



Attachment No. 5 of Addendum No. 9

Appendix.7. Fabrication Work of Steel Segments of Main Tunnel and Equipment Rooms in TBM Section

1. GENERAL

1.1 Submittals

The Contractor shall submit following statements and records for approval of the Engineer.

- a. Method Statement
- b. Resource Report
- c. Fabrication and Inspection Record

1.2 Contractor's Welding and Painting Supervisors

Prior to carrying out welding and painting works, the Contractor shall appoint appropriate number of welding and painting engineers with at least 5 (five) years of experience for supervising the work.

2. STRUCTURAL STEEL WORK

2.1 Fabrication

2.1.1 General

The Contractor, prior to commencing fabrication, shall submit following details of fabrication-workshop to the Engineer for approval.

- 1) Location
- 2) Organization chart
- 3) All serviceable major items, and plant and equipment,
- 4) Detail of paint shop including blasting machine and rooms.
- 5) Details of Welding Procedure Specification (WPS) and Welding Procedure Qualification Record (WPQR).



2.2 Method of Fabrication

The Contractor shall carry out the fabrication work in accordance with IRS: B-1 2001.

2.2.1 Welding

2.2.1.1 General

All welding shall be carried out in accordance with the Drawings and Welding Procedure Specification (WPS). Provisions of the Welded Bridge Code and IS: 9595 may be followed, if not in contravention to the provisions mentioned hereinafter.

2.2.1.2 Welding procedure

- a) Welding procedure shall conform to IS: 16003 Annex C.
- b) The Contractor shall provide Welding Procedure Specification (WPS) based on Welding Procedure Qualification Record (WPQR) which is approved by the Engineer.

2.2.1.3 Qualification of welder

The welder shall pass the tests specified in IS 817 or JIS (JIS Z 3801 and JIS Z 3841) or equivalent. However, welder already having passing certificate conforming to JIS may be exempted tests.

2.2.1.4 Weld profiles

- a) There shall be no crack at welding bead and in its vicinity.
- b) There shall be no lack of penetration, slag inclusion, harmful blow hole and overlap, crater and pit 0.3mm diameter or more. Even if pit diameter is less than 0.3mm, repair shall be carried out in the area to be painted.
- c) If finishing is specified in the Drawings, undercut shall not be permitted.
- d) Tolerance of welding profile shall conform to Table 1 and Figure 1 below of these technical specifications.

Table 1: Tolerance of Welding profile

No	Check item (* Refer Figure 1)	Tolerance
1	Difference in height of bead surface (*1)	2mm or less in any 25mm length in run direction
2	leg length (except front fillet welding)	+3mm to 0mm +4mm to -1mm (within 10% total length of a run)
3	Difference between two leg	3mm or less

	length (at any section) (*2)	4mm or less (within 10% total length of a run)
4	Throat thickness (at any section) (*3)	+2mm to 0mm +4mm to -0.7mm (within 10% total length of a run)
5	Depth of undercut (where no finishing)	primary members 0.3mm or less 0.5mm or less (within 10% total length of a run)
		secondary members 0.5mm or less 0.7mm or less (within 20% total length of a run)
6	Excess-weld (where no finishing) (*4)	$H \leq 3\text{mm}$ as $b < 15\text{mm}$, $h \leq 4\text{mm}$ as $15\text{mm} \leq b < 25\text{mm}$, $h \leq 4b/25\text{mm}$ as $25\text{mm} \leq b$ where b as bead width, h as excess-weld height
7	Difference in height of joint and end return (*1)	2mm or less
8	concave/convex value at any section (*5)	2mm or less

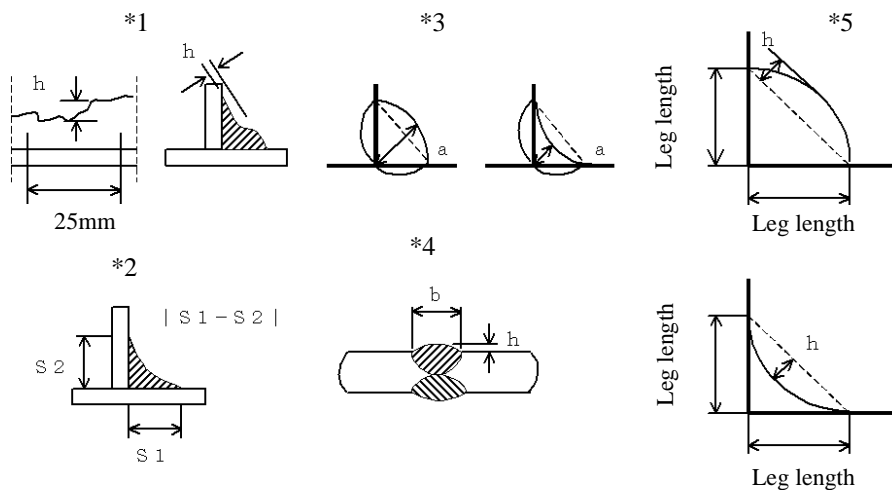


Figure 1: Weld Profiles

2.2.1.5 Non-destructive testing (NDT)

a) General

- 1) The Contractor shall confirm suitability of NDT operators through test. The Contractor shall judge operator's ability of flaw detection and shall decide whether their suitability for fabrication.
- 2) NDT shall be carried out using Dye Penetration Test (DPT) and UT, as specified below.
- 3) Qualification and responsibility of operators for DPT and UT as applicable shall conform in the relevant categories to IS: 13805 or JIS Z 2305 or ISO 9712 and the minimum qualification of operator shall conform to following.



- i) For operation of device: Level II
- ii) For judgement: Level III

Also, the Contractor shall check the ability of NDT operators through test.

- 4) If the welding fails the test, then weld shall be repaired in accordance with Sub-Clause 2.3.3 (Table 2) and retest shall be carried out after repair.

b) Procedure for Dye Penetration Test

All welds except those of receiving girder shall be tested by DPT as per IS: 3658.

c) Procedure for Ultrasonic Test (UT)

UT shall conform to JIS Z 3060 or ISO:10863 and the standard test blocks for calibration of angle probe shall conform to ISO: 2400.

2.2.2 Inspection and Testing of fabrication work

The Contractor shall submit the Inspection and Test Plan (ITP) to the Engineer for approval in accordance with the relevant provisions under Division 07000 of General Specifications.

2.2.3 Repair of fabrication defects

- a) If the Quality Management (QM) team of the Contractor finds any defect during and/or after inspection work as per Inspection and Test Plan (ITP), the Contractor shall report it to the Engineer.
- b) Repair of the following defects shall be carried out as per Table 2 below. For other defects if any, the Contractor shall propose the rectification method for the approval of the Engineer.

Table 2: Types of Defects and Repair

No.	Types of defects	Repair methodology
1	Crater and scratch on the steel surface	0.1mm ≤ depth ≤ 1mm: smoothen by grinding. 1mm < depth: weld and finish by grinding.
2	Layered crack at end of steel plate	Repair by gouging a quarter depth of plate thickness, then weld and finish.
3	Notch on gas cutting edge	Depth ≤ 2mm: smoothen by grinding. Depth > 2mm: After scraping more than 10mm width in the vicinity area then weld and finish by grinding.
4	Arc strike	After scraping the area of defect by grinder, then weld and finish. However, for E 350, E410 and E 450 of steel material, preheating shall be carried out before scraping work by grinding. Preheating shall be maintained at 650 degrees Celsius for few minutes.
5	Crack of weld and crack by bending	Remove the cracked part then re-weld with preventive measures against re-cracking.

6	Lack of penetration, incomplete fusion, slag inclusion, blowhole and pit	Remove the defect with arc-air gouging and/or mechanical devices then re-weld.
7	Unevenness of bead	Scrape and smoothen by grinding.
8	Undercut	Depth <0.5mm: scrape and smoothen by grinding 0.5mm ≤ Depth: after weld, finish by grinding.
9	Overlap	Remove defect by grinder or arc-air gouging or mechanical devices then re-weld.
10	Hole by failed drilling	Replace with new material, or after filling by weld into hole then finish by grinding. In the latter case, radiography testing shall be carried out.

- c) Disc grinder shall not be used for repair of steel surface flaw and weld bead. Conical grinder shall be used for repair of weld bead. Repair the weld bead so that it becomes smooth in the direction of the bead without damage.
- d) Short bead shall be avoided in the repair work by welding.

2.3 Painting at fabrication shop

2.3.1 General

Method Statement for anti-corrosive work by painting, with details of surface preparation, painting specification, painting procedure and ITP, shall be submitted to the Engineer for approval prior to commencement of work.

2.3.2 Painting Schedule

Painting schedule of steel segments shall be as follows:

2.3.2.1 Steel segments of main tunnel which will be infilled with concrete/shotcrete, steel segments of equipment rooms and all other steel work at junction of main tunnel and equipment room.

- a) Surface preparation – Sa 2 ½ as per ISO-8501-1
b) Primer – Zinc rich primer (15µm)

2.3.2.2 The steel segment of main tunnel which will remain exposed during service

Crown segments of steel rings of the main tunnel as shown in the Drawings will be provided with anti-corrosive paint as follows-

- a) Surface preparation: Blasting processing ISO Sa2 ½
b) Anticorrosion base: zinc rich paint (75 µm) [JIS K5553 or equivalent]



- c) Mist coat: Epoxy resin undercoat (50% dilution of epoxy resin undercoat) spray coating (160g/m²) (does not contribute to film thickness) [JIS K 5551 or equivalent]
- d) Undercoat: Epoxy resin paint undercoat (120 μm) [JIS K 5551 or equivalent]
- e) Intermediate coating: Fluoresin paint (30 μm) [JIS K 5659 or equivalent]
- f) Topcoat: Fluoresin paint (25 μm) [JIS K 5659 or equivalent]

All bolts, nuts & washers of steel segments of main tunnel and equipment rooms shall be dacrotized as per DX350: JIS B1046/ISO:10683 @ 25g/m².

2.3.3 Surface preparation for painting work

Surface preparation shall conform to RDSO specification No. M&C/PCN/129/2010.

2.3.4 Inspection and Testing for painting

- a) The Contractor shall submit the Inspection and Test Plan (ITP) to the Engineer for approval in accordance with the relevant provisions under Division 07000 of General Specifications.
- b) The measurement of DFT shall conform to ISO 19840.
- c) Painted surface shall be checked for any visual defects and for the required thickness. The defect area shall be marked out for further inspection by the Engineer, after which the suitable repair work shall be proposed by the Contractor for the approval of the Engineer.

2.3.5 Repair of painting defects

Any Repair painting required after the inspection by the Engineer, shall be based on the paint damage grade classified as under by the Contractor and painting carried out after due approval from the Engineer.

2.4 Site welding

2.4.1 General

Except as provided in this section, it shall be in accordance with sub-clause 2.2.1 welding in this specification.

2.4.2 Deformation due to welding

If deformation is occurred on base material, the contractor shall submit proposal of the treatment to obtain approval to the Engineer.



2.4.3

Welding inspection and quality

- a) The quality of weld profile shall be as per Table 1.
- b) Non-destructive testing of welding shall be in accordance with sub-clause 2.3.1.5 in this specification.
 - 1) The test method, inspection frequency and acceptance criteria are as per as Table 3.
 - 2) The Contractor shall submit the inspection report to obtain approval to the Engineer, after finished inspection as soon as possible.
 - 3) If there are fail section by inspection, the Contractor shall submit proposal of treatment method to obtain approval to the Engineer. And also, re-inspection shall be carried out after treatment.

Table 3: Non-destructive test and quality of welding

Test method and inspection frequency	DPT	All welds except those of receiving girder
	Ultrasonic Test (JIS Z3060)	All welds of receiving girder
Acceptance criteria	DPT	IS: 3658
	Ultrasonic Test	Class 3 or higher of JIS Z3060 or equivalent