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No. CBS/DRO Dated: 31-08-2020

Chief Bridge Engineer:

1. Central Railway, Mumbai CST-400 001.
2. Eastern Railway, Fairlie Place, Kolkata-700 001.
3. East Central Railway, Hazipur-844 101.
4. East-Coast Railway, Bhubaneshwar-751 016 (Orissa).
5. Northern Railway, Baroda House, New Delhi- 110 001.
6. North-Central Railway, Allahabad-211 001.
7. North Eastern Railway, Gorakhpur-273 001.
9. Northeast Frontier Railway, Maligaon, Guwahati-781 011.
10. Southern Railway, Park Town, Chennai-600 003.
11. South Central Railway, Rail Nilayam, Secunderabad-500 371.
12. South East Central Railway, Bilaspur-495 004
13. South Eastern Railway, Garden Reach, Kolkata-700 043
14. South-West Railway, Hubli-580 023.
15. Western Railway, Mumbai-400 020.
16. West-Central Railway, Jabalpur-482 001.

Sub: Checking of Non-Standard Composite Girder ROBs.

Ref: 1. Railway Board letter no. 2015/CE-IV/ROB/78 Pt. dated 23.06.2020.
2. VC of Railway Board with RDSO on 08.07.2020 and 25.08.2020.

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1.0 With respect to above subject and vide ref. (1) above, Railway Board has advised Zonal Railways to approve the non-standard girders of NHAI on its own. Moreover vide ref. (2), Railway Board advised RDSO to prepare a guideline for checking of non-standard composite girder ROBs. These guidelines will be issued to Zonal Railways and thereafter no non-standard design of composite girder of ROBs will be considered by RDSO.

2.0 Accordingly a guideline in form of checklist of important parameters to be checked during design check of the composite I-Girder has been prepared and is being given as annexure-I of this letter. Although all efforts have been taken to cover the items related to checking of design of composite I-Girder but there

might be some inadvertent errors or some issues might have not been covered. So any suggestions to improve the guideline are welcome.

3.0 In view of Railway Board's advice vide ref. (1) and (2), it is submitted that RDSO will not consider the design of non-standard composite girder henceforth.

This is for your kind information and further necessary action.

DA: Annexure-I (7 Pages)

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Copy to:

I. PED/Bridge/Railway Board, Rail Bhavan, New Delhi-110001 for kind information.

II. Chief Engineer, Metro Railway, Jawahar Lal Nehru Road, Kolkata-700071 for information and necessary action.

(Rajesh Kumar Srivastava)
ED/B&S/ Steel

Annexure-I

Checklist for important design checks of I-Girder type composite ROB

S. No.	Description	Check points
1.0 General Arrangement of structure		
a.	Effective Span Length	As per GAD.
b.	Skew	• For planning ROB with lesser skew refer BS-112 (Latest version) guidelines of RDSO. • It is preferable that skew should be limited to 20 degree as far as possible for applicability of square design calculations with certain precautions. However if it not possible due to site conditions then it should be accounted suitably in analysis and design calculations.
c.	Projection of I-Girder Beyond C/L of bearing	Preferably within 500 mm. beyond centre line of bearing
d.	Slab overhang beyond steel I-girder	Preferably within 250 mm. beyond girder end
e.	Overall Length of Girder	As per GAD
f.	Width of Carriage Way	As per GAD and as per IRC special publication for planning of Highways such as IRC SP 84; IRC SP 87 etc.
g.	Overall Width of Slab	
h.	No. of steel girder and C/C spacing of girder	Provisions of IRC Clause 504.3 of IRC:24-2010
i.	Haunch	• Deck slab with or without haunch to be decided. • Haunch details to be decided as per Cl.606.7 of IRC: 22-2015.
j.	Footpath	As per GAD or applicable IRC standards.
2.0 Material Specification		
a.	Grade of steel	• E350 grade B0 as per IS 2062-2011 should be used preferably over E250 grade B0. • In case of steel of grade higher than E350, issue of weldability of such steel to be checked as RDSO has not done any design in steel greater than E350.

b.	Grade of Concrete	In deck slab M40 or M45 grade
c.	Grade of reinforcement	Ductile grade reinforcement steel should be used. Normally Fe 500 D should be used however other grades can be used which have ductile grade.
d.	HSFG bolting assemblies with DTI washers	Material specification and other stipulations related to it as per RDSO report no. BS 111 (Latest version)
e.	STUD shear connector	IRC 22:2015 and RDSO report no. BS 115 (Latest version)
3.0 Loading		
a.	Dead load	Dead load calculation as per general arrangement decided. Unit weights form Cl 203 of IRC 6:2017.
b.	SIDL	SIDL calculation considering Crash barrier, railing, cables, bitumen top, wearing coat etc.
c.	Crash Barrier	Clause 109.6 of IRC:5-2015 & Cl 206 of IRC:6-2017
d.	Safety Kerb	• Clause 109.8 of IRC:5-2015 • 400 kg/m2 pedestrian live load considered on safety kerb. Cl 206 IRC:6-2017
e.	Live Loading	• Cl 204 of IRC:6-2017. • To be decided as per width of carriageway. Different combination of Class A and 70R to be taken as per number of lanes in considered in carriageway given in Table 6 and 6A of IRC:6-2017. • Placement of loads along width of carriageway as per IRC 6:2017.
f.	Impact factor	From Clause 208.2 & 208.3 of IRC: 6-2017
g.	Special Vehicle (SV) loading	Applicability to be confirmed from concerned road authorities and girder to be checked for SV loading in case this loading is applicable as per details of Cl 204.5 of IRC:6-2017.
h.	Congestion factor	As per clause 204.4 of IRC:6-2017
i.	Pedestrian loads	450 kg/m2 pedestrian live load considered on footpath. Cl 206 IRC:6-2017
j.	Centrifugal force	Clause 212 of IRC:6-2017
k.	Longitudinal loads	Clause 208 and 211 of IRC:6-2017
l.	Temperature effect i.e.	Clause 215 of IRC:6-2017

	rise, fall and differential shrinkage	
m.	Wind load	Clause 209 of IRC:6-2017
n.	Seismic load	Clause 219 of IRC:6-2017
o.	Fatigue load	Clause 204.6 of IRC:6-2017
p.	Load combinations for serviceability, ultimate and construction stage	Clause 202.3 and Annexure B of IRC:6-2017
	4.0 Main girder section	
a.	**Proportioning of Main Girder**	
	Overall depth of steel beam	Cl 504.4 of IRC:24-2010
	Minimum sections	Cl 504.7 of IRC:24-2010
	Top flange plate	Check classification of section as per table 2 of IRC 22: 2015.
	Bottom flange plate	Check classification of section as per table 2 of IRC 22:2015
	Web Plates	Check classification of section as per table 2 of IRC 22:2015
	Effective width of concrete	Cl 603.2 of IRC:22-2015
b.	**Cross section properties**	
	Modular ratio	• As per clause 604.3 of IRC 22:2015 • Short term modular ratio for short term load effects • Long term modular ratio for permanent or long term load effects
	Sectional properties calculation	Sectional properties such as Ixx, Iyy, C.G., Aeq, Zst, Zsb, Zct, Zcb etc. should be calculated for steel girder only section, concrete only section, Composite section with Kc=0.5 and Composite section with Kc=1 for calculation of stresses in different loading conditions.
c.	**Capacity calculation of main girder**	
	Plastic moment of resistance	As per clause 603.3.1 of IRC 22:2015
	Shear capacity	Plastic shear capacity: Cl. 603.3.3.2 (1) of IRC:22-2015 and Shear buckling capacity: Cl. 603.3.3.2 (2)(a)
	Buckling resistance moment (Construction stage)	During launching and slab construction stage: Cl.I.5 of Annexure I of IRC:22-2015 & Clause 509.2.2 of IRC:24-2010
	Permissible bending	During launching, slab construction and

	compressive stress	final stage: Cl 603.3.1 of IRC:22-2015; Cl 509.2, Table 10, 11, 12, 13 and Cl 509.3 IRC:24-2010
	Permissible tensile stress	Cl. 604.3.1(3) of IRC:22-2015 and fatigue analysis to be done separately
	Permissible stress in concrete	Cl. 12.2.1 of IRC:112-2011

d.	**Deflection of main girder**	• Deflection of girder to be calculated separately for:
		  • Dead load of steel portion of girder;
		  • SIDL such as Concrete Deck slab, Crash barrier, wearing coat, macadam, shuttering etc.;
		  • Live load.
		• Live load deflection and total deflection limit is to be checked as per Cl. 604.3.2 of IRC:22-2015

e.	**Camber**	Check total deflection limit as per Cl. 604.3.2 of IRC:22-2015. If total deflection of girder is under limit then no pre camber is required otherwise pre camber is provided to offset the effect of permanent loads
f.	**Weld design for I-Girder**	• Weld design for different welds in I-Girder to be done considering permissible stress in weld as per Cl 512.4.5.1.1, IRC:24-2010. • To be checked for fatigue as per table 5 of IRC 22-2015
	5.0 Shear Stud design	
a.	Stud Height	Height of stud as per clause 606.6 of IRC 22-2015
b.	Stud Diameter	Stud dia. as per clause 606.6 of IRC 22-2015.
c.	Spacing of stud	Spacing of stud as per clause 606.4 and 606.9 of IRC 22-2015. (Spacing of studs along longitudinal direction should be provided less in end and should be more in middle portion)
d.	Projection in slab	Projection in deck slab as per clause 606.6.1 of IRC 22-2015.
e.	Cover over shear connector	• Cover over shear connector as per clause 606.8 of IRC 22:2015 • Side cover on girder as per clause 606.9 of IRC 22:2015

f.	Capacity of stud shear connector	To be calculated as per Cl 606.3.1, IRC:22-2015 and characteristic properties to be taken from Table III.1, IRC:22-2015
g.	Detailing of shear connector	As per Cl 606.6 of IRC:22-2015.
6.0 Stiffener of girder		
a.	**End stiffener**	
	Outstand limit	Clause 509.7.1.2 of IRC:24-2010
	Bearing length	Cl 509.7.1.3 of IRC:24-2010
	Dispersion length	Cl 509.7.4 of IRC:24-2010
	Bearing capacity of stiffener	Cl 509.7.4 of IRC:24-2010
	Buckling capacity of stiffener	Cl 509.7.1.5 of IRC:24-2010
	Design of Bearing stiffener	Cl 509.7.6 of IRC:24-2010
	Connection of bearing stiffener	Cl 509.7.10 of IRC:24-2010
b.	**Intermediate Stiffeners**	
	Outstand limit	Clause 509.7.1.2 of IRC:24-2010
	Spacing of stiffener	Cl 509.7.2.2 of IRC:24-2010
	Check for web thickness requirement	Cl 509.6.1.1 of IRC:24-2010
	Check for compression flange buckling requirement	Cl 509.6.1.2 of IRC:24-2010
	Check for unsupported clear dimension of web panel	Clause 509.7.14 (g) of IRC:24-2010
	Moment of inertia requirement	Cl 509.7.2.4 of IRC:24-2010.
	Buckling check on intermediate stiffener	Cl 603.3.3.2(2) of IRC:22-2015
	Weld connection of intermediate stiffener	Cl 509.7.2.6 of IRC:24-2010
7.0 Splice Joints of girder		
a.	Splice location	• Splice at section of maximum B.M. or S.F. to be avoided. • Location of splice to be chosen considering maximum piece length of 13 m. and preferably symmetrical w.r.t. centre of girder.
b.	Bolt value of one HSFG bolt	Considering appropriate grade, dia and slip factor for bolt and no slip condition at ultimate load.

c.	Top Flange splice	• Top flange splice cover plates area as per clause no. 509.6.3.3 of IRC24-2010. • It is designed to transfer maximum stress of ULS condition at top flange.
d.	Web splice	• Cl 509.6.4.2 of IRC:24-2010. • The web splice carries a bending Moment equal to the total design moment on the section multiplied by the ratio of the moment of inertia of the web to the moment of inertia of the entire section. • In addition to this moment, the web splice also carries the Design Shear at the splice location and the moment due to the eccentricity of the shear force considering gap between plates 50mm.
e.	Bottom flange splice	• Bottom flange splice cover plates area as per clause no. 509.6.3.3 of IRC:24-2010 (Net flange area should be compared) • It is designed to transfer maximum stress of ULS condition at bottom flange
f.	Arrangement of bolts on splice and size of cover plates	Size of cover plates in splices also to be checked as per pitch and edge distance limits for HSFG bolts as per IRC 24:2010
8.0 Diaphragm, Lateral bracings and cross frames of I-girder		
a.	**End Diaphragm**	• End diaphragm to be designed for 50% of lateral force and for vertical load of total dead load and SIDL coming on each girder. • Design of End diaphragm and it's connection to be done to resist these loads in bending as well as axial compression as per the case using IRC 24:2010 considering the locations of jacking points • Recommended to have web depth between D to 0.75D, where D is depth of girder • Jacking point on end diaphragm should have minimum clear distance of 150 mm. from end of bottom flange
b.	**Bottom Lateral Bracing**	• Designed to resist 25% of lateral force • Bottom lateral bracing Design: For Max Lateral Force, clause 509.8, IRC:24-2010 • Member and connection to be checked

		for both axial tension and compression for max. Force coming on member as per IRC: 24-2010
c.	**Intermediate cross frame**	Intermediate cross frame designed to resist 50% of lateral forces. Member and connection to be checked for both axial tension and compression for max. Force coming on member as per IRC: 24-2010
9.0 Deck slab		
a.	Values of concrete to be taken in design	Cl. 6.4 of IRC:112-2011
b.	Values of reinforcing steel to be taken in design	Cl. 6.2 of IRC:112-2011
c.	Clear cover	Table 14.2 of IRC:112-2011
d.	Depth of deck slab	Cl 6.2.2, 6.4.2.8, table 6.5 and table 14.2 of IRC 112-2011
e.	Top & bottom reinforcement	Cl 16.5.1.1, 12.3.3, 15.2.1(2), 18.4.4.2(3), 16.6.1.1 of IRC:112-2011
f.	Transverse reinforcement	Cl 16.6.1.1 of IRC: 112-2011
g.	Shear reinforcement	Cl 10.3.2.2 of IRC:112-2011
h.	Crack width consideration	Cl 12.3 of IRC:112-2011
i.	Durability consideration	Cl. 14.3 and 14.4 of IRC:112-2011
j.	General detailing requirement of reinforcement steel related to spacing, bond, anchorage etc.	Cl. 15.2 of IRC:112-2011
k.	Detailing requirement related to solid slab	Cl. 16.6 of IRC:112-2011