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Shear Strength Improvement Welded Lap Joints

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Abstract: *Manufacturing Assembling forms unavoidably prompt a condition of lingering worry into materials and items. This can present potential issues, regarding dimensional dependability, Structural trustworthiness and diminished weariness life. The traditional method to alleviate the leftover anxieties is post-weld heat treatment, which is a successful procedure, however it experiences a few detriments: the expense of treatment as far as gear and vitality is high. Subsequently another methodology is expected to conquer the disadvantages experienced by the ordinary pressure easing procedures. As an expansion to the current strategies for better quality feasibility vibratory welding method is presented. The current test is planned to dissect the impact shear weight on the lap welded mellow steel plates of IS 2062 evaluation B, which are welded during vibration with varieties of current that is at various amplitudes and increasing speeds. What's more, it is recognized that the shear quality is expanding while the welding procedure is finished by offering vibrations to the work piece.*
Key words: *lap welded, vibratory welding, IS 2062*

I. Introduction

Welding is widely used in automotive industries to assemble various products. It is well known that the welding process relies on an intensely localized heat input, which tends to generate undesired residual stresses and deformations in welded structures, especially in the case of thin plates. Therefore, estimating the magnitude of welding deformations and characterizing the effects of the welding conditions are deemed necessary. Welding is widely used for construction of many structures. There exists residual stress near the bead because of locally given heat. Tensile residual stress on the surface degrades fatigue strength.

In order to eliminate the residual stresses which are formed during welding, some of the olden techniques like shot peening and heat treatment are used. However, those methods need special tools and are time consuming. So a new method is proposed in which vibrational load is used during welding operation. During welding, the pieces to be joined (the work pieces) are melted at the joining interface and usually a filler material is added to form a pool of molten material (the weld pool) that solidifies to become a strong joint. During the welding process the residual stresses are more and due to this the weld strength is reduced and some defects may be observed. So to minimize the residual stresses vibratory welding techniques have been introduced. Lu et al. [1] investigated the application of vibratory weld conditioning (VWC) on full welded valve. They found that the vibration applied during welding generally reduces the residual deformation and stress. Jijin et al. [2] compared VWC and normal submerged arc welding of multi pass girth-butt welded pipes. They found that VWC can reduce the residual hoop stresses at the outer surface and the radial distortion significantly. Munsi et al. [3] performed investigations on the effect of amplitude of vibration, time of vibration, and frequency of vibration. The work finds an optimum applied stress that will maximize the reduction in both longitudinal and transverse residual stresses. Rao et al. [4-40] found that dynamic solidification technique during welding has been proposed to improve the mechanical properties of butt welded joints. It was presumed that butt welded joints arranged under vibratory conditions had high hardness with no loss of its ductility. Authors' utilized the vibratory setup to affect the mechanical vibrations to the weld pool amid welding. Because of vibratory welding process, change of mechanical properties has been observed. It was inferred that the refined microstructure component was in charge of the change of impact strength, tensile strength, flexural strength and hardness of butt welded joints of mild steel plates. Authors' observed that post weld vibratory treatment will not influence the crystal structure, but the increase in all properties is related to the crystal structure only. Finally, General regression neural network technique (GRNN) based tool has been developed for estimating tensile strength, impact strength, flexural strength and hardness for given input vibratory parameters. Based on the past literature, this paper presents the effect of vibrations on shear strength of lap welded joints.

II. Methodology

2.1. Material

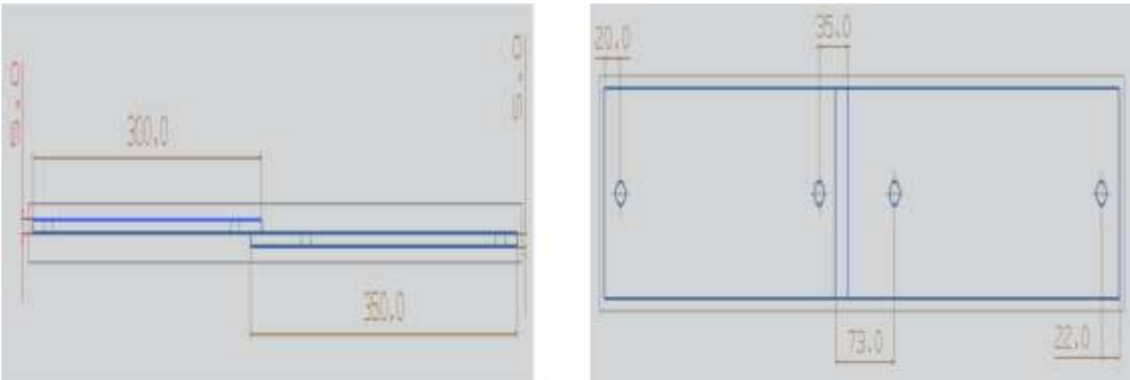
The chosen material for this experiment was Mild Steel 2062-B grade. It was selected in keeping view of its salient features like availability, cost effective and wide range of applications.

Table 1 Mechanical properties of the material

S.No.	Grade	Ultimate tensile strength (MPa)	Yeild Strength (MPa)	% Elongation
1.	A	408	210	21
2.	B	412	210	23
3.	C	410	210	22

The specifications of the specimen are Plates of mild steel are taken in two different dimensions that is 300mm X 100mm X 6mm and another one set is of 350mm X 100mm X 6mm dimensions Processes of material outline preparation:

- Specimens are cut using gas cutter to required dimensions and then edges are finished with hand grinder.
- Holes are marked on every set of plates with an overall diameter of 12mm. Then both plates were lap jointed and clamped on to the vibratory table.



Front view Top view

Figure 1 Specimen set-up

The vibratory welding experi ment was performed with an arc generated welding machine to weld MS plates of IS 2062 grade-B, The m ild steel IS 2062 grade-B is high strength m icro alloyed steels having a combination of desirable properties not attainable in conventional mild steel. These steels have higher yield strength, higher notch toughness, good fatigue properties, excellent weld ability and good formability.

2.2. Shear Stress

It is the external force acting on a n object or surface parallel to the slope or plane in which it lies; the stress tending to produce shear. In this t est material to be tested is inserted in between the jacks of a shear testing machine called Universal Testing Machine (UTM), and then load is applied gradually without any sudden rise in load. This machine has multiple testing features along with Shear test.

2.3. Specimen Preparation

The pair of plates which were lap welded was of 635mm each in length wise and of 100mm width before subjected to shear test. There was a problem raised with the plates to hold the m in the UTM by face plates in terms of gripping area laterally,, i.e. the plates can grip specimens of width less than 60mm, whereas the specimen is of 100 mm width. In order to solve this problem the welded paireed plates are cut length wise exactly in mid of the plates so as to reduce the width to 50 mm. Thus every pair was set in UTM, for testing.

2.4. Measuring and Marking

The lap welded mild steel specimens of 4 sets were taken for the shear test in Universal Testing Machine after the hardness was measured. Before subjecting to shear test each pair (three vibratory welded and one ordinary welded) was measured in length and breadth wise and a certain lenngth was marked from weld bead in both directions called 'G auge Length' which was 260mm. Gauge leength is the effective length between the gripping plates(excluding the portion of the specimen inside the grripping plates) which suffers the deformation while doing shearr test and as a result the gauge length is changed after shear, which is the measure of the strain. Similarly the thickness was also measured before and aftter the testing. After suitable gripping plates were found i.e. squ are plates; the specimens were set clamped within the gripping plates.

2.5. Shear Test

The machine used here for the shear test was 'Hydraulically operated computerized UTM' (model: TUE-C-1000) of measuring capacity 10 00KN max. and least count of 0.1KN. Out o f the various parameters the graph here is taken between 'Stress and Strain' since it is the standard curve to study the various material properties like elastic, yield, ultimate and breaking strengths.

Figure 2 Sample specimen between the holding plates of the UTM during shear test.

The generated graphs under different conditions are provided here with the mentioning of tensile, yield strengths and peak loads along with %change of elongation of the specimens. At 0 and 70 voltage the stress strain curve is shown in figure 3 and figure 4

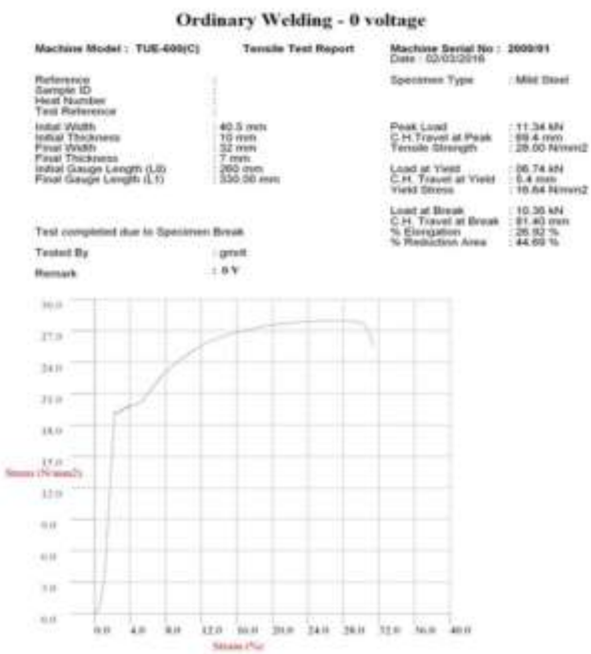


Figure 3 Sample specimen at 0v stress strain curve

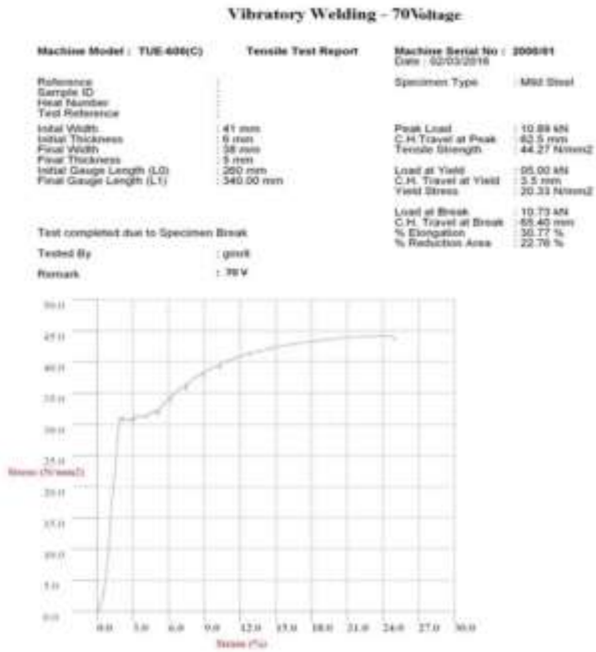
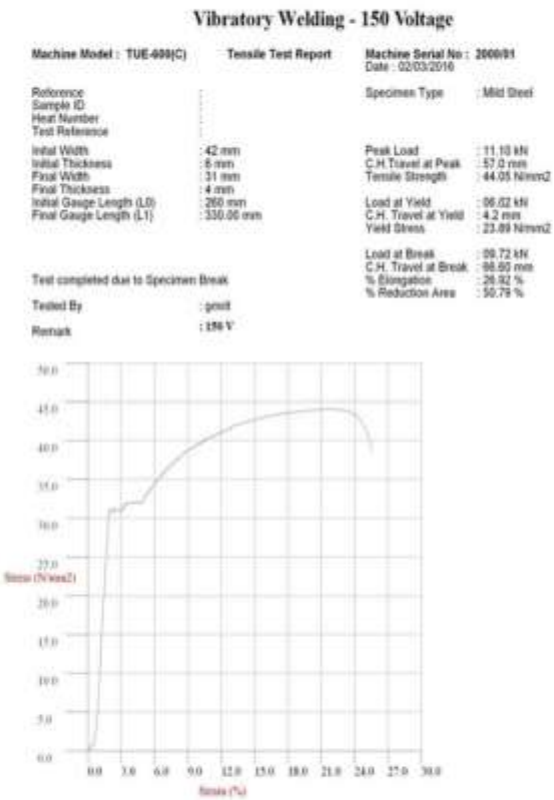


Figure 4 Sample specimen at 70v stress strain curve

At 150 and 230 voltage the stress strain curve is shown in figure 5 and figure 6



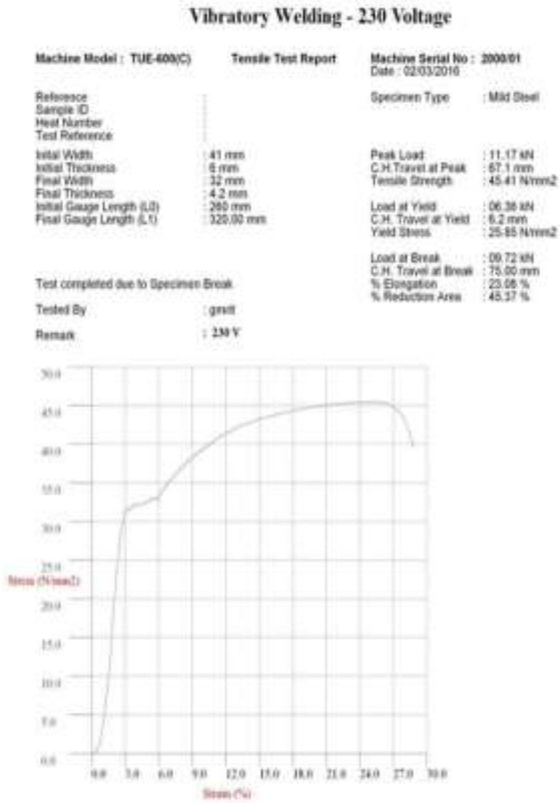


Figure 5 Sample specimen at 150v stress strain curve **Figure 6** Sample specimen at 230v stress strain curve

III. Results And Discussion

The obtained values of the shear test are tabulated here below. From elastic point to breaking point the graph follows a certain path via yield and ultimate strength points. Here the computer generated individual Stress-Strain curves are given for each kind of specimen set separately i.e. three with vibration and one without vibration. These individual graphs also provide different strengths and percentage change in area and other parameters values numerically.

From the computer generated graphs the different values of the specimen i.e. tensile and yield strengths are tabulated below at a place for the sake of comparison of changes of the properties in the specimens from without to with vibratory welding and inner to that variation of range of vibration in correspondence with the changes in the voltages.

Table 2 Obtained Tensile and yield strengths of specimen at different voltage conditions

STRENGTH(N/mm^2)	0 VOLTS	70VOLTS	150VOLTS	230VOLTS
Yield Strength(N/mm^2)	166.4	203.3	238.9	258.5
Tensile strength(N/mm^2)	280	442	440	454

From the table 2 it can be compared and concluded that the yield and tensile strengths are increased from ordinary welded mild steel specimen, to vibratory welded and within vibratory from 70Voltage vibration to 230Voltage vibration. But a slight decrease of yield and tensile strengths are observed from ordinary welded to normal mild steel specimen (without welding). The above tabulated results are plotted in graphs shown in figure 7 below.

3.1. Yield Strength Graph

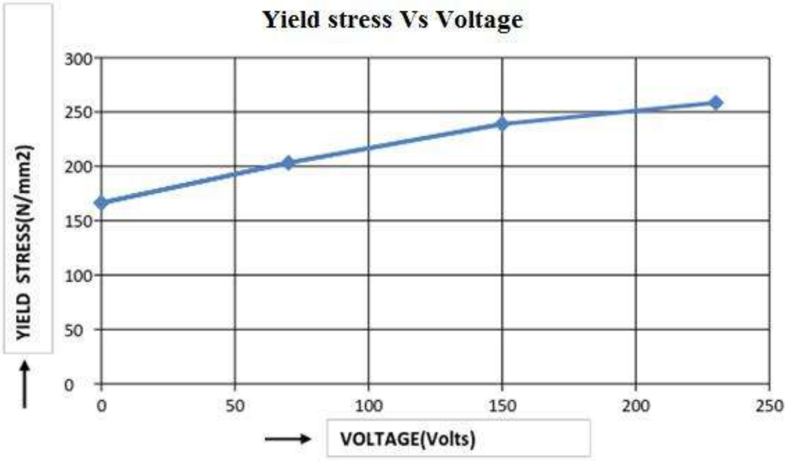


Figure 7 The variation of yield strength from 0-230 Voltage corresponding Vibrations.

The fig.7 depicts that the yield strength value of the specimen is increasing from 0volts corresponding vibratory welding to 230 volts corresponding vibratory welding. Hence it can be interpreted that the effect of vibration during welding on increasing the yield strength is positive in nature.

3.2. Tensile Strength Graph

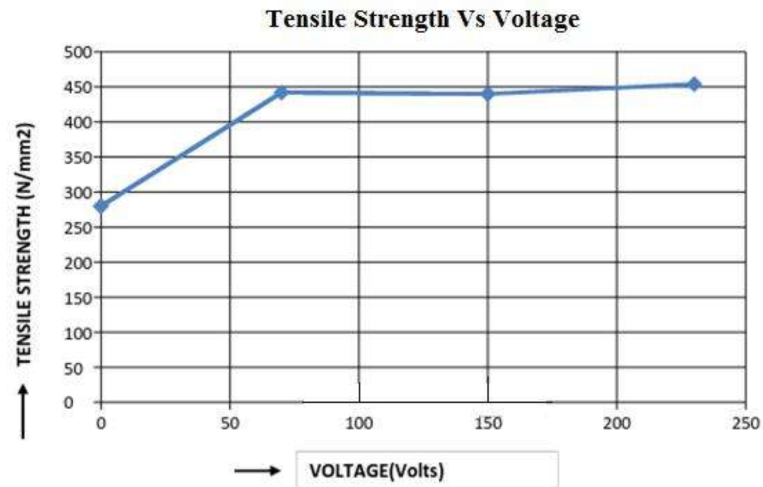


Figure 8 The variation of Tensile strength from 0-230 Voltage corresponding Vibrations.

The figure 8 depicts that the tensile strength value of the specimen is increasing from 0volts corresponding vibratory welding to 230 volts corresponding vibratory welding. Hence the same can be interpreted here for tensile strength as in the case of yield strength that the effect of vibration during welding on increasing the tensile strength is positive.

From the above graphs and tabular data it can be said that presence of vibration can significantly raise the tensile and shear strengths of the specimen. Higher the vibration voltages within the limits greater the improvement of strength.

IV. Conclusions

- The effect of various parameters such as voltage, current, frequency in altering the mechanical properties such as shear strength has been studied under vibratory welding process.
- In this work an efficient and standard methodology has been established to increase the shear strength when welding IS 2062 grade-B mild steel. The shear strength that is tensile and yield strengths are raised worth significantly from ordinary welded to vibratory welded lap jointed MS specimens.
- Even the same degree of rise of strength can be observed within the vibratory welded lap joint for an increase of intensity and magnitude of vibrations which is the result of increase in voltage, provided the

increment is within the range so that at higher voltage corresponding vibrations the welding will not become difficult at the same time the molten metal doesn't spill around.

- Since various mechanical properties like shear strengths are increased to noticing range, it can be concluded that vibratory welding is beneficial over other conventional methods alone to achieve a good improvement in properties with in less time and cost.
- Hence the proposed methodology facilitates the effective use of vibratory welding in order to increase the mechanical properties of the material in small scale industries where heat treatment can't be affordable.

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