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**Government of India
Ministry of Railways**

**GUIDELINES ON
Fabrication of Steel Channel Sleepers**

(REPORT NO. BS-45)

REVISED – May, 2004

ISSUED BY

**RESEARCH DESIGNS AND STANDARDS ORGANISATION
LUCKNOW – 226011**

FORWARD

Steel channel sleepers are widely being used on bridge girders in replacement of wooden bridge timbers. These sleepers are fabricated with rolled steel channels by welding. In order to enable field engineers to exercise proper quality control, RDSO had issued "Guidelines on Fabrication of Steel channel Sleepers" (BS-45, April, 2002). As a part of further improvement, RDSO has recently issued revised Drawings No.B-1636/R2 & B-1636/1/R2 of steel channel sleepers and also issued new drawing No.B-1636/2 with increased height of steel channel sleeper for locations having curtailed top flange plates. In all these drawings, galvanizing of steel channel sleeper has been proposed to enhance the life of steel channel sleepers. Accordingly, the revision of existing guidelines was considered necessary to update the guidelines in respect of galvanizing.

Shri R.K. Goel, Director/B&S/SB-I assisted by Shri V. Murlidharan, ARE/M&C, Shri R.N. Shukla, SE/Design and Smt. Suman Verma, PA have done a good job in searching out the available instructions on galvanizing in different codes and presenting them in a form which is easily understood by the field engineers. The contents have also been significantly improved by Shri. L. Pugazhenthay, Executive Director, India Lead Zinc Development Association and his staff, which is gratefully acknowledged.

I hope, the revised guidelines will be quite useful to the field engineers in ensuring quality fabrication of steel channel sleepers with galvanizing. Suggestions/comments for further improvement will be gratefully acknowledged.

Dated: 27th May, 2004

(R.K. Gupta)
27.05.2004
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Guidelines on Fabrication of Steel Channel Sleepers

1. Introduction:

RDSO had issued standard drawings RDSO/B-1636, and B-1636/1 for steel channel sleeper in the year 1992 to substitute wooden bridge sleepers. These drawings have since been revised as B-1636/R2 and B-1636/1/R2. Additional drawing B-1636/2 has also been issued with increased height of 175mm for locations having curtailed top flange plates, to avoid thicker packing plates. Galvanising of steel channel sleepers has been proposed in the revised drawings to prevent corrosion. Accordingly, guidelines titled as "Guidelines on Fabrication of Steel Channel Sleepers" have also been revised.

2. Details of Sleepers:

The steel channel sleeper designed by RDSO for BG and MG are fabricated from IS: 2062 steel. The sleeper consists of two mild steel channels, ISMC 150 or ISMC 175 connected by T-Shaped diaphragms. Rivets are used for the connection of channel and bearing plates. The channels are stiffened by mild steel plates. The sleepers are kept over elastomeric pads and connected to the bridge girder by hook bolts. The rails are kept on grooved rubber pads and are connected to the sleepers by 'T' headed bolts and nuts with mild steel inner and outer clips and spring washers etc.

3. Specification for Steel:

- 3.1 Where service temperature does not fall below 0°C, steel to IS: 2062 Grade "B" fully killed shall be used.
- 3.2 For sub-zero temperature areas, steel to IS: 2062 Grade "C" fully killed shall be used.
- 3.3 The channel section, in 'as rolled' condition may be used if there is genuine difficulty in getting normalised section.
- 3.4 The rolling and cutting tolerances shall be in accordance with IS: 1852.

- 3.5 All the steel sections used in the fabrication must have mill test certificate clearly indicating the specification to which the steel conforms and whether steel is killed and normalized. Use of steel of any quality other than those mentioned above would require the prior approval of Chief Bridge Engineer.

4. **Straightening & flattening of steel:**

All steel materials, plates and structural shall have straight edges, flat surfaces and be free from twist. If necessary, they shall be cold straightened or flattened by pressure before being worked or assembled. Pressure applied for straightening or flattening shall be such as it would not injure the material and adjacent surfaces or edges.

5. **Cutting of Steel:**

Flame cutting by mechanically controlled torch/torches shall be accepted. Preferably oxyacetylene gas should be used. While cutting the stiffener plates special care should be taken to ensure the proper profile/slope so as to fit in channel web and flange tightly.

6. **Jigs & Fixtures:**

- 6.1 To ensure quality and to have interchangeability of steel channel sleepers, fixtures shall be used and holes shall be drilled by the use of steel jigs. The steel jigs and fixtures shall be approved on the basis of the prototype steel channel which should meet the specified dimensional requirements.

- 6.2 The steel bushes used in jigs shall be case hardened by an approved process and checked for diameter after the heat-treatment. The bores of bushes shall initially have a tolerance of -0mm , 0.1mm . The tolerance shall be checked from time to time and when the bores exceed a tolerance of -0mm , $+0.4\text{mm}$, the bushes shall be rejected. For this purpose, go and no-go gauges are to be used. Tolerances for checking jigs from master plates shall be $+0\text{mm}$ - 0.13mm .

7. **Drilling of holes:**

Drilling of members of steel channel sleepers is done through steel bushes of the jig. All burrs left by the drill and sharp edges of the holes shall be removed.

8. Welding Process and Positions:

- 8.1 Welding shall be carried out in accordance with the approved welding procedure specifications by approved welders, processes and positions. Proforma for Welding Procedure Specification & Welding Procedure Qualification Records are enclosed as Appendix-1.
- 8.2 All welding should be preferably done in flat position (horizontal). Welding should be done as per drawing ensuring proper size of weld. Oversize welding may lead to excessive heat affected zone which may lead to failure of material. Welding should be carried out in a warm and dry place so that rain water or other atmospheric elements may not come in contact while welding is in progress.
- 8.3 Electrodes shall conform to class A2 of IRSM-28 and wire for CO2 welding shall conform to class I of IRSM-46..
- 8.4 All consumables shall be stored and handled with care and in accordance with the manufacturer's recommendations.

9. Riveting:

- 9.1 Before riveting is commenced the permanent contact surface of channel and plate shall be painted with ready mixed paint red lead conforming to IS 157 or a thick paste of dry red lead powder conforming to IS-57 mixed with linseed oil conforming to IS-77.
- 9.2 The dimensions on the drawings referred to the diameters of the rivet holes and their finished rivets. The rivet holes shall be 1.5 mm greater than the diameter of the rivet bars used. The rivets shall be made to IS: 1929. The shanks of the undriven rivets shall be made of a length sufficient to fill the holes thoroughly and form the head. The clearance i.e. the difference in diameter between the rivets measured under head before being heated and the rivet hole shall not be less than 0.75mm. Before rivetting is commenced, all works shall be properly bolted so that the sections rivetted are in close contact throughout. Riveting shall be done one by one by taking out the bolt and riveting the same in an approved manner by qualified and skilled personals. Rivets shall be machine driven by means of pressure or percussion rivetters of approved design.
- 9.3 All rivets shall be properly heated to straw heat for the full length of the shank, firmly backed and closed. Sparking or burnt rivets shall

not be used. Where it is impossible to back up by normal method of holding up, 'double gunning' may be resorted to. Alternatively pneumatic holding device may be used.

Gauges for rivet dimensions and contours shall be provided by the Contractor for the use of the Inspecting Officials.

Rivets when driven shall completely fill the holes, have the heads concentric with the shanks and shall be in full contact with the surface. Driven rivets when struck sharply on the head with the 110-gm. rivet testing hammer, shall be free from movement or vibration.

All loose and burnt rivets and rivets with cracks, badly formed, eccentric or deficient heads shall be cut out and replaced. Permissible deviation of driven rivets shall be as per Appendix-2. Rivets shall also be cut out when required for the examination of the work. Actual method of cutting out shall be approved by the Engineer. Recupping and caulking shall in no circumstances be resorted to.

Final Finishing:

Ends of the channel sleepers shall be ground in right angle and all the cutting burrs from ends of channels & plates shall be removed.

Inspection stages:

- (a) Before fabrication
- (b) During fabrication
- (c) After fabrication

(a) Before Fabrication:

- Quality Assurance Plan shall be prepared and got approved.
- Raw material such as channels and plates etc. to be inspected as per specification mentioned against each items and rolling Mark certificates.
- Lamination, piping, pitting, rolling defects and Straightness of material to be checked before fabrication.

- Consumables such as, rivets, welding electrodes and paints etc. are as per standard specifications.
- Welding Procedure Specifications need to be approved
- Welders approval as per Welding Procedure Specification.

(b) During Fabrication:

- Profile of stiffener plate by template
- Welding by qualified welders as per approved WPSS.
- Welding parameters are to be set & checked during welding.
- Riveting by qualified and skilled personal with approved work instructions.

(c) After fabrication:

- Verify rolling Mark number of steel sections used for fabrication, from Certificate issued by manufacturer. Check the register maintained by firm.
- Surface defects shall be checked visually.
- Quality of welds with respect to specified sizes, length and any visual defects.
- Quality of rivets to be checked visually and with the help of riveting hammer.
- Dye Penetration Test for welds
- Leading dimensions i.e. overall length, hole dimensions, end finishing etc. shall be checked. For this purpose detail measurement sheet shall be prepared for.

12. Galvanising

12.1 Galvanizing Process

Hot dip galvanizing of iron and steel articles is to be done as per IS 2629 "Recommended Practice for Hot Dip Galvanizing of iron and steel".

The surface preparation of steel articles before hot dip galvanizing shall be carried out as follows :-

- (i) **Degreasing** : Degreasing of steel surface, shall be carried out in accordance with IS 2629 (Clause 4.1) to remove oil, paint, grease etc.,. After degreasing the article shall be thoroughly rinsed.
- (ii) **Pickling Acid** : Pickling shall be done using either hydrochloric or sulphuric acid as recommended in IS 2629 (Clause 4.3). The actual concentration of the acid and pickling time depend on the extent of rusting on the material to be pickled. Suitable inhibitors also shall be used with the acid to avoid metal loss.

Rinsing : After pickling, the article shall be rinsed, preferably in running water to remove free acid, iron particles or any other impurities from the surface. Two rinse tanks are preferable, with water cascading from the second tank to the first to ensure thorough cleaning. If a single tank is employed, the water shall be periodically changed to avoid acid contamination.

- (iv) **Fluxing** : The rinsed article shall be dipped in a flux solution of Zinc ammonium chloride. The concentration and temperature of the flux solution (IS 2629 Clause 4.6) shall be maintained by the galvanizer. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. The pH value should be monitored periodically and maintained between 5.0 to 5.5.

Drying : The article shall be thoroughly dried after fluxing. For the purpose of drying, the galvanizer may use hot plate, air oven, air blower etc., ensuring complete drying of the article after fluxing and prior to dipping in the molten zinc bath. The drying process shall be such that the article shall not attain a temperature (120°C) at which the flux shall get decomposed. The article thus dried shall be galvanized before the flux coating picks up moisture from the atmosphere or the flux layer gets damaged or removed from the surface. The drying procedure, time, temperature, time lag between fluxing, drying and galvanizing etc., shall be taken care of by the galvanizer.

Quality of Zinc : Any grade or combination of the grades of zinc specified in IS 209 shall be used for galvanizing. The molten metal in the zinc bath shall contain minimum 98.5% zinc by mass. It shall be periodically measured and recorded.

- (vii) **Dipping Process** : The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at $450 \pm 10^\circ\text{C}$. The article should be immersed in the bath as rapidly as possible without compromising on safety aspects. The galvanizing bath temperature, immersion angle & dipping time, rate of withdrawal etc., shall be monitored and controlled depending upon the size and shape of the article such that the mass of zinc coating and its uniformity meet the specified requirements and the galvanized surface is free from imperfections and galvanizing defects.
- (viii) **Post Treatment** : The article shall be quenched in water. The quench water is to be changed / drained periodically. If water quenching is not done, alternative cooling arrangements could be made. However water quenching is strongly recommended. The galvanized articles shall be subsequently dipped in a chromating solution containing sodium dichromate and sulphuric acid or chromic acid base additive at a predetermined concentration to prevent white rust formation. The temperature of the chromate solution shall not exceed 65°C . The articles shall not be stacked immediately after quenching and chromating. It shall be ensured that the articles are dry before any further handling operation.
- ix) **Storing, Packing and Handling** : In order to prevent white rust formation, sufficient care should be exercised while storing, handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site.

For fasteners, the galvanizing shall be done with centrifuging arrangement after all mechanical operations are completed. The nuts may however be tapped (threaded) or rerun after galvanizing and the threads oiled. The threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of bolts.

12.2 Galvanized Coating :

The Zinc coating weight/thickness is the most important factor from a corrosion prevention point of view. A hot dip galvanized steel surface should have a nominal coating weight of 610 g/m^2 (86 microns) and its corrosion resistance property is such that it can give 20 years life in normal circumstances. However, for severe corrosion prone areas like

coastal areas etc., a coating weight of 750 g/m^2 (105 microns) may be prescribed for a similar life i.e., 20 years.

12.3 Painting :

For most applications, the galvanized channel sleepers do not need any paint coating. However, in order to prolong the protection given by galvanizing the galvanized channel sleepers shall be painted with one coat of ready mixed paint Red oxide Zinc Chromate conforming to IS:2074 followed by one coat of Aluminium paint conforming to IS:2339.

12.4 Coating Weight -Testing and Inspection :

The Zinc coating shall be adherent, smooth, continuous and free from such imperfections as flux, ash and dross inclusions, bare and black spots, pimples, lumpiness and runs, rust stains, bulky white deposits and blisters. The galvanized steel channel sleepers shall be tested for coating uniformity. For a quick approximate measurement of coating weight/thickness, magnetic gauges may be used. The Zinc coating weight, thickness and uniformity of zinc coating may be determined in accordance with IS : 2633.

12.5 Adhesion Tests

Following tests may be conducted to determine the adherence of Zinc coating on steel:

12.5.1 Pivoted Hammer Test :

The hammer used shall conform to the drawing shown in Fig.1. The hammer blow shall be controlled by holding the pivoted base of the handle on a horizontal surface of the galvanized member and allowing the hammer head to swing freely through an arc from vertical position to strike the horizontal surface. The test shall consist of two or more standard blows forming parallel impressions with 6mm spacing and a common axis, as illustrated in Fig.1. No part of an impression shall be closer than 12mm to the edge of the member. Removal or lifting of the coating in the area between the impressions shall constitute a failure. An extruded ridge less than 2mm wide immediately adjacent to the impression shall be disregarded. The specimen may be tested in several places throughout its length to the satisfaction of the engineer.

12.5.2. Knife Test :

When the coating is cut or pried into, such as with a stout knife applied with a considerable pressure in a manner tending to remove a portion of the coating, it shall only be possible to remove small particles of the coating and it shall not be possible to peel any portion of the coating so as to expose underlying iron or steel.

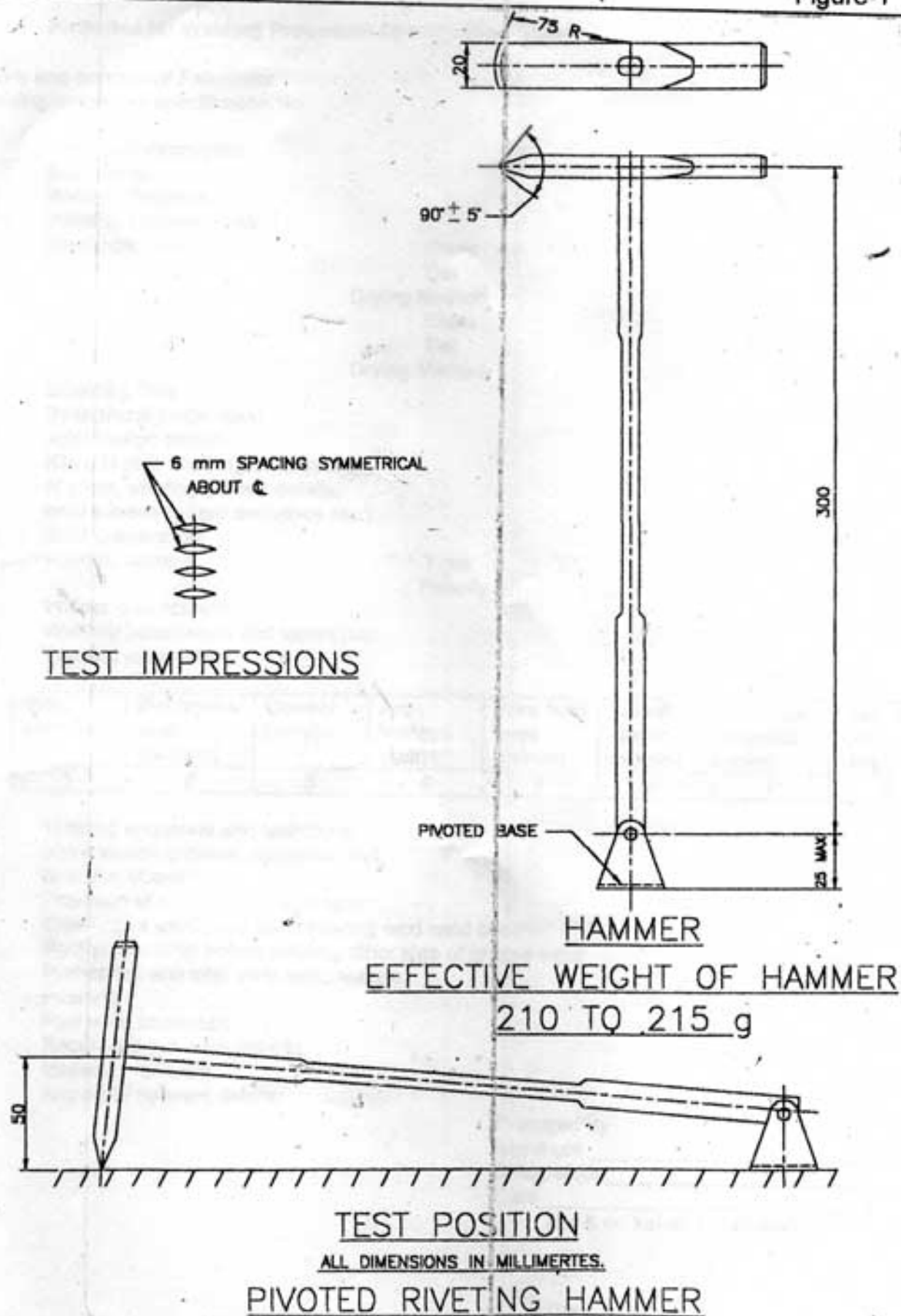
13. Record to be Maintained by Fabricator:

- i) Jig register
- ii) Rivet checking register
- iii) Offering & inspection file/register
- iv) Material test certificate register.
- v) Welding Procedure Data Record.
- vi) Record for inspection and testing on galvanizing

14. Handling & Stacking:

- i) Care should be taken for safe transportation.
- ii) Stacked on properly levelled plate form.
- iii) Store the channels in safe place away from atmospheric action to avoid scaling, rusting, pitting etc.

Figure-1



APPENDIX-1

1. Proforma for Welding Procedure Specification Sheet

Name and address of Fabricator :
Welding procedure specification No. :

1. Weld joint description :
2. Base Metal :
3. Welding Process :
4. Welding Consumables :
5. Electrode/Wire :
Class :
Dai :
Drying Method :
6. Flux :
Class :
Dai :
Drying Method :
5.3.1 Shielding Gas :
6.0 Base Metal preparation :
6.1 Joint design details :
(Give sketch showing arrangement
of parts, welding groove details,
weld passes & their sequence etc.)
6.2 Joint preparation :
7. Welding current :
Type :
Polarity :
8. Welder qualification :
9. Welding parameters and technique :
9.1 Welding parameters :

Weld Pass No.	Electrodes/ wire dia.(mm)	Current (amp)	Arc Voltage (volt)	Wire feed speed (m/min)	Travel speed (m/min)	Electrical stickout (mm)	Gas flow rate (litre/min.)
1	2	3	4	5	6	7	8

- 9.2 Welding sequence and technique:
(Give sketch showing sequence and
direction of welding).
10. Provision of run in and run-off tabs:
11. Cleaning of weld bead before laying next weld bead:
12. Root preparation before welding other side of groove weld:
13. Preheating and inter pass temperature:
14. Peening :
15. Post weld treatment:
16. Rectification of weld defects:
17. Inspection of weld:
18. Any other relevant details:

Prepared by
Signature _____
Designation _____
Date _____
(for & on behalf Fabricator)

2. Proforma for Welding Procedure Qualification Record

NAME AND ADDRESS OF FABRICATOR

1. Description of weld joint :
2. Welding procedure specification no. :
3. Name of welder :
4. Date of preparation of test piece :
5. Dimensions of test piece :
6. Base Metal :
7. Welding Process :
8. Welding position :
9. Welding current: :

Type :
Polarity :

10. Weld joint design details
11. Welding consumables
- 11.1 Electrode/wire

Class :
Dia :
Brand:
Class :
Dia :
Brand:

- 11.2 Flux

- 11.3 Shielding gas :
12. Welding parameters

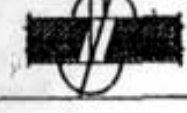
Weld Pass No.	Electrodes/ wire dia.(mm)	Current (amp)	Arc Voltage (volt)	Wire feed speed (m/min)	Travel speed (m/min)	Electrical stickout (mm)	Gas flow rate (litre/min.)
1	2	3	4	5	6	7	8

13. Preheating and interpass temperature :

Test	Specimen No.	Result
1	2	3

APPENDIX-2

PERMISSIBLE DEVIATIONS FOR DRIVEN RIVETS

SL. No.	DESCRIPTION OF DEVIATIONS	SKETCH	TOLERANCE
1.	SHANKING OR SHIFTING OF THE HEAD UNDER THE KNOCKS OF HAMMER.	—	NOT ALLOWED
2.	CAULKING OF THE HEAD.	—	NOT ALLOWED
3.	IMPROPER BEARING OF THE HEAD ON THE ELEMENT WHILE RIVETTING ALONG THE ENTIRE CONTOUR OF HEAD		NOT ALLOWED
4.	IMPROPER BEARING OF THE HEAD ON THE ELEMENT WHILE RIVETTING ALONG THE ENTIRE PART OF CONTOUR OR RIVET.		NOT ALLOWED
5.	PRESENCE OF CRACKS IN THE HEAD.		NOT ALLOWED
6.	NOTCH IN THE HEAD.		2 mm.
7.	SHIFTING OF HEAD FROM THE AXIS OF RIVET.		$b \leq 0.1d$
8.	BAD SHAPE OF HEAD ALONG THE PART OF CONTOUR OF RIVET.		$a+b \leq 0.1d$
9.	BAD SHAPE OF HEAD ALONG THE ENTIRE CONTOUR OF RIVET.		$a+b \leq 0.1d$
10.	HEAD OF REDUCED DIMENSION.		$a+b \leq 0.1d$ $a \leq 0.5d$
11.	CROWN NEAR THE HEAD.		NOT ALLOWED
12.	NOTCHING OF STEEL BY SNAP.		NOT ALLOWED
13.	UNEVENNESS OF THE SURFACE OF THE HEAD.		$a \leq 0.3 \text{ mm}$
14.	OBLIQUE RIVETTING.		DEVIATION UP TO 3% OF THICKNESS OF JOINT ELEMENTS BUT NOT MORE THAN 3 mm.

ANNEXURE-I

List of Members of Indian Galvanizer's Association

S. No.	Name of the firm	Address	Contact person	Telephone/ Fax
1	Associated Power Structures Pvt. Ltd.,	905/3, GIDC, Makarpura, Baroda-390 010	Farag V Khothari or Satish R Desai Director	0265-644789 0265-656272
2	Baroda Galvanizers	A-513, GIDC, Makarpura, Vadodara-390 010	Mukesh Gupta or Narendra Sharma Executive	0265-643469/19 0265-642900
3	Crescent Corrosion Control Pvt. Ltd.	Survey No.320/3A, Poonamalli-Tiruvallur Main Road, Gudapakkam Village, Tiruvallur Dist., Chennai-602 109	T.A.S. Nazeer MD or P. Sathya Prabhu Product Dev. Manager	044-6490664/0693 044-6274502
4	Tansi Structural & Galvanizing	Mettur Dam 636 401 Tamil Nadu	A. Subramani, Work Manager or J. Sankaranarayanan Jy. Manager (Strl. & Engg)	04298-44038, 44138
5	Signet Steels Limited	Plot No. 17 & 18, Autonagar, E Block, Visakhapatnam 530 012	A.T. Reddy, Managing Director or J.P. Shrivastava, General Manager	0891-587100/163 0891-587162
6	Hot Dip Galvanizing	Plot No. 142-I, Baikampady, Mangalore-575011	S.S. Shettigar Proprietor or Akshaya	0824-408175 0824-408780
7	Poly Qual (India) Pvt. Ltd.	A-210, Okhla Industrial Area, Phase-I, New Delhi-110 020	D.K. Bansal MD S.H. Arora Director	011-6814137 011-6812231
8	Super Metal Industries	A 2, NICE, Street No.2, Satour, Nashik-422 007	N.M Shah Partner	0253-350222 0253-350911
9	Karamtara Engineering Pvt. Ltd.	G-3/1 & 2, MIDC, Tarapur, Boisar, Distt. Thane 401 506 Maharashtra	Rajeev Singh Director D.P. Nair General Manager	02525-74351, 78962 02525-74373
10	Jenco Industrial Corpn.	Chincholi Bunder Road, Devrukhhkar Wadhi - Nr. Link Rd., Malad (W) Mumbai 400 064	Rajeev Kandhari	022 28725402/ 5765 022 2972378
11	Sagar Steel Pvt Ltd	39, SNS Plaza, 41 Kumara Krupa Rd, Bangalore-1	S. Chouraria, MD	080 2269242 080 2203332

12	M.J. Engg Works	B-132 Okhla Indl Area, Phase-1, New Delhi 20	P.K. Jain, Director	011 26817536 26816198
13	Steel Products	96, Garden Reach Road, Kolkata 23	Hemant Kr Khaitan, MB	033 24597879 033 24593944
14	Galfan Engineers Pvt Ltd.	Kannabiran Koil Sreet-G, N T Road, Kanakanchatram- Madhavavaram, Chennai 60	K.R.P. Mohan, MD	044 25375068 044 25375068
15	Utkal Galvanizers Ltd Tower Divn	Jagatpur Industrial Estate (New), Jagatpur 021	K.K. Mohanty, MD	0671 2490219 0671 2491629
16	General Engg Indus.	9/35 Athani, Kakkanad, cochin 682 030	Gijo George, Partner	0484 2422306 0484 2428712
17	Reliable Galvanizer & Fasteners Pvt. Ltd.	Manjeet Niwas, Opp. Namaskar Mandal Agra Road, Kalyan 421 301	Ganesh K Potdar, Director	0251 2690093 0251 2696489
18	Sri Balaji Metalizers	I-16 & 17 Electrical & Electronics Indl Estate, Thuvakudhi , Trichy 620 015, TN	V. Ramesh, Director (Marketing)	0431 2500982 0431 2414376

Note : The above list neither includes the names of all the firms having the facilities of galvanising nor should be considered as the approved source of galvanisation.