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Analysis and Quantification of Mechanical Properties of Various ERW Seam Steel Tubes Manufacturing Processes Using Drift Expanding Test

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Abstract:- Electric resistance welded (ERW) seam steel tube are frequently used in numerous industrial and household applications and also used in automotive industries. To ensures the acceptability of ERW seam tubes are prepared by various industrial process, the quality of ERW tubes must be evaluated. Drift expanding test is one of the best ways to do so is to examine the quality of tubes. In this paper the authors considered the mechanical properties of various manufacturing processes and different -2 sizes of tubes using drift expanding test. This paper concludes that there is a comparison between the different -2 sizes and standards with a single type of material known as ERW materials they have same composition for all sizes.

Keywords:- *ERW seam tube, Drift expanding test, Automotive industries, Mechanical properties, Standards, Electric resistance welding.*

I. INTRODUCTION

The usage of ERW seam steel tubes have increased in many applications and industries over the decades. Currently the usage of ERW seam steel tube has grown over the last few years mostly due to their beneficial characteristics such as high corrosion resistance, high thermal - exchange efficiency, easily processing and availability. Apart of this, these tubes has a long useful life and is environmentally friendly - 100% recyclable, lightweight, and easy to join. Thus these properties made ERW seam steel tubes as the cost effective material for different -2 tube applications. These tubes are basically classified into three major categories:

- Automotive tubes
- Industrial applications tubes
- Furniture tubes

Basically these tubes are manufactured by electric resistance seam welding process. There is a complete assembly of different -2 portions in this process. The whole process is known as Mill machines manufacturing steel tubes. The complete formation of these tubes are done in the following step by step processes.

- Edge miller process
- Roll forming process
- Welding process
- Heat treatment process (optional)
- Cooling and Sizing
- Cutting process

Thus the main purpose of this study is to investigate the mechanical properties of the ERW seam steel tubes samples prepared by typical industrial processes using drift expanding test.

II. LITERATURE REVIEW

Shaikh Ozair et al. [1] has done study on the different parameters of the seam welding process are studied and ways to reduce the current consumption of the seam welding machine.

Inoue Tomohiro et al. [2] researched on an electric resistance welding (ERW) line pipe technique with a high performance weld seam developed by JFE Steel. The finite element analysis method to construct an analytical model of the ERW seam. The development of homogeneous heating technology helped to achieve improved seam mechanical properties.

Robert Matteson [3] studied the fundamentals of resistance seam welding. This paper presents that there is an improvement in the welding range in speed if weld force increases under given electrode conditions. It also helps to control cracking.

Khosravi et al. [4] concluded that increasing current for low welding speeds results in the decrease nugget size. It also increases joining zone thickness in each galvanized and electro- galvanized sheet when higher current used. Increase of welding speed while keeping welding current constant, increases the thickness of joining zone and nugget size decreases. It was found that maximum hardness had always been in the center of the weld.

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Habdel – Aleem et al. [5] found that increasing exhausting pressure, Increases nugget penetration at an identical welding current. The results of tensile shear testing of joints stated that fracture always takes place near to the fusion boundary on the 1050 material. The hardness increases at the fusion boundary of 1050 Aluminum metal.

Masamura Katsumi et al. [6] has presents an outline of the distinctive features of the manufacturing processes at JFE Steel, together with representative steel pipe and tube products. also his study is on distinctive products and manufacturing processes include large diameter, heavy wall electric resistance welded (ERW) pipe for line-pipes, UOE pipe for high strength, high performance line-pipes, and high performance and high formability welded steel tubes used in automotive parts.

Miyata Yukio et al. [7] has done his study on the pipe has X80 - grade strength and sufficient low temperature toughness for the practical use as a line - pipe. Post weld heat treatment (PWHT) in a few minutes, the reduction of content and addition of Ti are effective to prevent inter –granular stress corrosion cracking (IGSCC) at the heat affected zone. Further application of the pipe is expected for the transportation of product fluid with corrosive gas such as CO2, as an economical material with low life cycle cost.

Kitzawa et al. [8] increased the flaring limit of aluminum alloy welded tube by orbital rotary forming.

Sun and yang et al. [9] investigated the flaring limit of circular tube using fillet and conical die taking into the consideration of tearing and buckling failure.

III. EXPERIMENT ANALYSIS

A. Drift Expanding Test

Drift Expanding Test – Drift – expanding test is " Expansion of the end of the test- piece cut from the tube, by means of a conical mandrel, until the maximum outside diameter of the expanded tube reaches the value specified in the relevant product standard". The length of specimen is dependent on alloy materials for example for aluminum and light alloy tube the length of the specimen is to be not less than twice the external diameter and for copper and copper alloy tubes, the length of the specimen is to be not less than twice but not more than three times the external diameter of the tube. To perform this test, the test specimen is expanded by a mandrel until it fractures.

After test, on the surface of tube and the expanded zone of the specimen, in addition to the fracture may not be visible any cracks. In this research, drift expanding test done by a hydraulic press at ambient temperature and truncated-cone shaped mandrel of hardened steel [10,11].

Symbols, designation and units for the drift-expanding test of tubes are presented in **Table 1 and shown** in **Figure 1. Figure 2 (a and b)** illustrates the test procedure, which have been carried out to identify the mechanical properties of ERW seam steel tube and Figure 2 (c) shows the collection of samples during the experimental analysis.

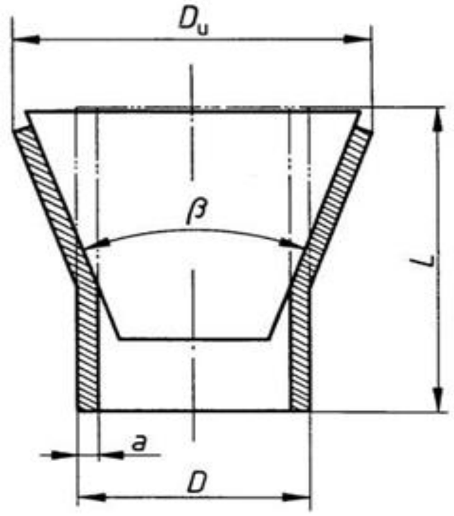

Fig 1:- Designation of the drift-expanding test of tubes

Symbol	Designation	Units
A	Wall thickness of the tube	Mm
D	Original outside diameter of the tube	Mm
Du	Maximum outside diameter after testing	Mm
L	Length of the test- piece before testing	Mm
B	Angle of the conical mandrel	Degree

Table 1:- Symbols, Designation and Units for the drift - expanding test of tubes

In this research, drift expanding test done by a hydraulic press at ambient temperature and truncated - cone shaped mandrel of hardened steel. The length of the specimen was selected less than twice size of the external diameter of the tube. Finally, the drift expanding percentage, calculated.

Now the ERW steel tube samples tested in the research is as described in a tabular form as given below. Here we considered the 6 size samples of different - 2 sizes in the experimental analysis as given below in table 2 diameter of tube after fracture divided by the original diameter of tube.

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Fig 2 (a) Drift Expanding Test

Fig 2 (b) Specimen after fracture

Fig 2 (c) Collection of samples during the experimental analysis

Sr. No.	Sample	Size (OD x Thickness mm)
1	First set	22.20 x 1.50
2	Second set	22.20 x 1.90
3	Third set	25.40 x 1.50
4	Fourth set	25.40 x 2.50
5	Fifth set	31.75 x 2.00
6	Sixth set	31.75 x 2.95

Table 2:- Shows the samples and their sizes used in the experiment

B. Material Used for Experimental Analysis

There is only a one type of material is used in whole of the material is generally known as ERW -1 material whose chemical composition is as described below in table 3.

Tube designation	ERW -1
C % (max.)	0.12
Mn % (max.)	0.60
S % (max.)	0.04
P % (max.)	0.04

Table 3:- shows the chemical composition of ERW -1 material used in experiment.

Also the drift test value of the material is 12.50 % minimum as given according to the standard. Also the value of the cone angle is generally taken as 30°.

IV. RESULTS AND DISCUSSION

Now Compare the mechanical properties of the ERW seam steel tube samples prepared by various experimental analysis was investigated using the tube drift expanding test. The calculated data and the drift expanding test results are illustrated in **Figure 3 and Table 4**. It should be notable thing that each set consists of five samples and expanding percentage is on the basis of average value of these samples.

The above table and figure shows the variations of mechanical properties of different samples. There is same manufacturing processes applied to each tube. Thus from the above figure, we find that the size 25.40 x 1.50 mm has the highest drift percentage and this sample has greater tendency to expand and the sample having size 31.75 x 2.95 has minimum drift percentage i.e. have lower tendency to expand.

No	Samples	Size (OD x Thickness mm)	Average Expanding Percentage (%)
1	First set	22.20 x 1.50	38
2	Second set	22.20 x 1.90	34
3	Third set	25.40 x 1.50	42
4	Forth set	25.40 x 2.50	30
5	Fifth set	31.75 x 2.00	32
6	Sixth set	31.75 x 2.95	46

Table 4:- Drift expanding results

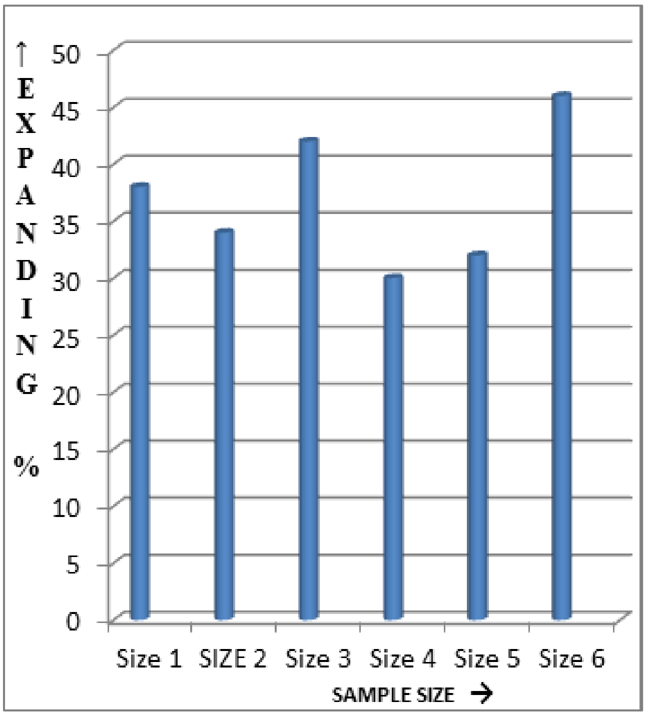

Fig 3:- comparison average expanding percentage of ERW seam steel tube samples

V. CONCLUSIONS AND FUTURE WORK

In this study, drift expanding analysis carried out on various ERW seam steel tube samples. From the above results, it can be concluded that:

- The average expanding percentage is high for the low thickness up to 2.00 mm and low for the heavy thickness from above 2 mm.
- As the size of the tube increases, then the drift percentage of the tube is decreases almost in all samples.
- From this experiment analysis, it is also concluded that for a better quality controls in manufacturing of tubes, the drift percentage is more than 25 %. This conformance the better and believable quality ERW seam steel tube.
- Thus from the above results it is also clear that average drift percentage for the tubes used for automotive purpose is 25 % i.e. it's value is double the value of drift percentage given in standard. Thus for automotive purpose tube the essential drift percentage is minimum 25 %.
- Also one point should be noted before this experiment is that the de-burring process of the sample is being done before doing drift expanding test otherwise the drift percentage or expanding percentage is decreases from the 25 %. Thus for the future work, the research can be extended deeply by this investigation.

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