SIA

(vii) DIN

(viii) BS:5400 Part-III

IS 4000/1992 is being widely used for the design of HSFG Bolts in ROB's. Para 506.5.6 of IRC 24-2001 also recommends use of IS:4000 for usage of HSFG Bolts in the ROB's. Para 512.3.1 of IRC-24 says that minimum dia of HSFG Bolt used in load bearing members shall be 16mm diameter.

Important Issues for design of HSFG Bolts:

(I) Value of Slip Factor for Design – Slip factor plays a very crucial role in determining the Load Carrying Capacity of HSFG Bolt. For e.g. reduction in Slip Factor from 0.45 to 0.20 on 24mm Dia cat. 8.8 Bolt will reduce the friction load carrying capacity from 6.95 tonne to 3.09 tonne. Role of surface preparation and painting is very crucial to attain the desired slip factors.

(II) Selection of proper method for tightening of HSFG Bolts to ensure minimum bolt tension – IS:4000 prescribes two types of Tensioning Procedure in Para 7.2 as below:

1 A: Part turn tensioning of bolts and nuts in the joints shall be to snug tight condition to ensure that load constraint plies are brought into effective contact.

(i) After completing this primarily tightening location marks shall be establish to mark the relative position of bolt and nut. Bolts shall b e finally tensioned by all defined amount of half turn to ¾ turn as per IS-4000 Table-4 to achieve the desired tension in the bolt.

(ii) Tension by use of direct tension indication: This is a superior method where direct tensioning indication device is provided as per manufacturers instruction which gives the measurement of desired tension in the bolt.

Testing of effectiveness of tensioning can be done as per pera 8.2 of IS:4000.

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(III) **Risk for Sabotage –** The BSC has already discussed in 59th BSC the possibility of sabotage by removal of HSFG Bolts from Bridge Girders and noted that removal of these bolts is quite difficult (It is claimed that bolts do not work loose even in dynamically loaded structures due to high frictional resistance in the thread as a result of high tension in the Bolt).

The Recommended slip factor for various surfaces as per IS:4000 (Annex-C) are given as below:-

S.No.	Treatment of Surface	Slip Factor μ
1.	Surface are cleanas rolled sections	0.35
2.	Surface not treated	0.20
3.	Surface blasted with shot or grit with any loose rust removed, no pitting	0.50
4.	Surfaces blasted with shot or grit and hot-dip galvanized	0.10
5.	Surfaces blasted with shot or grit and spray-mtallized with zinc (thickness 50-70 μ_m)	0.25
6.	Surfaces blasted with shot or grit and painted with ethyl-zinc silicate coat (thickness 30-60 μ_m)	0.30
7.	Surfaces blasted with shot or grit and painted with ethyl-zinc silicate coat (thickness 60-80 μ_m)	0.30
8.	Surfaces blasted with sot or grit and painted with alkali-zinc silicate coat (thickness 60-80 μ_m)	0.30
9.	Surfaces blasted with shot or grit and spray-metalized with aluminum (thickness >50 μ_m)	0.50

Note: *The contact surfaces shall not be sand blasted.*

There are provisions for use of HSFG Bolts in Bridges as per BS:5400 Part-3:1982 and slip factor for different surface conditions/ faying surface are as below:

S.No.	Treatment of Surface	Slip Factor μ
1.	Weathered surfaces clear of all mill scale and loose rust	0.45
2.	Surfaces blasted with shot or grit and with loose rust removed	0.50
3.	Surfaces sprayed with aluminum	0.50
4.	Surfaces sprayed with zinc	0.40
5.	Surfaces treated with zinc silicate paint	0.35
6.	Surfaces treated with etch primer	0.25

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Note: *The slip factors given in (1) to (6) should be reduced by 10% where higher grade bolts in accordance with BS:4395 : Part 2 are used.*

The International Comparison of slip factors as given in various codes i.e. EURO Code, AASHTO, DIN, Japanese Code etc. are given as below:

Slip Factor	**The treatment or the condition of the friction surface**
• Eurocode[2] (1997).	
0.50	Shot-blasting or grit-blasting.
0.50	Zinc based metal spray guaranteed the slip factor 0.5 at least after shot-blasting or grit-blasting.
0.30	The surface removed loose scale after cleaned by wire brushing or flame cleaning.
0.20	None.
• ISO[4] (1997)	
0.33	The surface with clean mill scale.
0.40	The surface removed mill scale and loose scale and after exposure outdoors.
0.50	Shot-blasting or grit-blasting.
0.50	Inorganic zinc-rich painting with thickness under 60 micrometer.
0.35	Organic Zinc-rich painting with thickness under 60 micrometer.
0.40	Blasting on the galvanized surface with thickness over 50 micrometer.
• The Japanese Specifications for Highway Bridges[1] (2002)	
0.40	The rough surface removed mill scale.
0.40	Thick inorganic zinc-rich painting.
• AASHTO[3] (1994)	
0.33	The surface with clean mill scale.
0.50	Class A coating after blasting.
0.50	Blasting.
0.40	Class B coating after blasting.
0.40	The rough surface with galvanization.
• SIA[5] (1979)	
0.30	The surface with clean mill scale.

0.50	Sand-blasting or flame cleaning.
0.40-0.50*	Zinc based metal coating after sand-blasting.
0.43-0.45*	Zinc based organic coating after sand-blasting.
0.35	The rough surface with galvanization.
The value of * is depended on the process of the painting.	
• DIN[7)] (1990)	
0.50	Shot-blasting or grid-blasting.
0.50	Flame cleaning twice.
0.50	Alkali silica zinc powder painting.

Advantages of HSFG Bolts:

The following advantages are claimed for high strength frication grip fasteners:

(i) Higher fatigue strength than that of riveted joints. There is absence of heavy stress concentration due to absence of bearing between bolts & nuts. (As per table 15-1-9 of AREMA Manual for Railway Engineering, the category of connection is D for riveted joints which is upgraded to category 'B' for HSFG Bolted connections) Thus number of bolts can be reduced which will also reduce the size of gusset plate.

(ii) The frictional resistance is effective outside the hole and therefore lesser load is transmitted though the net section. Thus, the possibility of failure at the net section is reduced.

(iii) Easy and quick fabrication, as difference between the diameter of the hole and the bolt is large and higher tolerances can be allowed;

(iv) Erection at site is quicker and needs no special equipment;

(v) Requires less skilled labour than riveting;

(vi) Absence of shear, bearing and bending stresses in the bolt.

(vii) Noise nuisance while fabrication is not there as these bolts are tightened with wrenches.

(viii) Replacement can be done easily.

Caution for use of high strength friction grip bolts:

(i) There is remote possibility of nuts working loose. It is, however, claimed that nuts do not work loose even in dynamically loaded structures due to high frictional resistance in the thread as a result of high tension in the bolt;

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(ii) IS:4000-1967 provides for tightening of bolts by two method (a) Torque Control method, and (b) Part Turn Method. Whith the first method, there is no visual check possible on completion of job and special tools are required for the tightening of the nut. The second method does not require any sophisticated tools but the efficiency of this method depends on the initial condition of joints before giving the final turn. The characteristics of friction grip joint depends upon the clamping forces induced by the high bolt tension, and the variation in the bolts tension with either of these two methods can be ± 15 to 30 per cent. In latest IS:4000-1996 torque control method has been removed.

A comparison of rivet values and friction capacity of HSFG Bolts is made for different diameters as given below:

HSFG Bolt / Rivet Dia (mm)	***Rivet strength in single shear (tonne)***	***HSFG Bolt 8.8 Friction Capacity for single interface. (tonne)***				***HSFG Bolt 10.9 Friction Capacity for single interface. (tonne)***			
		Minimum Bolt Tension (tonne)	***Slip Factor***			***Minimum Bolt Tension (tonne)***	***Slip Factor***		
			0.20	***0.35***	***0.45***		***0.20***	***0.35***	***0.45***
16	2.45	9.63	1.38	2.41	3.10	13.25	1.89	3.31	4.26
20	3.70	14.98	2.14	3.75	4.82	20.69	2.96	5.17	6.65
22	4.42	HSFG Bolt of 22mm dia is not prescribed in IS:4000							
24	5.21	21.61	3.09	5.40	6.95	29.87	4.27	7.47	9.60
30	8.20	34.35	4.91	8.59	11.04	47.50	6.79	11.88	15.27
36	11.56	49.95	7.14	12.49	16.06	69.11	9.87	17.28	22.21

ar capacity of above shown HSFG Bolts will be reduced if

a) Grip length is more than 5d

b) Connection length is more than 15d

ii) The permissible stress in shear for rivets is 10.2kg/mm2

iii) No. of interface is one and FOS for HSFG bolts is 1.4

iv) When wind forces are under consideration, FOS is reduced from 1.4 to 1.2 i.e. in other words permissible stresses are increased by 16.67%, which matches provisions of SBC

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RDSO Views:

(i) That extensive field trials of HSFG Bolts may be undertaken in Plate Girders, Composite Plate Girders and ROB's. Provision of IS:4000-1992 should be used for such trials.

(ii) Replacement of riveted joints of the fatigue prone members of Railway Bridges may be done with "HSFG Bolts".

(iii) Instead of having separate specifications for HSFG Bolts use of IS:4000-1992 can serve the purpose.

Committee may deliberate further.

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80th MEETING OF BRIDGE AND STRUCTURES STANDARDS COMMITTEE (February, 2011)

ITEM NO. 1025

Subject : Standard Drawings for FOB's.

BSC Reference : CBS/DFOB.

RDSO File No. : Nil.

Agenda : Standardization of design and drawings of FOB to cater for most of the situations.

NOTES BY SECRETARY

Comments of CBE/East Coast Railway:

Till date, RDSO has not issued any standard drawing for FOB's on stations. As a result, different Railways are using different drawings. Standard FOB drawings should be issued by RDSO for different combination of tracks.

General:

In past RDSO had issued standard drawings of FOB for 1.8m width long back and the same were in use but subsequently they have gone in dis-use because of various site conditions and changes in the SODs.

RDSO also issued drawings for Foot Over Bridges for 3BG tracks using square and rectangular hollow sections in August, 2001 along with guidelines. However, none of the Railways preferred to deviate from the conventional sections and no feed back could be obtained regarding use of new drawing.

Construction of FOB is passenger amenity item and coordinated by CPDE's. Bridge Organization has limited control & responsibility limited to structural design only. In some Zonal Railways even this aspect is looked after by CPDE's.

Configuration of FOB depends on many aspects like;

Factors affecting Span and Superstructure of FOB:

i) Number of tracks across which FOB is to be provided.

ii) Track Centers which may vary from 4.265m to 5.3m or even more.

iii) The width of the FOB which is dependent on the number of passengers to be dealt.

Factors affecting Ramp/Stair cases of FOB:

i) The route on which it is to be provided since the vertical clearance are different for different routes like non-electrified section double stack container routes etc.

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ii) Height of Platform whether rail level or low level or high level.

iii) Slope of ramp/steps.

iv) Maximum steps in one flight before landing and length of interim landings.

v) Width of platform.

Hence, it is necessary to standardize the span, width, vertical clearances etc. which can cater for most of the situations. This may involve association of CPDE's.

Some suggestion can be:-

(i) Following Spans may be considered for design:-

S.No.	No. of Tracks to be crossed	Minimum clear spacing required @ 5.3m track C/C	Minimum clear Span proposed
1.	Two	16.02m	16.5m
2.	Three	21.32m	22.0m
3.	Four	26.62m	27.0m

Note: *Minimum horizontal distance from center line of track to any structure on platform is 5330mm.*

(ii) FOB may be designed for two standard widths:

- 3.0m wide FOB.
- 6.0m wide FOB.

(iii) Standard height of platform to be considered for design:

- Low level platform (455mm).
- High level platform (760mm and 840mm).

(iv) Material for construction:-

- Solid I-section.
- Truss type steel girder
- Square/ Rectangular Hollow Section.

❖ ***Item No. 1025 continued….***

This item was discussed in CBE's Seminar held at IRICEN on 18th & 19th Oct 2010. The recommendations are:-

"Eastern Railways shall submit design of FOB for checking to RDSO and then circulate to all Zonal Railways."

BSC may deliberate and decide-

(i) Role of Bridge organization in construction & maintenance of FOBs.

(ii) Constitution of a committee to decide standard configuration of FOBs which can cover most of the situations.

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80th MEETING OF BRIDGE AND STRUCTURES STANDARDS COMMITTEE (February, 2011)

ITEM NO: 1026

Subject	:	Coatings for Concrete structures
BSC Reference	:	14th Extra Ordinary BSC
RDSO File No.	:	CBS/C-Spl/99 & CBS/CODES/A&C
Agenda	:	To review provisions of IRS-Concrete Bridge Code regarding Coatings for Concrete structures.

NOTES BY SECRETARY

(A) CBE/SR OBSERVATION:

CBE/SR Vide letter no W.81/1/54 dated 29/30.12.2010 has pointed out following:-

Coatings for Concrete Bridges were incorporated vide Cl.5.4.7 of IRS Concrete Bridge Code for Super structure with Epoxy Phenolic IPN or CECRI Integrated four Coat System and Sub structure with Coaltar Epoxy Coatings in affected parts in Severe and Extreme environments. No Coatings are required in Non aggressive environment i.e. with Moderate Exposure. Subsequently, the same was deleted vide A&C No.8 dated 15.02.2006.

The above coatings are essentially required to provide adequate resistance against corrosion for Concrete Structures, particularly in coastal areas. In this connection RDSO have issued detailed coating system for concrete structures vide BS-14 in the year 2001, giving the same recommendations as in Cl.5.4.7 of IRS Concrete Bridge Code. The deletion from the code, however, has given an impression that the concrete coatings are not the favoured mode of corrosion protection.

(B) BACKGROUND :-

1) Clause 5.4.7 containing provision for coating of concrete structures was incorporated in IRS: CBC by A & C Slip No 1 Dated 26.04.2000 based on recommendations of an expert committee constituted on "Durability of concrete structures" consisting of Dr.N.Rajagopalan, Professor and Deen/IIT/Chennai, Shri Krishan Kant, Chief Engineer (Bridges) S&R/MOST/ New Delhi, Shri S.Srinivasan, Scientist/CECRI/Karaikudi, Shri S.C.Gupta, Divl. Rly. Manager/C.Railway/Mumbai, Shri P. Sriram, Chief Bridge Engineer/ Southern Railway/Chennai and Shri A.K. Harit, Executive Director/B&S/ RDSO/Lucknow.

   The recommendations were discussed in 14th Extra Ordinary BSSC Meeting and in pursuance to Board's order thereupon provisions were inserted vide Clause 5.4.7 of IRS : CBC as per A&C No.1 of IRS : CBC.

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i) Recommendation of 14th Extra Ordinary BSC Committee:

"(i) Coating over concrete, whether required or not shall be decided by the Chief Engineer, incharge of the work.

(ii) Wherever required, the coating for concrete is recommended to be as under:-

Aggressive Environment (Severe, Very severe & Extreme)		***Non aggressive environment (Mild & Moderate)***
Buildings and Super structure of bridges	*Substructure of bridges (in affected part only)*	*All structures*
Epoxy – Phenolic IPN coating *Or* *CECRI Integrated four coat systems.* *Or* *Any other suitable method*	*Coaltar epoxy* *Or* *Any other suitable method*	*No coating is necessary*

ii) Expert Committee Observation:

"i) Committee is of the opinion that the coating over concrete is an important aspect to avoid corrosion of steel rebar as well as carbonation etc. of concrete. Therefore, the recommendation given by BSC that coating over concrete whether required or not shall be decided by the Chief Engineer, will not be desirable. Therefore, committee does not agree with recommendation number (i) of BSC.

ii) To take decision regarding adoption of 'any other suitable method' for coating over concrete is difficult without proper supporting study/research. Therefore, recommendations of BSC needs to be revised as under:

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The coating for concrete is recommended to be as under:

Aggressive Environment (Severe, Very severe & Extreme)		***Non aggressive environment (Mild & Moderate)***
Buildings and Super structure of bridges	*Substructure of bridges (in affected part only)*	*All structures*
Epoxy – Phenolic IPN coating Or CECRI Integrated four coat systems.	*Coaltar epoxy*	*No coating is necessary*

Note:-

(i) If any other suitable method is proposed it should be proven with sufficient research/experimental works in a established organization and it should be used with the approval of competent authority.

(ii) The periodicity of coating shall depend upon the condition of the existing coating."

iii) Railway Board Orders on recommendations of 14th Extra Ordinary BSC:

"Recommendation (i) not accepted.

Recommendation (ii) as modified by the Expert Committee accepted.

Necessary correction slip to IRS Concrete Bridge Code may be issued."

iv) Clause 5.4.7 of IRS: CBC incorporated as per A&C No.1 of IRS : CBC:

"5.4.7 Coating for Concrete:

5.4.7.1 *In order to provide adequate resistance against corrosion of embedded material in RCC structures, concrete shall be provided with suitable coating depending upon the environmental conditions."*

Item No. 1026 continued….

The recommended coating is as under: -

Aggressive Environment (Severe, Very severe & Extreme)		***Non aggressive environment (Mild & Moderate)***
Super structure of bridges	*Substructure of bridges (in affected part only)*	*All structures*
Epoxy – Phenolic IPN coating Or CECRI Integrated four coat systems.	*Coaltar epoxy coating*	*No coating is necessary*

5.4.7.2 *The frequency of coating shall depend upon the condition of the existing coatings.**”***

2) Modification in the IRS: CBC was based on observations of Member Engineering, Railway Board vide Note No 2005/ME/Notes/29 Dated 07.12.2005 The extract of which for Clause 5.4.7 is as follows :-

“Clause 5.4.7: *Efficacy of providing a coating to provide resistance against corrosion of embedded material in RCC structures is suspect. As such we need not insist upon this provision. In my view, this clause should, therefore, be kept in abeyance. If necessary, some trial should be conducted and further action should be taken only on the basis of results of such trail.**”***

3) Clause 5.4.7 was deleted from IRS: CBC by A & C Slip No 8 Dated 15.02.2006 in pursuance of Board’s directions mentioned in para (2) above.

The provision of A&C Slip No.8 for Clause 5.4.7 was as follows:-

“Clause 5.4.7: This clause is deleted, along with its sub clauses.”

4) Zonal Railways must have utilized the provisions of Concrete Bride Code regarding coating of concrete while they were in force. Zonal Railways may share their experience in this regard.

5) The committee may deliberate upon the issue and make recommendations.

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