# Manual Welding Of Thicker Slab

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## 1.0 INTRODUCTION

In the field of fabrication and welding, we sometime come across jobs which are heavy in nature and need auto or semi-auto welding machine to give the required results. But in the absence of such facilities and machineries in a particular situation, engineers have to take daring steps to attempt the same with ordinary transformers and weld manually. While doing such uncommon jobs, a series of precaution measures and supporting facilities are to be thought over before starting and ending the job.

This is a case history of a thicker slab of 200 mm thick, 2100 mm diameter welded manually.

## 2.0 DESCRIPTION

2.1 Various parts of 14 M MCF Antenna were fabricated as required by M/s. Space Application Centre, Ahmedabad. The antenna is meant for tracking the satellites in orbit and various other communication network. The national significance of the project is thus obvious.

2.2 The Main Assembly diagram is given in Fig. 1.

2.3 The revolving azimuth tube shown in Fig. 2 has a Bottom Flange, which is under discussion. The tube is 6 meters long and 1.5 meters in diameter and carries a load of 150 T approximately. The

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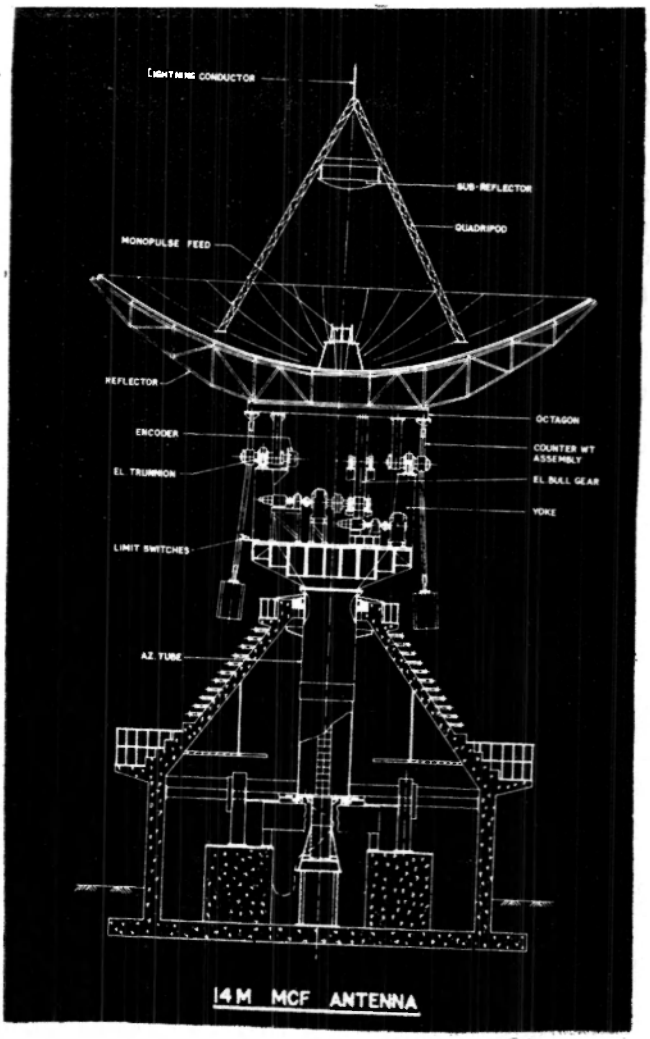


*Fig. 1 Main Assembly Diagram*

Bottom Flange accommodates a roller bearing for circular motion.

2.4 The original material envisaged was Cast Steel, IS-1030 ; Gr. 20-40 with the specification as shown in Table-1.

**( Table 1 )**

| C | Yield Stress | Tensile Strength | Elongation | Ultrasonic Test |
|---|---|---|---|---|
| 0.2% | 20.4 Kg/mm² min | 40.8 Kg/mm² min | 25% min | ASTM SA-609 Level 2 |

2.5 Because of various reasons, the castings could not be procured and hence it became necessary to fabricate the same from IS-2062 slabs. Actual material specifications are listed below in Table-2.

**( Table 2 )**

| C | S | P | U.T.S. | Y.T.S. | Elongation |
|---|---|---|---|---|---|
| 0.14 | 0.03 | 0.032 | 42.42 Kg/mm² | 25.33 Kg/mm² | 34.64% |

2.6 In order to ensure that defect free material is chosen ultrasonic test was recommended for the parent material before and after the welding. Magnaflux Test methods were adopted for ensuring freedom from defects during various stages of welding. Dye Penetrant method was abandoned in view of the need to cool the job periodically from the pre-heated stage.

## 3.0 STAGES OF FABRICATION

3.1 All the slabs were ultrasonically tested to satisfaction as per ASTM A-435 (as specified by the client).

## 3.02 SELECTION OF EDGE PREPARATION

3.02.1 The volume of the weld metal has to be minimum.

3.02.2 Approach for welding, grinding and testing should be adequate.

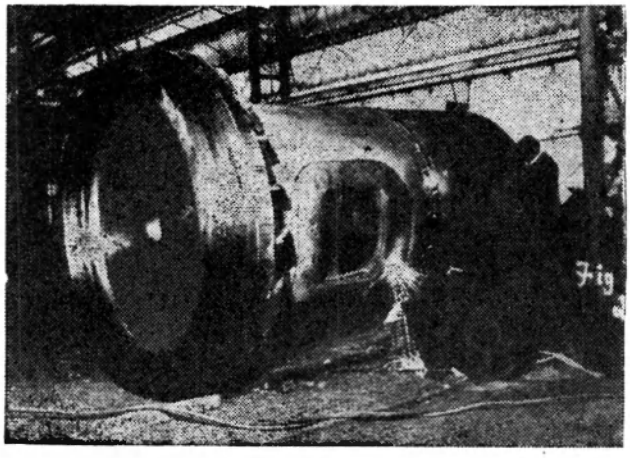

*Fig. 2 Revolving Azimuth Tube*

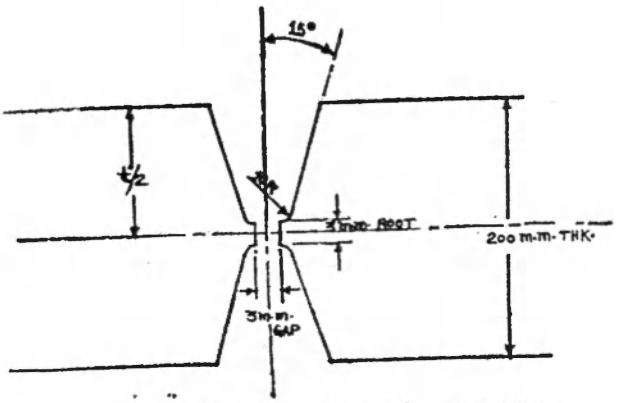


Fig - 3 : Showing actual edge preparation

3.02.3 Distoration has to be controlled and kept to a minimum.

3.02.4 The actual preparation adopted is given in Fig. 3.

3.02.5 It is interesting to note that this preparation was chosen after prolonged discussion with Clients, Consultants and expert's opinions.

## 3.03 EDGE PREPARATION

The edges were machined and examined by Dye Penetrant Test.

## 3.04 PREHEATING REQUIREMENTS

The following preheating requirements were decided.

3.04.1 Preheat to 250°C.

3.04.2 Interpass temperature 200°C. (minimum).

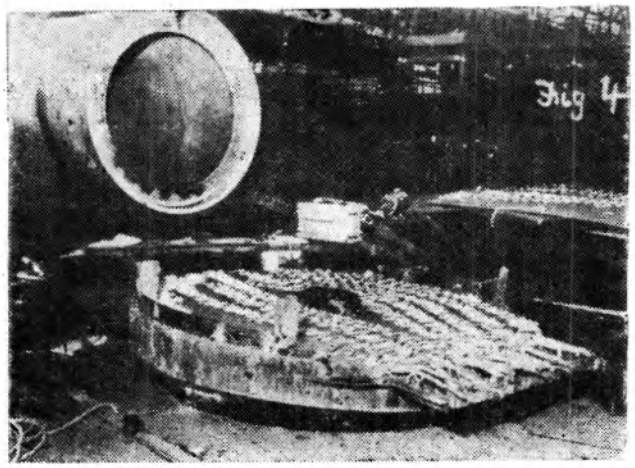


*Fig. 4 Electric Resistance Preheating Method*

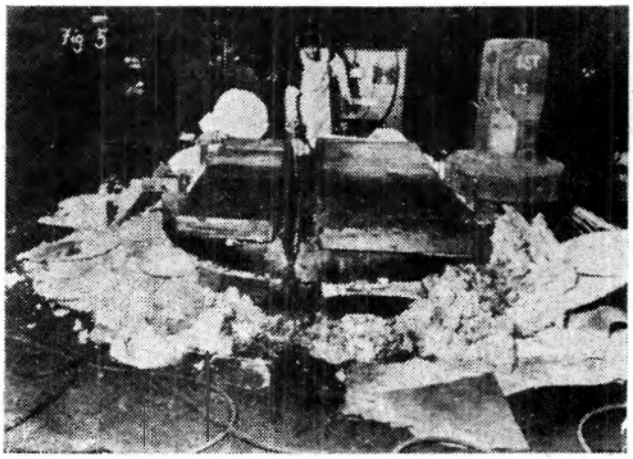


*Fig. 5 Electric Resistance Preheating Method*

3.04.3 Whenever preheating is to be stopped due to any reason, it was decided to maintain the preheat temperature of 250°C for two hours before allowing the slag to cool down.

3.04.4 After completion of welding raise the temperature of the job to 300°C for three hours to allow any hydrogen to diffuse and cool slowly.

**3.05 Preheating**

3.05.1 It was clear that no local preheating methods including normal LPG Burners can be used in order to achieve the requirements listed in 3.4.

3.05.2 Electric resistance preheating methods were devised and adopted. General details are given in Fig. 4 and 5.

3.05.3 Power requirements were drawn through welding transformers in order to avoid electric shocks.

3.05.4 Since the coils were insulated well and only the weld area was exposed, it was easy for welders to sit over the job without much inconvenience and carryout the welding.

**3.06 Choice of Electrodes**

Low hydrogen iron powder electrodes with about 1.4% manganese was chosen particularly for the root runs. Rest of the runs were carried out with E-7018 (same type) and E-7016 electrodes.

**3.07 Pre Drying of Electrodes**

Electrodes were dried at 300°C for two hours prior to use to ensure low hydrogen levels.

**3.08 Welding Procedure Qualification Test**

The test pieces were welded under identical conditions of the job. Ultrasonic and radiography tests were taken and found OK. The test pieces were subjected to test as per ASME Sec. IX. Test results obtained are listed in Table-3.

**( Table 3 )**

| Radio-Graphy | Ultrasonic Test as per ASTM E-169 | Root Bend Test 2 Nos | Face Bend Test 2 Nos | Tensile Test U.T.S. |
|---|---|---|---|---|
| OK | OK | OK | OK | 1-40.85 $Kg/mm^2$ 2-39.94 $Kg/mm^2$ Broken out of weld-OK |

**3.09 Sequence of Welding**

The job was done in four stages as per Fig. 6 in order to control distortion. In addition, dead weights were used for the same purpose.

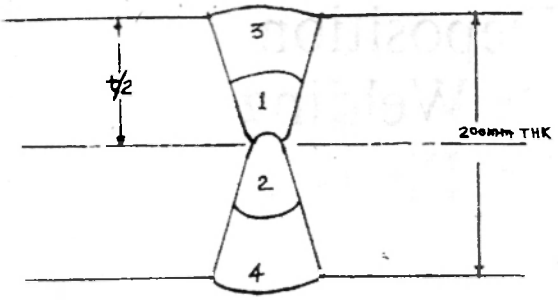


Fig. 6 - Showing sequence of welding

### 3.10 Quality control measures

3.10.1 All runs were thoroughly cleaned and visually examined.

3.10.2 Root run back chip and every 1/4'' thick deposits were checked by dry powder magnetic particle examination at temperature around 200°C with 200 mm spacings about 1500 Amps on 1/2 wave DC.

3.10.3 Finished welds were ultrasonically tested and no defects were noticed.

## 4.0 POST WELD HEAT TREATMENT

The slabs were stress relieved as per UCS-56 of ASME Section VIII-Div. 1 after carrying out low temperature PW HT as per para 3.04.4.

## 5.0 OTHER DETAILS

5.1 Electrodes used were 4 mm, 5 mm and 6.3 mm.

5.2 Power sources used for welding : transformer with over 80 OCV.

5.3 Number of runs on 200 mm thick 2 metre long weld was 285.

5.4 Total time taken—66 man shifts.

5.5 Total number of electrodes consumed—3600 Nos.

5.6 Distortion was controlled within 1/4'' in the diameter of 2.2 metres.

## 6.0 WELDING OF RING TO THE SLAB

6.1 The slab was premachined on one side after PW HT to accommodate ring as per Fig. 7.

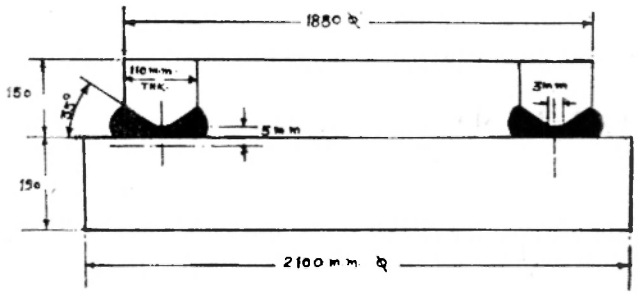


Fig 7 : Showing slab to ring weld set up

6.2 The machining and special welding techniques were adopted to avoid the risk of lamellar tearing effects.

## 7.0 GENERAL

Although we have detailed more on the welding of slab, the entire job was fabricated to very close tolerance. Our intentions are to share our uncommon experience with those in the field and hence we have taken this opportunity of presenting this paper.

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