Welding mechanisation at L & T

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ABSTRACT

Consistent quality of weld joint can be achieved when welding arc is properly directed at the joint. It is difficult to achieve accurate fit-up and straightness of any weld joint in heavy structural fabrication. Further, heat of the welding arc causes distortion of the joint. Hence, mechanised welding processes would still require constant monitoring by the operator. To derive the maximum benefits of welding mechanisation, manual intervention should be kept to a minimum. This is achieved by the use of Seam Trackers.

Weaving of the welding arc reduces the number of passes required to weld a groove joint. Weaving also helps in avoiding lack of side wall fusion in narrow groove joints. Narrow groove joint reduces weld metal requirement. Hence, arc oscillation can improve productivity and quality. Weld arc oscillation (weaving) can be achieved by the use of Magnetic Arc Oscillators.

Larsen & Toubro, Bangalore works, use both Seam Tracker and Magnetic Arc Oscillator to improve productivity and weld quality.

1.0 INTRODUCTION

Productivity improvement is essential to reduce fabrication cost. Productivity improvement can be achieved using higher deposition welding processes and welding mechanisation. Welding mechanisation results in reduced welder fatigue. This leads to higher operator efficiency.

However, weld joints can have fit-up errors and distortion due to welding thermal stresses. Mechanised movement of welding head should take care of all such errors and deviations.

1.1 Larsen & Toubro Limited manufactures Hydraulic Excavators and Vibratory Compactors at its Bangalore works. Manufacture of these equipments requires heavy fabrication which naturally involves large amount welding. Presently about 5000 Kgs of weld metal is deposited every month. As a first step towards higher productivity, GMAW (MIG-CO2 process) is largely employed for the first time in India.

Authors are in Larsen & Toubro Ltd. Bangalore Works.

1.2 Mechanisation in welding of excavator parts is difficult because of short weld lengths, variation in contour and constrained welding positions. Mechanisation should reduce set up time in addition to welding time. This can be achieved by the use of on-line seam tracker, mounted independent of the job.

1.3 Width of circumferential groove joint depends on depth of joint and welding process used. If some method could be used to reduce the number of passes, the width of the groove joint can be reduced which automatically reduces the quantity of the deposit. Reduction in number of passes decreases cleaning time and the reduction of width decreases the total weld deposit. Obviously the productivity increases.

2.0 MECHANISATION

2.1 Improvement in productivity at Bangalore works is achieved by deploying productive processes and mechanisation. Some of the cases are explained below.

a) Linear joints are welded by Column & Boom weld head manipulator. It is fitted with a seam tracker and a high current submerged arc welding head.

b) Circular joints are welded either by rotating the job or rotating the weld head around the job.

c) Circumferential groove joints in cylinders are welded continuously using seam tracker and arc oscillator.

3.0 SEAM TRACKER

3.1 A seam tracker is an equipment used for automatic positioning of weld head on to the joint. Several types of seam trackers are available ranging from manual to automatic on-line control. Use of manual control is not beneficial as it requires constant operator attention. On-line control is an automatic path finder which accurately positions the weld head as it travels along the joint. Seam tracker is most useful when used with a process where the arc is not visible e.g. Submerged arc welding process.

3.2 Welding Institute classifies seam trackers based on weld head guidance and positioning systems. Presently rail guided system with autamatic on line control is widely used. At Bangalore works batch production concept is used and hence automatic on line control type of seam tracker was chosen along with rail guided welding head movement.

3.3 The seam tracker has a contact type probe which traces the weld seam. Any deviation in the seam creates a corresponding electrical imbalance in the control system. This imbalance is used to drive the cross slide motors to correct the position of the weld head mounted on the seam tracker.

3.4 Accuracy of tracking depends on distance between the probe and the torch. The optimum probe to weld head distance is set at 25 mm. At this offset diatance, the response time to correct deviations in weld contour would be the same over a rahge of welding speeds.

3.5 Various types of probe tips are available. From experience, the authors feel that the probe tips will have to be modified to suit each job configuration.

3.6 Seam trackers are available with number of programable options like auto cycle timed/auto cut off option, multipass option, switched auto disable option etc.

3.7 The major advantage of seam tracker is improvement in productivity by the extension of automatic welding to more difficult applications ensuring consistent weld quality.

3.8 Type of seam tracker to be chosen depends on number of jobs, its repetitiveness and complexity. For mass production it may be better to adopt special purpose work handling machines rather than to using seam trackers.

4.0 ARC WEAVER

4.1 Mechanical or magnetic arc weaving are two major methods of weaving. Mechanical methods try to oscillate the torch and require larger cross sectional area for the torch movement. Magnetic arc oscillator weave the arc about the fixed torch by super imposing fluctuating magnetic field and consequently require a smaller cross sectional area. Considerable saving in weld metal can be obtained by using magnetic arc oscillator compared to mechanical weavers as the joint size gets reduced.

4.2 Magnetic arc oscillators can be used only with processes using spray transfer or non-consumable electrodes. The oscillator cannot be used with "CO2 welding" process.

5.0 AREAS OF MECHANISATION

5.1 Linear joints which were welded with semi-automatic CO2 process are changed to mechanised high current submerged arc welding with column & boom positioner with seam tracker. The seam tracker has two axes with stroke of 250 mm in horizontal and vertical directions and a load capacity of 200 lbs. To improve machine utilisation, welding stations are set up around the positioner (Fig.1).

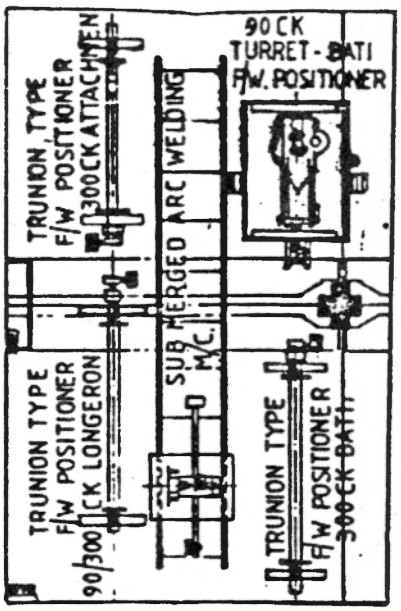

Fig. Fig. 1 : Layout of Welding Stations.

The column & boom manipulator is designed to have both base and boom traverse at welding speeds. Fig. 2 illustrates seam tracker set up. Seam tracker cross slides are set perpendicular to the joint. Fig. 3 & 4 show the typical jobs being welded. Table 1 compares welding times with different combinations of processes and equipment.

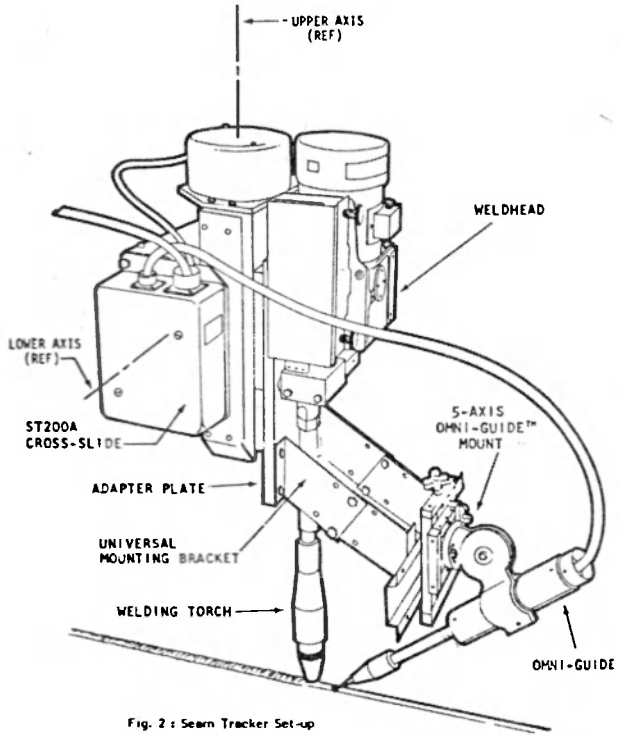

Fig. 2 : Seam Tracker Set-up

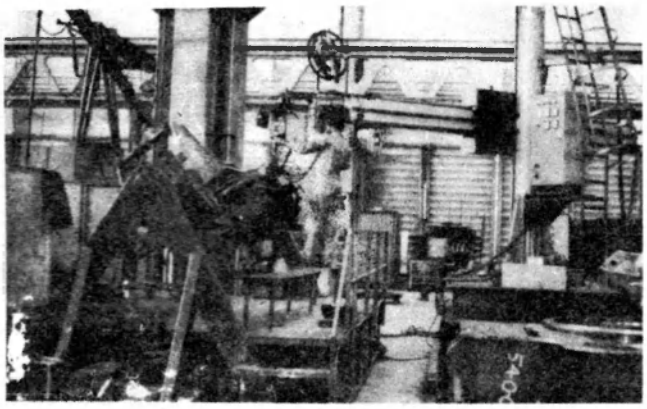

Fig. 3 : MECHANISATION USING SEAM TRACKER AND COLUMN & BOOM

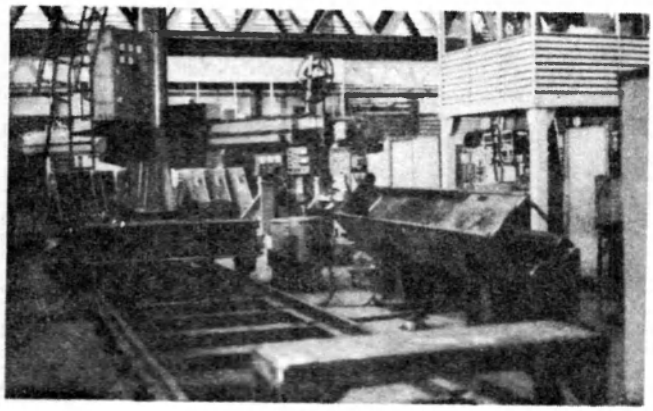

Fig. 4 : MECHANISATION USING SEAM TRACKER AND COLUMN & BOOM

It can be observed from the table that arcing duty cycle increases with the use of seam tracker for both GMAW and SAW processes. Mechanising with lower productive process will not be advantageous as the cycle time is more or less the same. Use of higher productive process like high current SAW is more advantageous. Quality improvement is another major advantage of seam tracker. Less operator concentration at the joint is needed while using seam tracker and hence the operator is free to do other work like slag cleaning etc.

5.2 Circular welds are automated by :

a) Rotating the weld head around the joint.

b) Rotating the job around the weld head.

Geometrical dimension in circular joint is better controlled and hence seam tracking is done through operator feed back. Circular welder, with semiautomatic welding gun attached to its arm, rotates around the joint. The circular welder should be light in weight and have positive drive. Good weld quality and higher productivity is achieved through this. Fig. 5 shows the setup for welding. Table 2 compares the welding time. Universal positioner with tacho feed back control is used for rotating the job around the welding torch. Fig. 6 illustrates the setup for welding. Table 3 compares welding time Considerable improvement in productivity and quality are achieved in these applications.

5.3 Hydraulic cylinders were being welded by CO_2 welding process. To improve productivity it was decided to weld continuously from start to finish. This requires automatic vertical torch movement and arc weaving. Seam tracker and arc oscillator along with GMAW process, was chosen for this purpose. Weld head can be easily positioned at the joint and corrections are made, during welding, by the seam tracker. Weld cross sectional area is reduced with the use of magnetic arc oscillator. Figs. 7 & 8 illustrates the setup for welding. Welding times are compared in Table 4. About 50% improvement in productivity is achieved by mechanisation.

6.0 CONCLUSIONS

1. Considerable improvement in productivity and quality are achieved by mechanisation using seam tracker and arc oscillator.

2. Choice of mechanisation depends on job complexity and quantity.
3. Any mechanisation should bring down cycle time and cost of production.
4. On line seam tracker is advantageous for batch production. Special purpose welding machine may be advantageous for mass production.
5. Contact type seam trackers cannot be used for contoured fillet welds.
6. Probe tip will have to be modified to suit individual job requirements.
7. Magnetic arc oscillator cannot be used with CO_2 welding process.

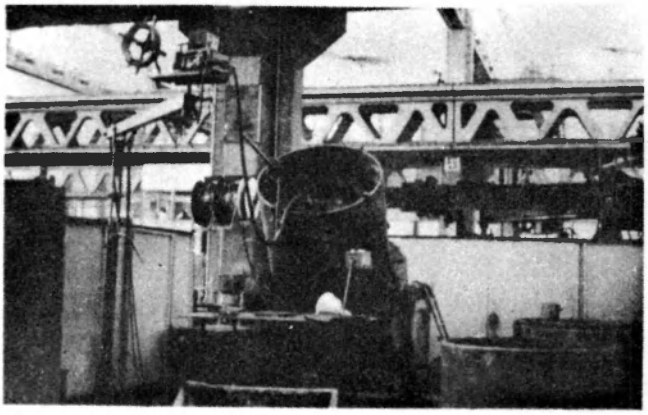

Fig. 6 . CIRCULAR WELDER – JOB ROTATED

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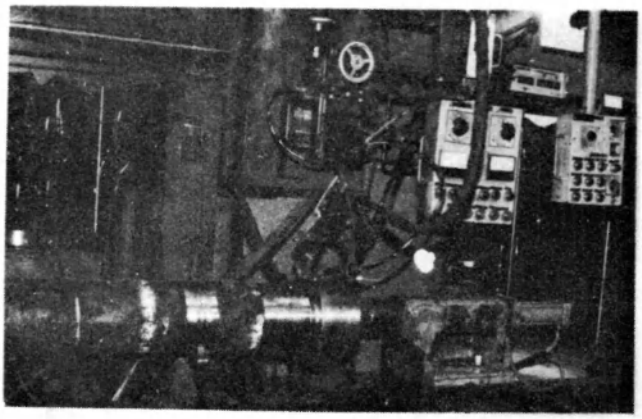
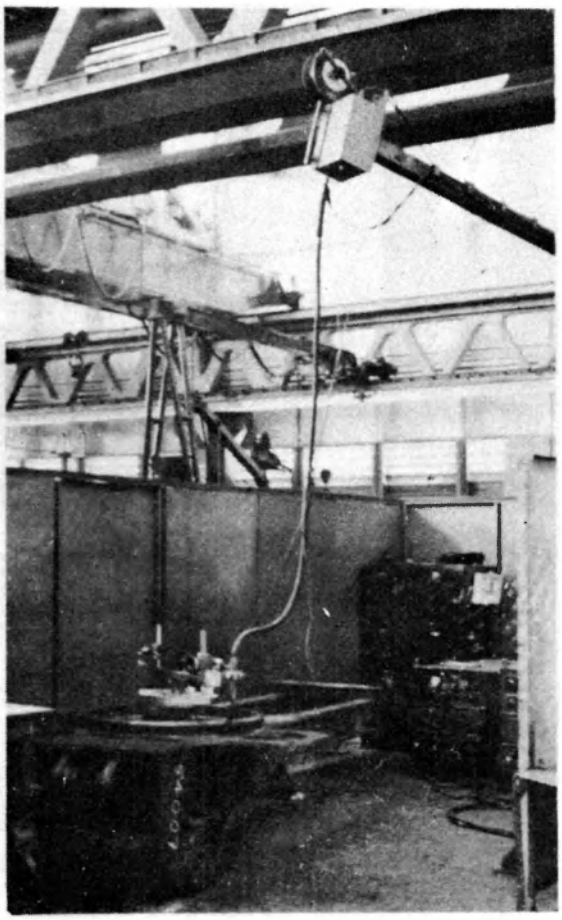


Fig. 7 : SET UP FOR CYLINDER WELDING



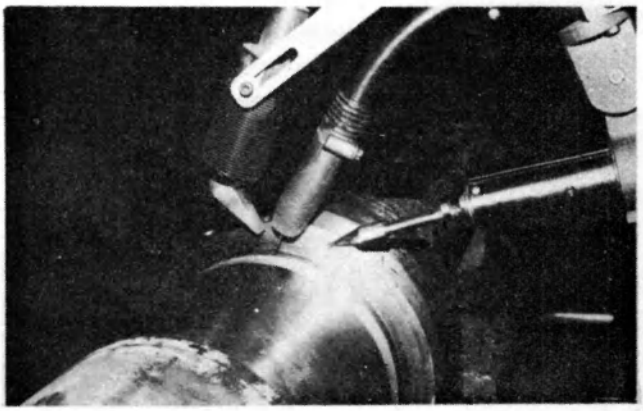


Fig 8 : CONFIGURATION OF WELDING TORCH SEAM TRACKER AND ARC OSCILLATOR PROBES

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Fig. 8 : CIRCULAR WELDER – TORCH ROTATED

TABLE - 1 COMPARISON OF WELDING TIMES

COMPONENT A

DETAILS	SEMI-AUTOMATIC GMAW	COLUMN & BOOM GMAW	COLUMN & BOOM WITH SEAM TRACKER(GMAW)	COLUMN & BOOM HIGH CURRENT SAW	COLUMN & BOOM WITH SEAM TRACKER HIGH CURRENT SAW
Arc Time (Min)	102.00	102.00	102.00	47.00	47.00
Cycle Time (Min)	223.00	245.00	209.00	170.00	134.00
Arcing Duty Cycle	45.7	41.6	48.8	27.6	35.1
Saving in Cycle Time due to Seam Tracker. %	-	-	14.7	-	21.2
Saving in Cycle Time compared to SA. %	-	-	6.3	23.8	40

COMPONENT B

Arc Time (Min)	83.8	83.8	83.8	47.6	47.6
Cycle Time (Min)	228	254.6	213.0	201.0	165.0
Arcing Duty Cycle	36.6	32.8	39.2	23.7	28.8
Saving in Cycle Time Due to Seam Tracker. %	-	-	14.4	-	18.0
Saving in Cycle Time compared to SA. %	-	-	6.6	11.85	27.7

TABLE - 2 COMPARISON OF WELDING TIMES

COMPONENT C

DETAILS	SEMIAUTOMATIC	MECHANISED
Arc Time (Min)	50	50
Cycle Time (Min)	172	128
Weld Duty Cycle %	29	39
Saving in Cycle Time %	-	25.6

TABLE - 3 COMPARISON OF WELDING TIMES

COMPONENT D

DETAILS	SEMIAUTOMATIC	MECHANISED
Arc Time (Min)	152	140
Cycle Time (Min)	223	179
Weld Duty Cycle %	68	78
Saving in Cycle Time %	-	19.7

TABLE 4 - COMPARISON OF WELDING TIME OF CYLINDERS

COMPONENTS	WITHOUT ST & AO	WITH ST & AO	% SAVING IN TIME
A	262	107	59
B	114	62	56
C	48	25	47

ST & AO - Seam Tracker & Arc Oscillator