

INDIAN RAILWAYS INSTITUTE OF CIVIL ENGINEERING

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Senior Professional Course (Bridges and General)

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PROJECT REPORT

Method Statement for Construction of PSC Girders

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1. General

Extensive use of PSC girders has been started in Railways as a superstructure for the Bridges. PSC Bridges are now being constructed even for larger spans. Steel Girders have been extensively used in the past and enough expertise is available within the Railways for fabrication and launching of steel girders. PSC girders are now being cast on several Bridges and it is necessary to share the experience and methodology for execution to avoid problems during construction and subsequent difficulties in maintenance. In this paper, effort has been made to list out different aspects which are to be kept in mind while executing the works involving PSC girders. Experience gained during construction of the PSC girders for viaduct in zone E-18 on Jammu Udhampur Rail Link Project has been used to prepare this method statement.

Salient features of PSC girder used on viaduct zone E-18 are as given below:

1. Clear span	26.18 m
2. Effective span	27.33 m
3. Length of Girder	29.68 m
4. Depth of Girder	3.034 m
5. Deck width inside ballast retainer	4.7 m
6. Girder width at bottom	3.03 m
7. Height of ballast retainer	0.765 m
8. Concrete mix	M 40
9. Weight of girder	
At the time of launching	385 MT
Complete	416 MT
10. Reinforcement	18.5 MT
11. Quantity of HTS wires	5600 m (4.35 MT)
12. No. of Cables	
Working cables	8 nos in each web
Future cables	20 (10 on each side of centre line)
Emergency/dummy cables	1 in each web
13. Pre-stressing strand per cable	
Cable no. 6	Dummy
Cable no. 3	9 nos
All other cables	12 nos
14. Total pre-stressing force	
Cable no. 3	126.56 MT
Other cables	168.75 MT
15. Pre-stressing system	Freyssinet
16. No. of stages in concreting	Single
17. Sheathing	Bright metal sheathing
	Inner dia 75 mm
	Outer dia 76 mm
18. Span arrangement	40x29.68 m
19. Standard of loading	MBG 1987

2. Records to be maintained at site

It is necessary to maintain the record of each activity at site. It is helpful not only to ensure the quality of construction but also to assess the behavior of the girder and to decide the remedial action in case of problems in maintenance. Following registers are to be maintained at site:

- i. Site order Book
- ii. Labour register
- iii. Machinery register
- iv. Cement Register
- v. Steel register
- vi. Cube testing register
- vii. Fine aggregate register
- viii. Coarse Aggregate Register
- ix. Pre-stressing record register
- x. Batching plant register
- xi. Trial mix register
- xii. Concrete supervision register
- xiii. Shuttering register
- xiv. Girder cable profiling register
- xv. Girder History sheets

3. Collection of drawings

All the drawings pertaining to the work should be collected and kept at site in a separate file/folder in sequence. It should be ensured that drawings are as per the latest revision. A list of drawing for Viaduct at E-18 is indicated below:

Sheet	Name of drawing	Rev.	Date	Remarks
1	General Arrangement (A2 to P34)	R5	26.11.96	
2	General Arrangement & Sections	R5	26.11.96	
3	Details of Foundation (P35 to P39)	R1	12.12.96	
4	Dimensional details of superstructure	R1	31.12.96	Changed
5	Details of piers (P35 to P39)	R3	16.01.97	
6	General arrangement (P33 to P16)	R1	17.01.96	
7	Details of Foundation (P24 to P34)	R1	19.02.97	
8	Details of piers (P24 to P34)	R1	27.02.97	
9	General Arrangement (P15 to P0)	R1	25.02.97	
10	Details of casting yard Sheet 1 of 2	R1	06.03.97	
11	Dimensional details of abutment A2			Changed
12	Details of free bearing (Pier P39 to P22)	R1	21.03.97	Changed
13	Details of free bearing (Pier P39 to P22)	R3	26.05.00	
14	Details of fixed bearing (Pier P39 to P22)	R2	26.05.00	
15	Details of staging- pier cap		11.04.97	Changed
16	Details of Foundation (P9 to P23)	R1	03.05.97	
17	Details of free bearing abutment A2	R2	26.05.00	

18	Details of Foundation (P5 to P8)	R1	08.05.97	
19	Reinf. details of foundation, abutment A2	R3	13.09.97	
20	Dimensional details of abutment A2	R8	13.05.97	
21	Reinf. details of abutment A2	R1	13.05.97	
22	Dimensional details of pier cap, straight span	R1	27.05.97	
23	Details of free bearings (Pier P9 to P21)		29.05.97	
24	Details of fixed bearings (Pier P9 to P21)		29.05.97	
25	Details of piers (Pier P9 to P23)	R1	29.05.97	
26	Details of piers (Pier P5 to P8)	R1	31.05.97	
27	Details of staging- pier cap, sheet 1 of 2			Changed
28	Details of staging- pier cap, sheet 2 of 2			Changed
29	Reinf. details of pier cap (P39 to P22)	R2	12.06.97	
30	Dimensional details of superstr. straight span	R3	24.06.97	
31	Pier layout P3 to P20	R1	23.06.97	
32	Details of launching girder sheet 1 of 2	R5	24.06.97	
33	Details of launching girder sheet 2 of 2	R3	24.06.97	
34	Details of foundation P2 to P4	R1	25.06.97	
35	Details of piers P2 to P4	R1	25.06.97	
36	Reinf. details of pedestal (P39 to P22)	R3	22.07.97	
37	Cable layout for straight span	R4	31.07.97	Changed
38	Details of guide bearings (Pier P9 to P39)	R1	10.06.97	
39	Reinf. Details of superst. Sheet 1 of 2, A2 to P21			
40	Reinf. Details of superst. Sheet 2 of 2, A2 to P21			
41	Details of anchorages and future external prestressing, span A2 to P21	R3	19.08.97	
42	Details of trolley refuge	R1	03.09.97	
43	Details of ladder inside pier P9 to P39			
44	Reinf. details of pier cap (P39 to P22)	R3	04.12.97	
45	Details of pin bearing P9 to P39	R2	30.05.97	
46	Details of misc. items	R3	16.03.98	
47	Details of guide bearings abutment A2	R2	24.03.98	
48	Details of abutment cap A2 Sheet 1 of 2	R4	22.04.98	
49	Details of abutment cap A2 Sheet 2 of 2			Changed
50	Details of pipe staging for pier cap P39 to P9	R2	22.04.98	
51	Arrangement for lowering of box girder Sheet 1 of 2	R5	21.03.98	
52	Arrangement for lowering of box girder Sheet 2 of 2		23.11.98	
53	Scheme for load testing of trolley and launching girder	R4	04.02.99	
54	Details of abutment cap A2	R8	27.02.99	
55	Cable layout for span A2 to P22	R6	05.03.99	
56	Reinf. Details of superst. Sheet 1 of 2			
57	Reinf. Details of superst. Sheet 2 of 2 A2 to P21	R8	29.03.99	
58	Reinf. Details of pedestal abutment cap A2	R2	18.03.99	

59	Arrangement for launching of PSC box girder straight span	R5	26.03.99
60	Details of piers P6	R3	07.04.99
61	Details of foundation P6	R3	06.04.99
62	Installation scheme for bearings	R4	13.04.99

4. Testing of material for concrete

As soon as the drawing for the girder is received, it should be studied in detail to know about the grade of concrete to be used for casting of girder. In case the drawing is old or it has been issued for another site, latest provisions of Concrete Bridge Code should also be referred to ensure that the provisions regarding minimum grade of concrete as per the exposure conditions at the site are followed.

Contractor should be asked to select the source for the ingredients of the concrete i.e. aggregate and water. Samples should be taken and these should be sent to any reputed laboratory for testing. All the tests to be carried out should be specifically mentioned and all tests should be got done in one go to avoid delay in deciding the source of material. Tests which are generally to be carried out are discussed in following paras.

4.1. Coarse Aggregate:

SN	Description of test	Reference to code for procedure
1.	Deleterious materials Clay lumps Materials finer than 75 micron IS sieve	IS:2386 Part II IS:2386 Part II
2.	Aggregate crushing value	IS:2386 Part IV
3.	Aggregate Impact Value	IS:2386 Part IV
4.	Aggregate Abrasion Value	IS:2386 Part IV
5.	Soundness (for concrete liable to be exposed for frost action) When tested with Na ₂ SO ₄ and Mg SO ₄	IS:2386 Part V
6.	Size and Grading	IS:2386 Part I
7.	Flakiness Index	IS:2386 Part I
8.	Elongation Index	IS:2386 Part I
9.	Water absorption test	IS:2386 Part III
10.	Specific gravity	IS:2386 Part III
11.	Alkali aggregate reaction	IS:2386 Part VII
12.	Chloride contents	
13.	Sulphate contents	

Code for acceptance values- **IS: 383**

Instructions in **Para 4.2** of IRS Concrete Bridge Code should be followed regarding the properties of aggregates.

4.2. Fine Aggregate:

SN	Description of test	Reference to code for procedure
1.	Deleterious materials Clay lumps Materials finer than 75 micron IS sieve	IS:2386 Part II IS:2386 Part I
2.	Soundness (for concrete liable to be exposed for frost action) When tested with Na ₂ SO ₄ and Mg SO ₄	IS:2386 Part V
3.	Size and Grading	IS:2386 Part I
4.	Specific gravity	IS:2386 Part III
5.	Alkali aggregate reaction	IS:2386 Part VII
6.	Chloride contents	
7.	Sulphate contents	

Code for acceptance values- **IS: 383**

Instructions in **Para 4.2** of IRS Concrete Bridge Code should be followed regarding the properties of aggregates.

4.3. Water

SN	Description of test	Reference to code for procedure
1.	Physical Character	IS 3025
2.	Organic solids	
3.	Inorganic solids	
4.	Sulphates (as SO ₄)	
5.	Chlorides (As Cl)	
6.	PH Value	
7.	Limit of acidity (with N/10 NaOH)	
8.	Limit of alkalinity (with N/10 HCL)	

Code for acceptance values- IRS Concrete Bridge Code

Instructions in **Para 4.3** of IRS Concrete Bridge Code should be followed regarding the properties of water.

4.4. Cement

Cement test certificate is received along with the rake of cement. In addition, testing should be done at site to confirm that it has not deteriorated during transportation and storage. Some of these tests are as under:

- Initial setting time
- Final setting time
- Compressive strength
- Fineness
- Soundness
- Chemical composition

Instructions in **Para 4.1** of IRS Concrete Bridge Code should be followed regarding the properties of aggregates.

4.5. Admixtures

Admixtures are used from following considerations:

- To improve the workability
- To increase initial setting time. This helps in avoiding the cold joints.

Large no. of products are available in the market but it is necessary to select the correct product since a wrong admixture may affect the life of concrete. Admixture should be complying to **IS: 9103** and it should be compatible to the cement being used for concreting.

Instructions in **Para 4.4** of IRS Concrete Bridge Code should be followed regarding the use of admixtures.

4.6. Other Materials

Testing of other construction materials has to be carried out as per relevant codes. Instructions in **Para 4.5&4.6** of IRS Concrete Bridge Code should be followed regarding the properties of Reinforcement and prestressing steel.

A typical format for the letter to the testing laboratory, regarding concreting materials, is shown in Ann.-A.

5. Collection of Codes, manuals and technical literature

Codes and other such literature pertaining to the method of testing the materials and concrete should be collected and one copy of each code should be kept at site for reference. Similarly, codes pertaining to acceptance criteria are also to be kept at site.

6. Set up of Testing laboratory

Several tests pertaining to materials and finished product are to be carried at site. Testing laboratory should be set up at site to facilitate the testing.

7. Mix Design

As soon as the source for the ingredients of the concrete are decided, design of concrete mix has to be done. Specified procedure should be followed to decide the ingredients of the mix. Help may also be taken from the mix used at other sites, with the same source of materials. Trial may be carried out at site and optimum mix should be decided as per provisions for strength, durability and workability.

Mix adopted for the work on viaduct zone E-18 was as under;

Grade of concrete	M 40
Cement	500Kg
CA 20 mm	768.4 Kg
10 mm	512.3 Kg
FA	438.2 Kg
Water	185.0 litres
Admixture	0.8- 1.2%
W/C ratio	0.37

8. Assessment of Material Required for Casting

Drawing of the girder should be studied in detail to list out the requirement of material for the casting of girder. All the activities involved for the work should be discussed with the site supervisors along with the requirement of material for the same. All the material should be brought in advance to avoid the shortage at the time of execution.

A typical list of material required for casting of PSC girder is shown below:

SN	Description	Quantity	Unit
Major Items			
1	Cement	1360	Bags
2	Steel reinforcement	17.5	MT
3	20& 10 mm aggregate	115	Cum
4	Fine aggregate(sand)	60	Cum
5	Admixture	650	Ltr
6	Bearing Templates	6	Nos
7	Guide tubes + Bearing plates + stressing wedges	36	Nos
8	Sheathing pipe	600	M
9	HT Strands	5	MT

Misc. Items			
1	Insulation tape	35	Nos
2	Grease (ordinary)	25	Kg
3	HSD	40	Ltr
4	Hydraulic oil (for stressing and side shifting)	15	Ltr
5	Foam sheets	12	Nos
6	Adhesive	10	Kg
7	Shuttering putty	20	Kg
8	Grease (special) for side shifting	10	Kg
9	Wire Brush	20	Nos
10	GI pipe (35 mm OD)	30	m
11	PVC pipe (40 mm OD)	35	m
12	Cutting wheel (dia 180 mm)	5	nos
13	Grinding wheel	2	nos
14	Hand gloves	6	Nos
15	Binding wire	150	Kg
16	Cutting oil	10	Ltr
17	Hacksaw blade	15	Nos
18	Nuts and bolts	10	Kg
19	Welding rod 3.15 mm	6	Pkt
20	Welding rod 4 mm	2	Pkt
21	Paint	1	Ltr
22	M Seal (for grouting)	3	Kg
23	Patrol (for stressing)	7	Ltr
24	Wooden planks for packing	LS	
25	Fuel for Machinery		
	Generator sets (90 hrs x 12)	1080	Ltr
	Tippers (100 hrs x 5)	500	Ltr
	Crane (60 hrs x 6)	360	Ltr

9. Bar bending schedule

Bar bending schedule for the steel reinforcement should be prepared as per the details given in the drawing. Shape, size and location of each bar should be clearly mentioned to avoid confusion.

Typical columns in this schedule are shown below:

Bar marked as	Dia (mm)	Spacing (mm)	Nos.	Shape	Length of each bar(mm)	Total length (m)	Remarks
1	16	240	121x1		5650	683.65	Deck top,

			= 121	5650			transverse

10. Assessment of steel

Requirement of steel for different diameter bars has to be calculated. It has to be ensured that steel required for the work is collected in advance to avoid delay in planned activities.

Typical pro forma for the requirement of bars is shown below:

Dia of bar	Requirement of steel (MT)			
	Girder	Trolley refuge	Wearing coat	Total
6	-	-	0.61	0.61
8	2.76	0.22	-	2.98
10	4.18	0.029	-	4.209
12	1.886	0.137	-	2.023
16	6.722	-	-	6.722
20	0.325	-	-	0.325
25	0.673	-	-	0.673
28	0.669	-	-	0.669
Total (MT)	17.215	0.386	0.61	18.211

11. Assessment of machinery and operators

Requirement of machinery has to be listed out based on the activities involved during casting of girder. Supervisors should be nominated for each shift of working of these machines. A typical requirement is listed below:

SN	Machine	Nos	Name of operators /supervisors
1	Crane	1	
2	Batching plant	1	
3	Moving Gantry	1	
4	Tippers with concrete bucket	3	
5	Shutter vibrators	20	
6	Vibrators	5	
7	Vibrating needles	15	
8	Generator	1	

12. Assessment of Labour

Assessment of skilled, semi skilled and unskilled labour should be made in advance so that activities during execution are not hampered. A typical assessment is shown below:

SN	Job	Requirement of labour			
		skilled	Semi skilled	unskilled	total
1	Cement feeding to Batching plant and admixture mixing	0	1	12	13
2	Concrete bucket hooking and opening at pouring	2	6	0	8
3	Operation of needle vibrators	0	6	4	10
4	Top chute placing and cleaning etc.	0	2	2	4
5	Shutter vibrator changing etc.	2	6	0	8
6	Movement of cables during concreting	0	2	2	4
7	Masons +helpers for finishing etc.	4	0	2	6
8	Manual concreting at diaphragm portion	0	1	5	6
9	Leakage control	0	4	0	4
10	Cleaning at web	0	0	12	12
11	Roding	0	2	0	2
12	Sampling	0	2	0	2
13	Misc. job during concreting	2	2	3	7
	Total	10	34	42	86

13. Pouring plan

Pouring sequence for the concreting of Girder has to be decided in advance. Depth of each layer has to be decided considering the production capacity, ease in construction and elimination of cold joints. Pouring plan adopted on E-18 was as given below:

VIII 18cum 90 min	X 34 cum 180 min	0.35 m		
VII 7 cum 40 min	IX 3 cum 25 min	0.4 m		
VI 10 cum 55 min		0.4 m		
V 10 cum 55 min		0.4 m		
IV 10 cum 55 min		0.4 m		
III 10 cum 55 min		0.4 m		
II 10 cum 55 min		0.4 m		
I 18 cum 90 min		0.25 m		

Pouring By gantry

Pouring by Crane

14. Requirements for safe working

Requirements for safe working at site are to be listed out and arrangements should be made in advance to avoid any untoward incidence during working. These arrangements depend upon the working conditions at site and may require helmets, safety belts etc. If the casting is being done in situ at higher level, safety nets may be provided so that labour and supervisors may work without fear.

15. Form work/Shuttering

Requirement of shuttering has to be assessed and it has to be collected in advance. Some of the pieces have to be fabricated as per special shape of the girder and this work should be carried out in advance. In the case of E-18, special collapsible shuttering was designed to facilitate the casting of girder in single stage, except for the diaphragm. Detailed drawing was got prepared and shuttering was fabricated at site accordingly.

Instructions in **Para 6.2, 6.2 & 6.4** of IRS Concrete Bridge Code should be followed regarding the finishing, treatment and stripping of formwork.

Detail of collapsible shuttering used at site of viaduct zone E-18 is shown in Ann. B

16. Staging

If the girder is to be cast in situ, staging has to be erected for shuttering. Detailed checking of staging should be done and following items should necessarily be checked:

- a. Members in staging should be as per approved drawing. Drawing no. should be specifically recorded.
- b. Deviations from the drawing should be recorded and these should not be allowed unless approved.
- c. Condition of welding should be checked. Sometimes, tack welding is done in place of structural welding to facilitate the reuse of the same member in next staging. This practice should not be allowed.
- d. All the packing should be of hard wood.
- e. Verticality of the members should be checked
- f. All the nuts and bolts should be tight.

17. Level of Casting Bed/ Bottom Shuttering

In case the casting is in situ, level of bottom shuttering has to be taken to ensure that the girder is as per drawing. Similarly, level of casting bed should be taken in case of casting in yard. A typical format for recording the levels is as indicated below:

Distance from JAT end	0	5	10	15	20	25	28.33
Centre							
Left							
Right							

18. Check lists

Detailed check lists have to be prepared for various stages of construction. Contractor should check and fill up the details in check list and it should be submitted to Railway supervisor for allowing further work. Entries should be checked by the Railway officials and necessary rectifications should be got done, if required. Further activity should be allowed only after ensuring that arrangements are as per approved drawings/code provisions.

19. Placing the inside shuttering

Check list used for allowing the placing of inside shuttering on E-18 is attached as Ann- C. It indicates the checks to be made before allowing the placing of inside shuttering. Major items to be checked are listed below:

- a. Level and condition of casting bed
- b. Alignment, verticality and condition of formwork
- c. Position of Bearings
- d. Reinforcement, cover to reinforcement and cover blocks
- e. Inserts and fixtures (as per drawing)
- f. Cable profiling, condition, adequacy and testing of pre stressing material
(Typical profile shown in Ann. D)

20. Casting of Girder

Check list used for allowing the concreting on E-18 is attached as Ann- E. It clearly indicates the checks to be made before allowing the concreting Major items to be checked are listed below:

- a. Alignment, verticality and condition of formwork
- b. Reinforcement, cover to reinforcement and cover blocks
- c. Inserts and fixtures (as per drawing)
- d. Requirement and availability of concreting material along with testing certificates
- e. Requirement and availability of manpower and machinery, along with stand by arrangements

Prestressing cables should be moved during the concreting to avoid jamming due to leakage of cement slurry inside the sheathing. Concreting in the end portion should be done carefully with the concrete having desired workability. This portion of girder consists of heavy reinforcement including the prestressing cones, helical

reinforcement etc. Lot of effort and close supervision is required to avoid any hollow portion in this area.

Instructions in **Para 8 of IRS** Concrete Bridge Code should be followed regarding transportation, placement, compaction and curing of concrete.

21. Casting of Diaphragm

Casting of Diaphragm is done in the next phase. Check list used for allowing the casting of Diaphragm is shown in Ann. F.

22. Removal of shuttering & Curing

Shuttering should be removed as per sequence decided in advance, in the presence of Railways representative. Concrete surface should be inspected for any defect/deficiency and rectification measures should be taken, if required.

Proper curing of the girder is essential for preventing evaporation from the surfaces. It is normally done by establishing a high humidity environment. Curing compounds may also be used in place of traditional methods such as continuous water curing.

Instructions in **Para 8.4** of IRS Concrete Bridge Code should be followed regarding curing of concrete.

23. Prestressing

Study the drawing

Instructions regarding the prestressing of girder are mentioned on the drawing. It is specified that how much time/strength is required before allowing the prestressing. It is also to be checked whether stressing is to be done in single or double stages. Generally, 1st stage pre stressing has to be done before allowing the movement of girder/removal of bottom shuttering. Sometimes, it is specified that wearing coat has to be done before second stage of prestressing. Exact procedure is generally mentioned on the drawing and it is to be strictly followed.

Prestressing steel

Prestressing steel to be used in girders is specified in **Para 4.6** of IRS Concrete Bridge Code. However, drawing should be studied to know regarding the exact quality of steel considered while designing and only that steel should be allowed. Every Coil of steel comes with a tag for identification of coil. This tag should be checked and carefully kept for reference. In case this tag is lost, it may not be possible to know about the exact properties of the steel. A test certificate is sent by

the manufacture along with the material. This certificate should be kept in record as these properties are required while calculating the actual elongation and prestressing force in field. Generally, uncoated stress relieved low relaxation strands conforming to **IS: 14268** are used for the PSC girders. A sample test report for prestressing steel and sheathing is shown in Ann. G & H.

Prestressing operation

- Check adequate reserve of pumping fluid
- Fix jack at both the ends
- Check that all strands are projecting outside by sufficient margin
- Tighten the master wedges of jack
- Close the entry to back side of the strands because since in case of breakage, strands may hit the working staff.
- Apply initial pull 5-15 kg/cm² to take out slackness
- Put markers & marking distances from jack face
- Apply 20 kg/cm² pressure and take first reading of elongation
- Further readings also at interval of 20 kg/cm²
- Conscious efforts to make uniform elongation at both ends.

Calculations are simultaneously made to decide the pressure and elongation at which locking has to be done. All the details should be directly filled on the register to avoid confusion at a later stage. Actual slip should be measured after 24 hrs of prestressing and it may be used while deciding the locking pressure in further work.

Instructions in **Para 7.2** of IRS Concrete Bridge Code should be followed regarding the tendons, sheathing and prestressing operation.

24. Measurement of Camber

After completion of stressing operation, camber should be measured. In case of casting in yard, camber can be measured with the help of feeler gauge. Camber after stressing should be as per the values mentioned on the drawing.

25. Grouting

- Grouting should be done as early as possible after stressing.
- Grouting of lower ducts should be done first to avoid chances of leakage of grout into ducts.
- Grouting with cement grout is the most widely used method of protecting tendons in the ducts of post-tensioning systems.
- The initial discharge will be contaminated with the oil and discolored: it must be discarded.
- Grout should be dense and homogeneous so as not to leave voids along the steel.

- The grout must also be thoroughly mixed by machine to ensure complete mixing and to obtain workable grout for injection.
- After mixing, the grout should be kept continuously agitated or moving
- The grouting pump should be positive displacement pump, capable of producing the discharge pressure and having adequate seals to prevent introduction of oil, air, or other foreign substances into the grout.
- The grout should be screened prior to introduction into the pump.
- Standby water flushing equipment powered by a separate power source should be available.
- Grouting must be continuous until the consistency of the grout emerging from the vents is the same as that being injected, without visible slugs of water or air.
- Before injecting the grout, the duct should be cleaned.

Instructions in **Para 7.2.7** of IRS Concrete Bridge Code should be followed regarding protection of prestressing steel and anchorages. Para 9 of IRS concrete Bridge Code deals with the recommended practice for grouting of cables.

26. Shifting of Girder

Shifting of girder is generally done after 1st stage prestressing so that the casting bed can be used for the casting of next girder. Approved scheme should be used for lifting and side slewing of girder to avoid the uneven stresses and subsequent cracks/damage to the girder.

27. Casting of Wearing coat.

Casting of wearing coat should be done after 1st stage of prestressing or second stage of prestressing, taking guidance from the drawing. Due care should be taken for the protection of surface since it is highly prone to cracking.

28. Acceptance of Girder

Sampling should be done during the concreting and these samples should be tested to get the idea regarding the quality of construction. Instructions in **Para 8.7** of IRS Concrete Bridge Code should be followed regarding procedure, frequency of sampling and acceptance criteria of concrete.

29. Launching of Girder

Girder should be launched as per the approved scheme. Safety and careful handling of girders are the prime requirements during the operation. Launching scheme used on viaduct zone E-18 is shown in Ann. I.

30. Fixing of Bearings

Bearings are to be accompanied with the test certificate from RDSO and marking from the RDSO should be checked. General checking including the dimensions, should be done so that there is no problem at the time of fixing.

31. Other Miscellaneous jobs

Other Miscellaneous jobs including casting of Gap slab, Trolley refuge, fixing of railings etc. should be done and the girder should be finally finished.

32. Workmanship and Quality

It is essential to ensure the desired standard of quality for PSC construction. Some of the important factors in this regard are:

- Deputing of qualified supervisory staff.
- Testing and inspection of each and every material
- Availability of detailed working drawings
- Set up of laboratory for carrying out the testing of various materials as well as the finished work
- Accurate stressing procedure
- Proper control on dimensions as per specified tolerances
- Proper preparation, mixing, handling, placing, consolidation and curing of concrete
- Accurate dimensions, rigidity, proper surface of shuttering
- Proper handling, transportation and launching of girders
- Documentation of each activity regarding the girder in form of Girder History Sheet

33. Conclusions

An attempt has been made in this report to prepare the method statement for PSC girders, based on the experience gained during the construction of Viaduct E-18 (cast in yard) and Bridge no. 100 (cast in situ) on Jammu-Udhampur Rail Link Project. Despite technical advances, failure of concrete structures is taking place. This is primarily due to lack of awareness regarding proper procedure to be followed during construction. There is a need to create the awareness amongst Engineers/supervisors to follow the proper procedure during execution to achieve the desired quality, safety, optimum use of resources, minimizing delay and systematic execution of works.

Ann.-A

_____Railway

No. _____

Date: _____

Material Testing Laboratory,

_____,
_____.

Subject: Testing of Material

Please find enclosed herewith following sealed samples for conducting the tests as per procedure given in IS codes. Testing should be done for judging the suitability of the material for concreting and should include the tests given in Annexure-A.

SN	Sample no.	Description	Source

Testing charges will be paid by.....(Railways/contractor).

Enclosures: As per Ann-(i)

(Name)

(Designation)

Copy to:

- i. _____(supervisor) to ensure collection, sealing and delivery of material to the testing laboratory.
- ii. _____ for information please.

List of Tests to be conducted

- A. Coarse Aggregates: 20 mm & 10 mm
 - a. Sieve Analysis
 - b. Alkali - Aggregate reaction
 - c. Aggregate Impact Value
 - d. Aggregate Abrasion value
 - e. Aggregate Crushing Value
 - f. Soundness
 - g. Chloride contents
 - h. Sulphate contents
 - i. Deleterious materials
 - Clay lumps
 - Material finer than 75 micron sieve
 - j. Water absorption
 - k. Specific Gravity
 - l. Flakiness Index
 - m. Elongation Index

- B. Fine aggregate (River Sand)
 - a. Sieve Analysis
 - b. Alkali Aggregate reaction
 - c. Soundness
 - d. Chloride content
 - e. Sulphate content
 - f. Deleterious materials
 - Clay lumps
 - Material finer than 75 micron sieve
 - g. Specific Gravity

- C. Water
 - a. Physical character
 - b. Organic solids
 - c. Inorganic solids
 - d. Sulphate contents (as SO₄)
 - e. Chloride contents (as Cl)
 - f. PH Value
 - g. Limit of acidity (with N/10 NaOH)
 - h. Limit of alkalinity (with N/10 HCl)

Detail of Shuttering

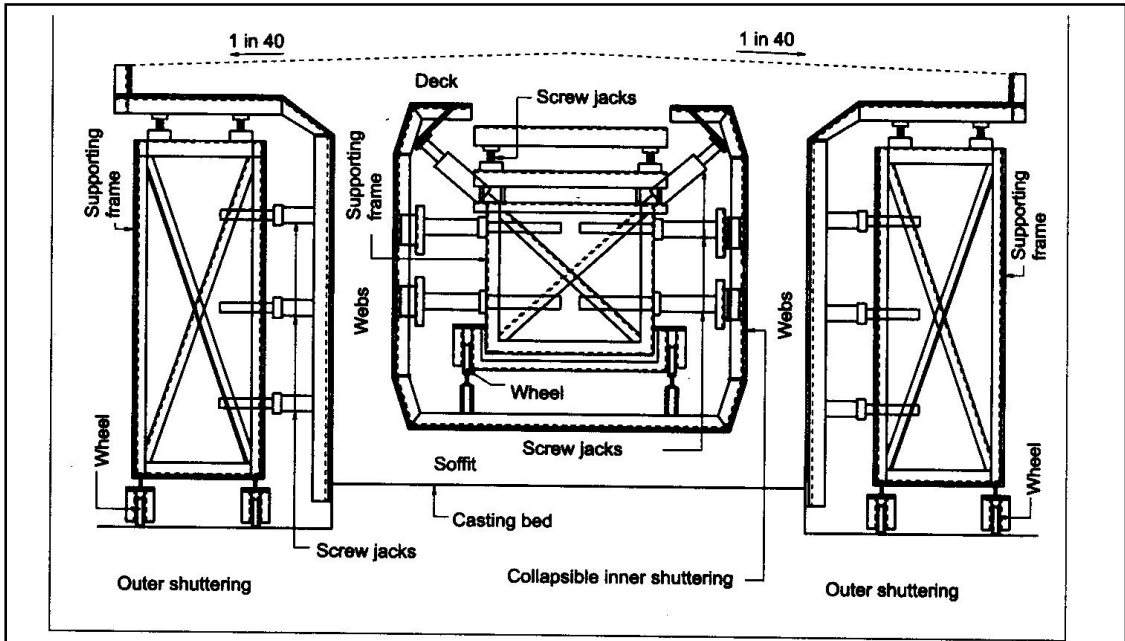


Fig 9 Shuttering detail for single pour casting of box girder of E-18 viaduct

Viaduct Zone E-18
Check Request for placing the inside shuttering

Girder No.- -----

D. Casting Bed

- a. Centre line of Bed, position of deviator blocks
- b. Cleaning of bed by compressed air
- c. Oil used to prevent sticking of concrete
- d. Levels

Distance from JAT end

Location	0m	5m	10m	15m	20m	25m	28.33m
Centre							
Left							
Right							

E. Form Work

- a. Alignment
- b. Verticality
- c. Surface condition
- d. Type of shuttering oil used
- e. Condition of Joints
- f. Rubber seal/dense foam along the length of shuttering
- g. Sealing of joints with putty
- h. Dimensions

F. Bearings

- a. Position
- b. Level
- c. Thickness of plate
- d. Whether hot dip galvanized
- e. Fixing in position

G. Cover to Reinforcement

- a. Cover to reinforcement

Distance from JAT end

Location	0m	5m	10m	15m	20m	25m	28.33m
Tawi side							
Grid side							
Bottom							

- b. Whether cover blocks tested for strength and found ok
- c. Thickness of cover blocks
- d. Binding arrangement for cover blocks with reinforcement

H. Reinforcement

- a. Whether reinforcement details submitted
- b. Whether reinforcement is as per approved drawing
- c. Drawing no.....
- d. Deviations from approved drawing, if any

Deviation	Approved by
-----	-----
-----	-----
-----	-----

- e. Condition of reinforcement
- f. Whether binding of reinforcement is ok
- g. Whether overlaps are correct and staggered
- h. Whether sufficient no. of adequate dia chairs for supporting the top layers of reinforcement in soffit slab are provided.
- i. Verticality of Web bars
- j. Whether web bars are at right angle to the longitudinal bars

I. Inserts and Fixtures

- a. Whether sufficient no. of spacer sleeves (ventilation holes) are provided in soffit.

J. Cable profiling

- a. Whether actual ordinates of cable profile are taken and recorded
- b. Whether sheathing, HTS strands and guide tubes are approved
- c. Test certificate no. and date for material testing including sheathing
- d. Detail of cables

Cable no.	1	2	3	4	5	6	7	8	9
-----------	---	---	---	---	---	---	---	---	---

Reel no. Left
Right

- e. Joint of sheathing with cones
- f. Any kink formation in the cable at ant point
- g. Anti corrosive protection of strands
- h. Position of helical reinforcement
- i. Provision of GI pipes in diaphragm for future stressing
- j. Whether sheathings are threaded properly including correct threading of couplers

- k. Whether fixing of cables on supports is firm
- l. Fixing of Guide cones
- m. Whether taping of joints is proper
- n. Whether length of the couplers is adequate

Signature of contractor

Date.....Time.....

Signature of SE/JE

Date.....Time.....

Accepted and permitted.

Signature-----

Designation-----

Viaduct Zone E-18
Check Request for Casting of Girder

Girder No.- -----

A. Form Work

- a. Alignment
- b. Verticality
- c. Surface condition
- d. Type of shuttering oil used
- e. Condition of Joints
- f. Rubber seal/dense foam along the length of shuttering
- g. Sealing of joints with putty
- h. Dimensions

B. Cover to Reinforcement

- a. Cover to reinforcement

	Distance from JAT end					
Location	0m	5m	10m	15m	20m	25m
Cantilever -Tawi side						
Grid side						
Haunch - Tawi side						
Grid side						
Centre						

- b. Whether cover blocks tested for strength and found ok
- c. Thickness of cover blocks
- d. Binding arrangement for cover blocks with reinforcement

C. Reinforcement

- a. Whether reinforcement details submitted
- b. Whether reinforcement is as per approved drawing
- c. Drawing no.....
- d. Deviations from approved drawing, if any

Deviation	Approved by
-----	-----
-----	-----
-----	-----

- e. Condition of reinforcement
- f. Whether binding of reinforcement is ok
- g. Whether overlaps are correct and staggered
- h. Whether chairs used are sufficient and as per specifications

D. Inserts and Fixtures

- a. Galvanised drainage spout
- b. Galvanised railing inserts

E. Concreting material

SN	Material	Requirement	Available	Last testing done on	Test certificate no.	Other details
1	Cement					
2	CA-20mm					
3	CA-10mm					
4	Coarse sand					
5	Plasticiser					
6	Water					
7	Bond solution					

F. Density, Make, Batch no. & type of plasticizer

G. Whether strength of cement has been checked by actual strength test and found ok

H. Machinery and other accessories

SN	Machine	Requirement	Stand by requirement	Availability at site
1	Weigh batcher			
2	Batching plant			
3	Mixers			
4	Generator			
5	Pouring bucket			
6	Vibrators			
7	Vibrator needles			
8	Shuttering vibrators			
9	Curing pump			
10	Cube moulds			
11	Slump cone apparatus			
12	Thermometer			
13	Hydrometer			
14	Tarpaulin			

I. Manpower for concreting work

SN	Description	Required	Available
1	Supervisors		
2	Masons		
3	Mixer operators		
4	Vibrator operators		
5	Drivers		
6	Winch operators		
7	Generator operator		
8	Labour for concreting		

J. Safety Requirements

- a. Helmets
- b. Safety belts
- c. Fire extinguishers
- d. First aid and stretcher
- e. Condition of wire rope in winch
- f. Condition of pulleys and supports
- g. Limiting switch in passenger hoist (if available at site)
- h. Communication with winch operator
- i. Railings
- j. Safety net

K. Concreting plan

- k. Total quantity of concreting to be done
- l. Output of mixture per hour
- m. Total time required for concreting
- n. Total no. of shifts
- o. Whether pouring sequence has been submitted
- p. Whether pouring sequence has been approved by Engineer in charge
- q. Whether mix design has been approved by engineer in charge
- r. Detail of mix to be used

L. Any other detail including deficiency/defect noticed

Signature of contractor
Date.....Time.....

Signature of SE/JE
Date.....Time.....

Accepted and permitted.

Signature-----
Designation-----

Viaduct Zone E-18
Check Request for Casting of Diaphragm

Girder No.- -----

- A. Preparation of Construction Joint
- B. Positioning and straightening of existing bars
- C. Form Work
 - a. Alignment
 - b. Verticality
 - c. Surface condition
 - d. Type of shuttering oil used
 - e. Condition of Joints
 - f. Dimensions
 - g. Supports/Nuts and Bolts

D. Cover to Reinforcement

- a. Cover to reinforcement

Location	Centre	Left	Right
Top			
Bottom			
JAT side			
UDM side			

E. Reinforcement

- a. Whether reinforcement details submitted
- b. Whether reinforcement is as per approved drawing
- c. Drawing no.....
- d. Deviations from approved drawing, if any

Deviation	Approved by
-----	-----
-----	-----
-----	-----

- e. Condition of reinforcement

F. Concreting material

SN	Material	Requirement	Available	Last testing done on	Test certificate no.	Other details
1	Cement					

2	CA-20mm					
3	CA-10mm					
4	Coarse sand					
5	Plasticiser					
6	Water					
7	Bond solution					

G. Density, Make, Batch no. & type of plasticizer

H. Whether strength of cement has been checked by actual strength test and found ok

I. Machinery and other accessories

SN	Machine	Requirement	Stand by requirement	Availability at site
1	Weigh batcher			
2	Batching plant			
3	Mixers			
4	Generator			
5	Pouring bucket			
6	Vibrators			
7	Vibrator needles			
8	Shuttering vibrators			
9	Curing pump			
10	Cube moulds			
11	Slump cone apparatus			
12	Thermometer			
13	Hydrometer			
14	Tarpaulin			

J. Manpower for concreting work

SN	Description	Required	Available
1	Supervisors		
2	Masons		
3	Mixer operators		
4	Vibrator operators		
5	Drivers		
6	Winch operators		
7	Generator operator		
8	Labour for concreting		

K. Concreting plan

- s. Total quantity of concreting to be done
- t. Output of mixture per hour
- u. Total time required for concreting
- v. Total no. of shifts
- w. Whether mix design has been approved by engineer in charge
- x. Detail of mix to be used

L. Any other detail including deficiency/defect noticed

Signature of contractor

1

Date.....Time.....

Signature of SE/JE


Date.....Time.....

Accepted and permitted.

Signature-----

Designation-----

Sample test report for Prestressing cables

TEST CERTIFICATE											Total Pages : 1				
TATA SSL LIMITED Regd. Office and Factory : Dattapada Road, Borivli (East), Mumbai - 400 066 Phone : (022) 805 0421 Telex : 011 - 70010 SSL IN						 LICENCE NO : CMIL 7167273					TC No : Q0021439 TC Date : 29-MAR-2000 Invoice No : 99013533 Invoice Date : 29-MAR-2000				
Size(mm): 12.700 mm [7636] TYPE OF WIRE:- PCSTD LR C1 II															
We certify that the material described below fully conforms to IS:14268-CL-2-1995															
To M/s. : BHAGHEERATHA ENGG LIMITED P.B.NO. 2338 M G ROAD COCHIN KERALA STATE 682001						Coils : 3 Wt. of Coils (kgs) 8849 Your Order No : PO.NO.TBP/PI Our OA No. :									
CHEMICAL COMPOSITION %															
SPEC	C	Mn	Si	P	S										
MIN:				0.05	0.05										
MAX:															
Heat No.:															
37718	.8	.69	.2	.015	.015										
37868	.82	.63	.18	.02	.02										
PHYSICAL TESTING															
COL NO.	Dia of std. mm	Nom Cr Sec Area Str. mm ²	Break Load / Strnth kgs	Elong % GL=600 mm	Load at 1% Extension Kgs.	R H Lay Length mm.	Nom wt of strands kg/km	Diff core out wire %	Mod. of Elasticity E = kg/mm ²	0.2% Proof stress kgs	Heat No				
SPEC. NOM		98.7					775								
SPEC. MIN	12.55		18737	3.5	16860	152.4		1.5	18851	16860	--				
SPEC. MAX	13.36					203.2			20889		--				
3976C	12.77	98.95	19100	6.71	17500	188	777	2.53	20414	17800	37718				
4019A	12.81	99.35	19600	5.39	18600	189	780	2.53	19833		37868				
4018F	12.82	99.55	19500	5.69	18200	186	781	2.3	20090		37868				
Page 1 <i>Act as per</i> For Quality Control															


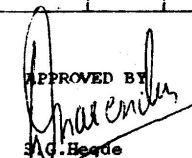
Sample test report for Sheathing

D.P. INDUSTRIES
 Corp. Off. : 72, Mahavir Centre, Sec-17, Vashi, Navi Mumbai Tele : 7892628, 7892755 Fax : 7891186
 Works : H-32, M.I.D.C., Shivaji Nagar, Satpur, Nasik Tele : 350935 Fax : 350935

TEST CERTIFICATE
ON C.R.C.A. BRIGHT METAL SHEATHING
 (AS PER IRC 18-1985)

TEST REPORT No. : DPIL/0113/2001 DATE : 06/04/2001

NAME OF CLIENT : M/s. BHAGERATHA ENGG LTD, JAMMU
 NAME OF PROJECT :
 SHEATHING SIZE : Dia. 090 mm (BRIGHT METAL)
 THICKNESS : 0.50 mm

Type of Test	Permissible Unit	Observations	Remarks																				
WORKABILITY TEST																							
Test sample 1100mm long is fixed on a test frame & bent to a radius of 1800mm alternately on either side to complete 3 cycles. No. of test samples-3Nos.	Failure or opening of joints should not take place.	Joints visually inspected in all the 3 samples after testing and observed no opening or failure of joints.	All the samples pass the satisfactory																				
TRANSVERSE LOAD TEST																							
Test samples were subjected to a Transverse load through a circular contact surface of Dia. 12.0mm on a test bed.	Max. deformation should be less than 5% at 1200N	<table border="1"> <thead> <tr> <th>Descrip.</th> <th>I</th> <th>II</th> <th>III</th> </tr> </thead> <tbody> <tr> <td>Ini. Dia.</td> <td>95.06</td> <td>95.18</td> <td>95.04</td> </tr> <tr> <td>Def. Dia.</td> <td>92.46</td> <td>93.55</td> <td>92.58</td> </tr> <tr> <td>Tot. def.</td> <td>2.60</td> <td>1.63</td> <td>2.46</td> </tr> <tr> <td>%Deflect.</td> <td>2.74</td> <td>1.71</td> <td>2.59</td> </tr> </tbody> </table>	Descrip.	I	II	III	Ini. Dia.	95.06	95.18	95.04	Def. Dia.	92.46	93.55	92.58	Tot. def.	2.60	1.63	2.46	%Deflect.	2.74	1.71	2.59	Deformation less than 5% sample and passes the satisfactory
Descrip.	I	II	III																				
Ini. Dia.	95.06	95.18	95.04																				
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Tot. def.	2.60	1.63	2.46																				
%Deflect.	2.74	1.71	2.59																				
TENSION LOAD TEST																							
3 Test samples were subjected to a tensile load with a coupler screwed at one end, upto a specified limit.	No deformation or opening of joints or slippage of coupler should take place at 2000N	No slippage of coupler occurred or deformation of joints took place.	All the samples pass the satisfactory																				
WATER LOSS TEST																							
The samples are sealed at both the ends after filled with water subjected to a pressure of 0.05MPa with the help of a hand Pump & retained at that pressure for 5 min.	water loss should not exceed to a max. of 1.5% of the total volume of water filled in Sheathing pipe.	<table border="1"> <thead> <tr> <th>Description</th> <th>I</th> <th>II</th> <th>III</th> </tr> </thead> <tbody> <tr> <td>Volume (cc)</td> <td>6978</td> <td>6957</td> <td>6969</td> </tr> <tr> <td>Wtr. los. (cc)</td> <td>NIL</td> <td>NIL</td> <td>NIL</td> </tr> <tr> <td>%Water loss</td> <td>NIL</td> <td>NIL</td> <td>NIL</td> </tr> </tbody> </table>	Description	I	II	III	Volume (cc)	6978	6957	6969	Wtr. los. (cc)	NIL	NIL	NIL	%Water loss	NIL	NIL	NIL	All the samples pass the satisfactory				
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Wtr. los. (cc)	NIL	NIL	NIL																				
%Water loss	NIL	NIL	NIL																				
TESTED BY  M.S. Nair Q.C. Engineer	APPROVED BY  S.G. Bhande Works Mgr.																						

Launching Scheme

