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WELDING SIMULATION AND EXPERIMENTATION OF MILD STEEL 1018 & 1062 USING ELECTRIC ARC WELDING PROCESS

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Abstract: Today all the metal industries utilizes distinctive kinds of welding forms for joining material. Assembling and outlining specialists should know the maximum capacity of accessible joining procedures. **In this project, the work is to compare and discuss the methods of Experimental & Simulation of Electric Arc welding process by taking AISI/SAE 1018 & 1062 Mild Steel as work piece material that are adopted in order to find the following objectives by both experimentally and Analytically. The objectives are to assess the welding simulation capabilities of the commercial software package ANSYS. To evaluate three different plate lap-joint designs, undergoing welding. To compare both Experimental & Simulated Analysis with respect to Maximum welding Tensile strength. Evaluate the verification of experimental and Numerical results. A sample containing three pieces are welded with electric Arc Welding process taking current, voltage, and welding time as a input parameters to define the variety of the tensile strength of the samples. The tensile test is carried out using uniformly varying load up to rupture strength. The experimentation is divided into three cases (1018+1018, 1062+1062 and 1018+1062) for these three cases strength analysis were conducted experimentally and analytically. Modeling is done in CATIA -V5 and Static Structural analysis is done in ANSYS. A quite good results were obtained between measurements and simulations. The results show that ANSYS is able to simulate welding, though with some limitations and difficulties.**

Keywords: Mild Steel 1018& 1062 plates, Electric Arc Welding Setup, Tension Testing Machine, CATIA V5, ANSYS.

1.INTRODUCTION

In a welding process, the primary task is to select a combination of process variables that produces an acceptable quality level for production. In a number of published studies, several methods have been proposed to predict and understand the effects of the process variables on welding performance. Generally, two major independent research areas are utilized to improve welding performance. These areas include the empirical method based on studies of real welding situations, and mathematical model- or simulated design- based studies. In this project we shows the welding simulation capabilities of the commercial software package ANSYS by comparing both Experimental & Simulated Analysis with respect to Maximum welding Tensile strength. ANSYS is an object-oriented programming environment that provides the ability to fully access and manipulate the model. Static Structural Analysis is carried out to the work piece.

2.LITERATURE REVIEW

Careful writing review has been completed to catch the voice of concerned individuals and their significant work similar to welding concerned; a point by point writing study is done as takes after. [1] Alam, M. M., Karlsson, J., and Kaplan, A. F. H. 2011. Generalizing fatigue stress analysis of different laser welds geometries. Materials and Design 32: 1814–1823.[2] "Recent Trends in Welding Science and Technology," edited by *S.* A. David and J. M.Vitek, ASM International, Materials Park, Ohio, 1990.[3] A Joseph, Sanjai K. Rai, T Jaikumar ―Evaluation of residual stresses in dissimilar weld joint‖ published in International Journal of Pressure Vessels' and piping 82 (2005) page No. 700-705 [4] AWS D1.1/D1.1M:2006 An American National Standard focused on the Maximum Weld Size in Lap Joints. As there are part of work is done in weld of level plate, almost no work is done in pertinent to examination of Test and Recreated welded joint of a Level plate. A short survey of some chosen references on the quality of flate plate, bends of plate, quality of welded joint.
After an extensive investigation of the current writing, various holes have been seen in Welding.

- The vast majority of the analysts have explored impact of process parameters on the execution measures utilizing Limited component technique.
- Literature review reveals that the researchers have carried out most of the work has been reported on optimization of process variables.
- The effect of Welding parameters has not been fully explored by Simulation Packages.

- Both Experimental & Simulated comparison of Welding process is another thrust area which has been given less attention in past studies.

Here in this, project we thoroughly studied the experimental and analytical results. The results showed that close values were obtained between Experimental and analytical processes.

3. MATERIAL & ITS PROPERTIES

1018 Mild Steel

AISI/SAE 1018 mild/low carbon steel has excellent weld ability and produces a uniform and harder case and it has good ductility, toughness and strength.

1062 Mild Steel

AISI/SAE 1062 is a low carbon steel. It has high hardenable and it is very suitable for wear-resistance.

SPECIMEN GEOMETRY : The geometry of single lap joint used for the analysis is taken as follows

Length: 125mm
Width: 75mm
Thickness: 6mm

Mild Steel 1018

Young's Modulus: 205GPa
Poisson's Ratio: 0.29

Mild Steel 1062

Young's Modulus: 200GPa
Poisson's Ratio: 0.295

4. EXPERIMENTAL PROCEDURE

WELDING PROCESS USED:

Electric arc welding: In this Electric Arc welding process AC or DC current is provided to the welding machine. Two Cables are masterminded one link is interface with cathode holder and other link is associated with work piece. A cathode is associated with terminal holder. This anode interacts with work a weld globule is framed. Consequently joining the work pieces.

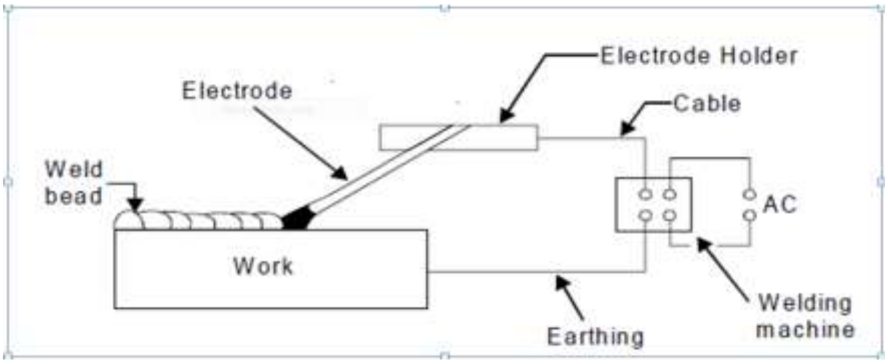

Fig 4.1: Electric Arc Welding

WELDING ELECTRODE USED:

Mild Steel E6013 Electrode is used as a filler material.

WELDING JOINT USED:

Double side Lap Weld Joint: A lap joint is by and large shaped by covering two plates and welding should be possible. For joining two different materials of various thickness the Lap joint can be utilized. Dissimilar to a butt weld, the lap joint does not require that the plates to be parallel. For Double side Lap Joint the welding is done on the both sides of plates.

Fig 4.2 : Test models of Weld lap joint

WELDING PROCESS PARAMETERS:

The thermal energy is supplied to the weld by three inputs current, voltage and weld time followed by each other, which are active for welding and their respective parameters are found in the Table.

Models	Current amperes	Voltage volts	Weld time inches/s
AISI(1018+1018)	120	220	0.066
AISI(1062+1062)	120	220	0.054
AISI(1018+1062)	120	220	0.0495

Table 4.1: Welding Process Parameters

METHOD OF MEASUREMENT

A sample containing three pieces for electric Arc Welding depending upon the value for the welding time, current and the voltage in order to define the variety of the tensile strength of the samples. The tensile test is carried out using uniformly varying load up to rupture strength. The experimentation is divided into three cases (1018+1018, 1062+1062 and 1018+1062) for these three cases strength analysis were conducted.

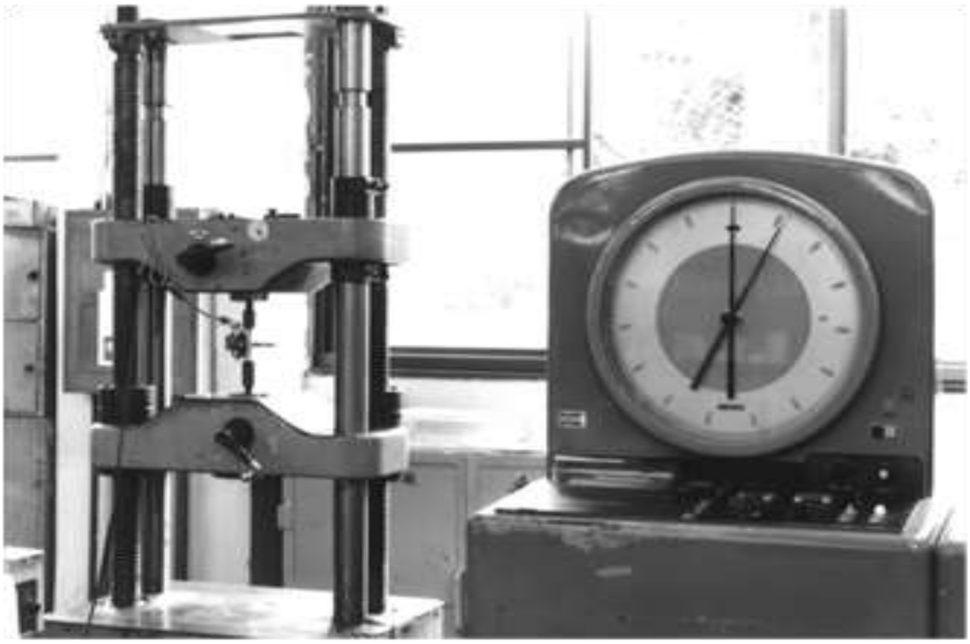

Fig 4.3: A tension test machine

Table 4.2: Experimental Results

S.No	MS (1062+1062)		MS (1018+1062)		MS (1018+1018)	
	FORCE (N)	STROKE (MM)	FORCE (N)	STROKE (MM)	FORCE (N)	STROKE (MM)
1	0	0	0	0	0	0
2	1500	7.1	1000	6.55	2000	13.64
3	5500	14.2	3000	13.1	3200	27.28
4	35000	21.3	8000	19.65	4000	40.92
5	187500	28.4	20000	26.2	20000	54.56
6	271650	35.5	244700	32.75	242000	68.2
7	161000	35.9	180000	35.3	60000	71

S.No	MS (1062+1062)		MS (1018+1062)		MS (1018+1018)	
	STRESS (N/MM^2)	STRAIN	STRESS (N/MM^2)	STRAIN	STRESS (N/MM^2)	STRAIN
1	0	0	0	0	0	0
2	1.52117	0.0001	1.1304	0.0001	2.1345	0.0001
3	5.5776	0.1972	3.3913	0.18194	3.4152	0.18186
4	35.4940	0.3944	9.0435	0.3638	4.2690	0.3637
5	190.1468	0.5916	22.6088	0.5458	21.3454	0.5456
6	275.4847	0.788	276.6190	0.7277	258.2793	0.72746
7	163.2727	0.80	203.4797	0.79861	64.036	0.7648

After doing number of iterations we get different values of maximum stress corresponding deformations maximum load that can be sustain by the model. So different graphs are plotted on the basis of the that data.

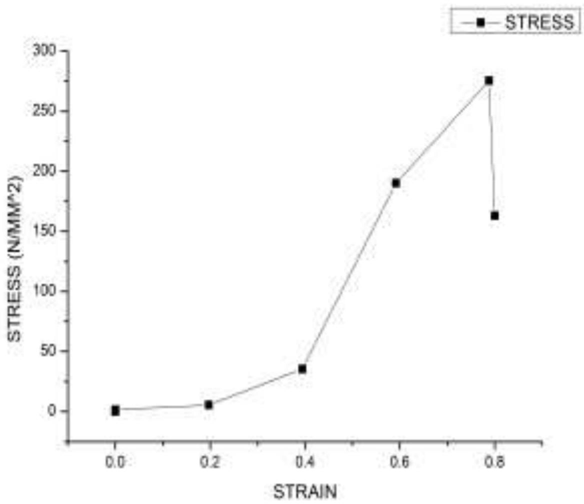

Fig 4.7: Stress-Strain Analysis for MS plates (1062+1062)

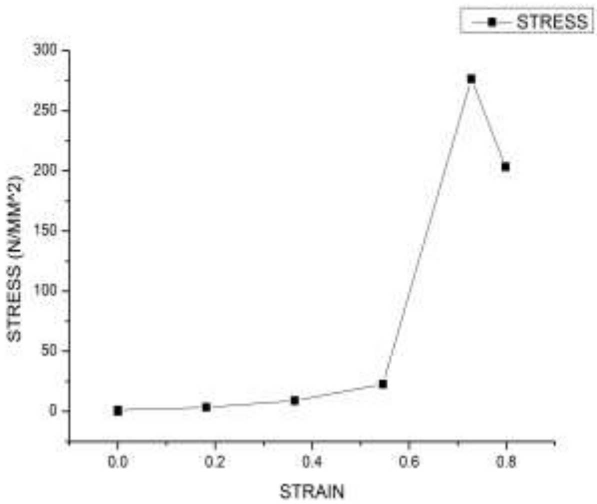

Fig 4.8: Stress-Strain Analysis for MS plates (1018+1062)

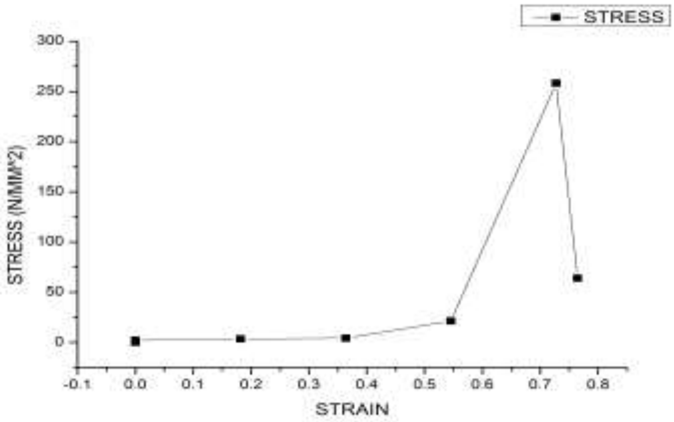

Fig 4.9: Stress-Strain Analysis for MS plates (1018+1018)

EXPERIMENTATION RESULTS AND DISCUSSION:

In first case i.e MS (1062+1062) of as there is increment in strength of weld joint. Quality of weld joint is expanding directly with increment in force. As the load is increased the deformation after reaching ultimate tensile strength the equivalent strain is 0.80. The maximum force is 271.65 KN of tensile strength 275.49 Mpa.

In Second case i.e MS(1018+1062) as there is increment in strength of weld joint. Quality of weld joint is expanding directly with increment in force. As the load is increased the deformation after reaching ultimate tensile strength the equivalent strain is 0.798. The maximum force is 244.7 KN of tensile strength 276.66Mpa.

In third case i.e MS(1018+1018) as there is increment in strength of weld joint. Quality of weld joint is expanding directly with increment in force. As the load is increased the deformation after reaching ultimate tensile strength the equivalent strain is 0.7648. The maximum force is 241.98 KN of tensile strength 258.26Mpa.

This effect is same for the deformation also due to application of restraining force there is certain change in deformation of weld joint but still it is not considerable.

Fig 4.10: Test report models of MS plates

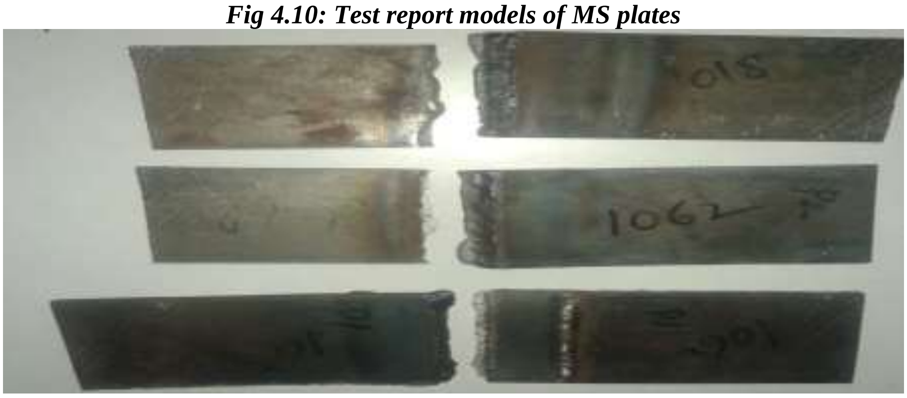

Table 4.3: Experimental test report of MS Flat Plates

Sample	Tensile strength (Mpa)	Fracture Location
1018+1062	276.66	Broken Outside the weld (1018)
1062+1062	275.49	Broken at weld
1018+1018	258.26	Broken at Outside the weld

5. SIMULATION PROCEDURE

The welding department of the company constantly develops new and improved welding routines. To improve this process the welding engineer at the welding department wants to have the possibility to stimulate with FEA-program, the results will reduce the time and simplify the welding developments.

The stress distribution in different welded Joints is investigated with a computer modeling technique. Finite Element Method (FEM) is a numerical technique used to perform Finite Element Analysis (FEA) of any physical phenomena such as structural behaviour .The finite element analysis is used for the analysis of joints in the plane – stress condition, under static load. Under finite element analysis we used the static structural analysis. Modeling is done in CATIA -V5 and analysis is done in ANSYS.

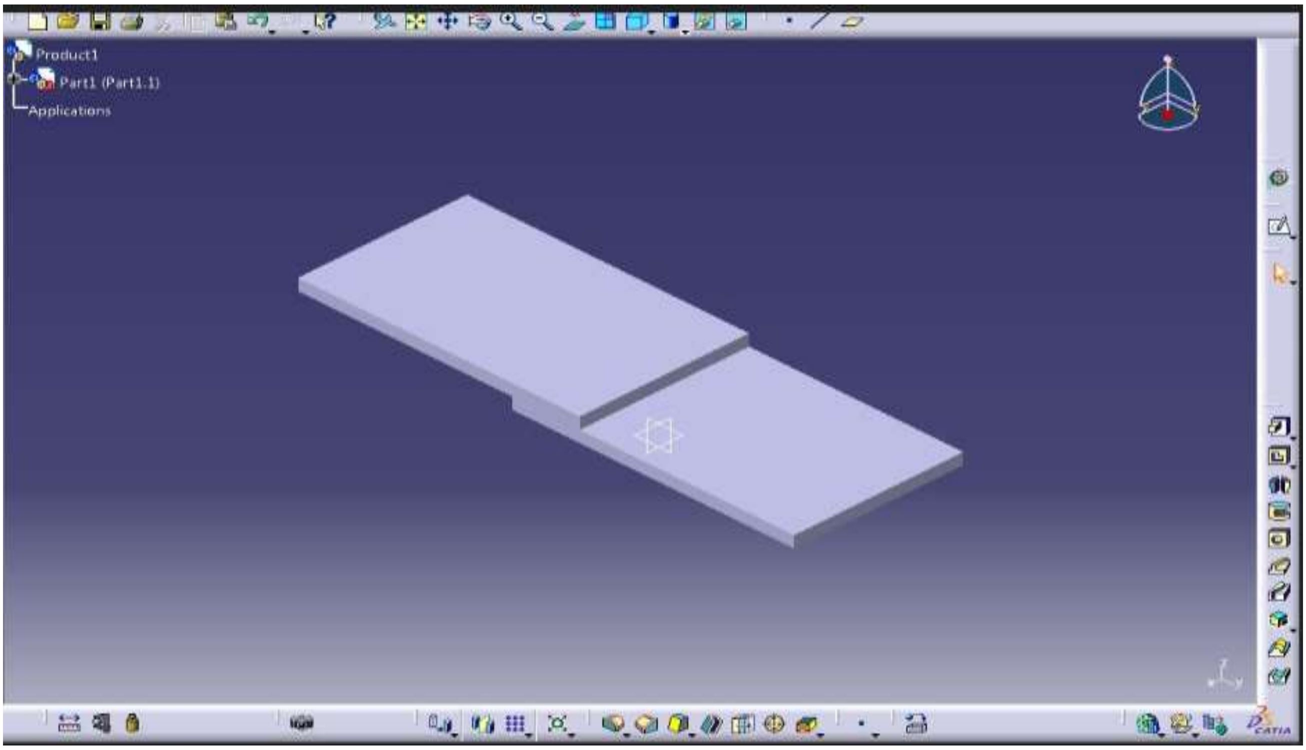

Fig 5.1: Design of Lap joint for Mild Steel 1018 &1062 in CATIA V5

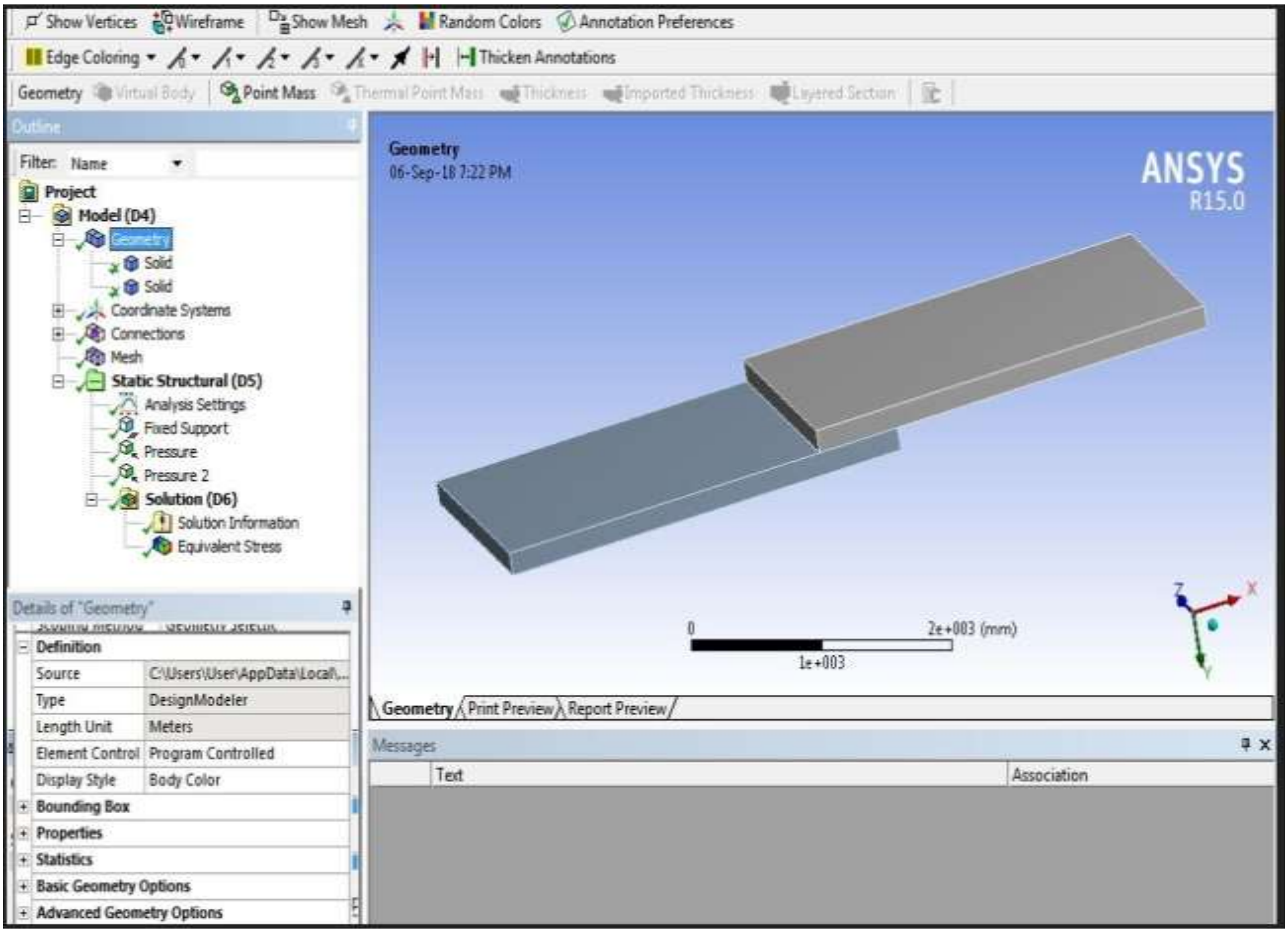

Fig 5.2: Imported model in ANSYS

PERFORMING STATIC STRUCTURAL ANALYSIS

MATERIAL: AISI 1018+1062

EQUIVALENT STRESS

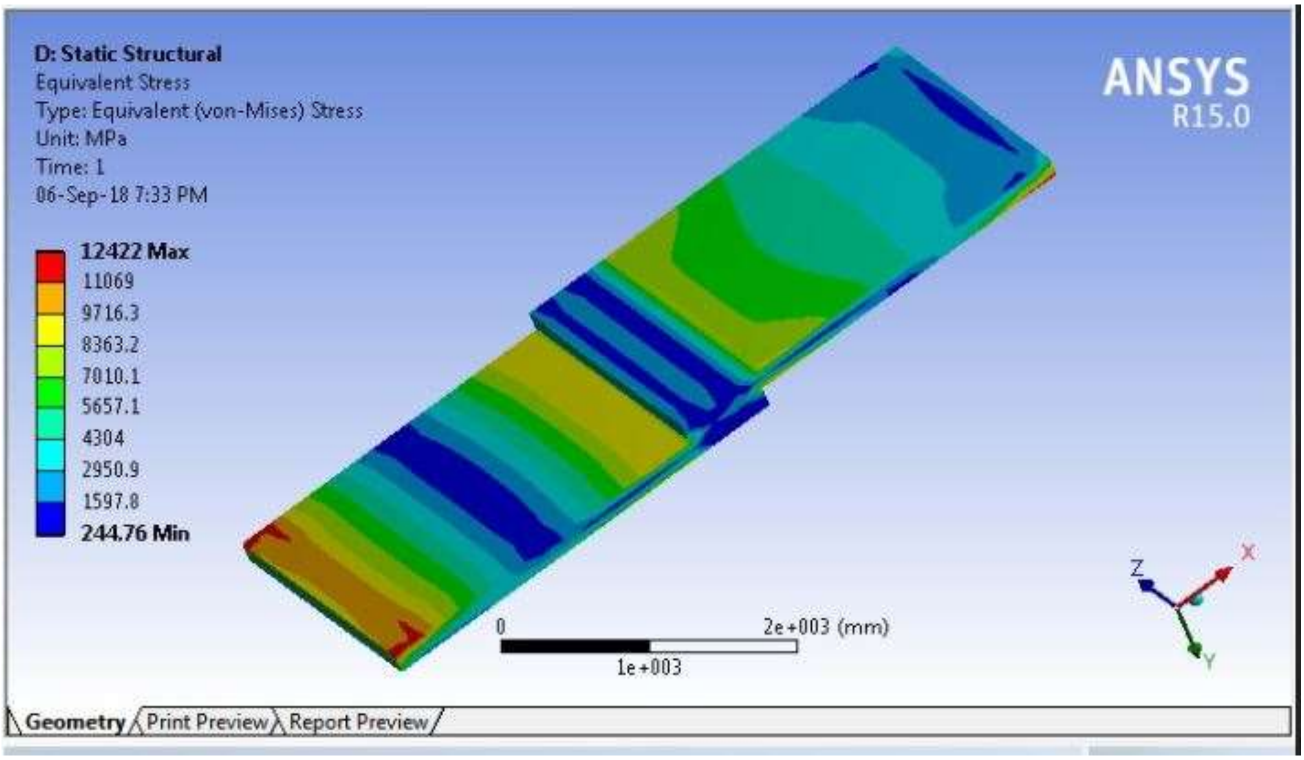

Fig 5.4: Stress for Weld Lap joint of 1018+1062 MS plates

EQUIVALENT STRAIN:

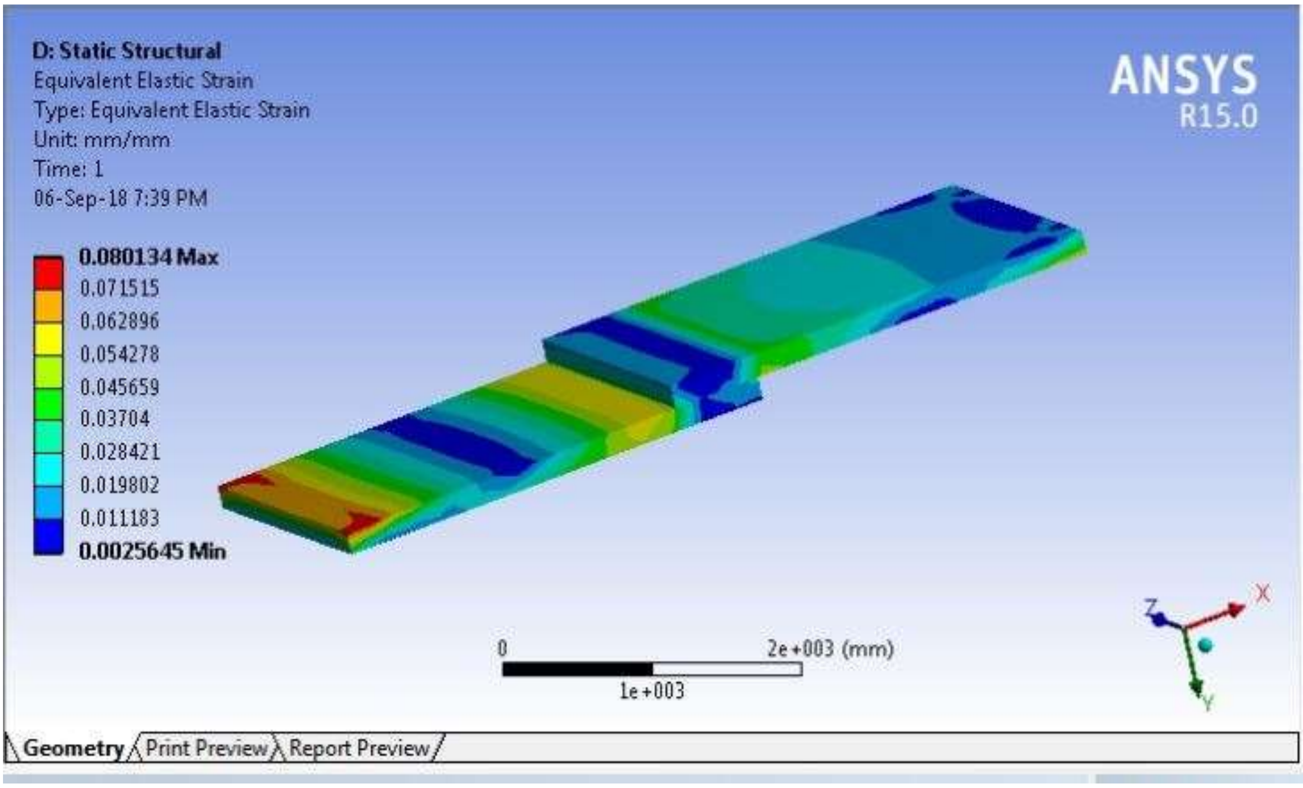

Fig 5.5: Strain for Weld Lap joint of 1018+1062 MS plates

Fig. 5.4 and Fig. 5.5 shows Force and Stroke graphs plot for the Lap weld joint of AISI 1018+1062 MS flat plates. In this case failure of weld joint happens at the association of plate and weld that is at Weldment. When restraining force is applied on the free end of single transverse weld we get different stress pattern and then equivalent stresses are observed on weld as well as plate (Fig. 5.4). When restraining force of 244.73 KN is applied on system minimum stresses are induced. It shows that at minimum stress we can increase the axial tensile force, ultimate tensile strength is 244.76 Mpa, which increases load carrying capacity of system.

MATERIAL:AISI 1018+1018

EQUIVALENT STRESS:

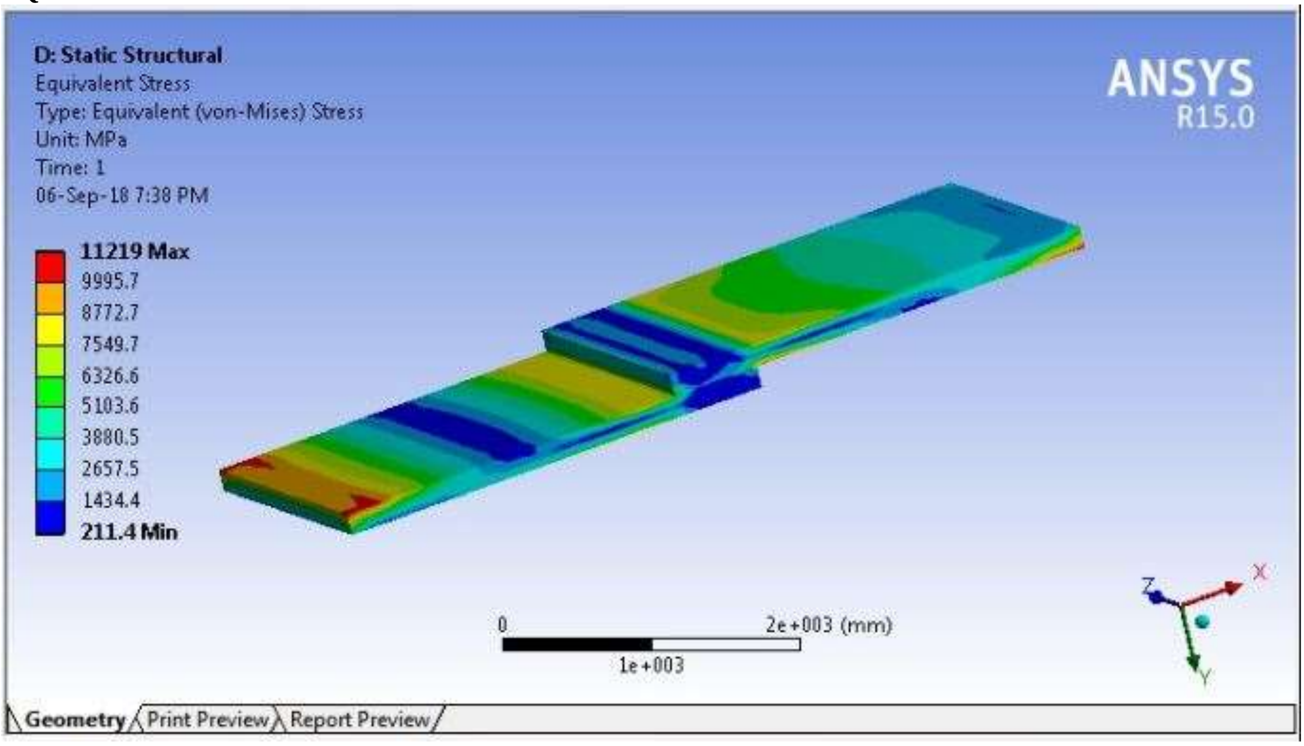

Fig 5.6: Stress for Weld Lap joint of 1018+1018 MS plates

EQUIVALENT STRAIN:

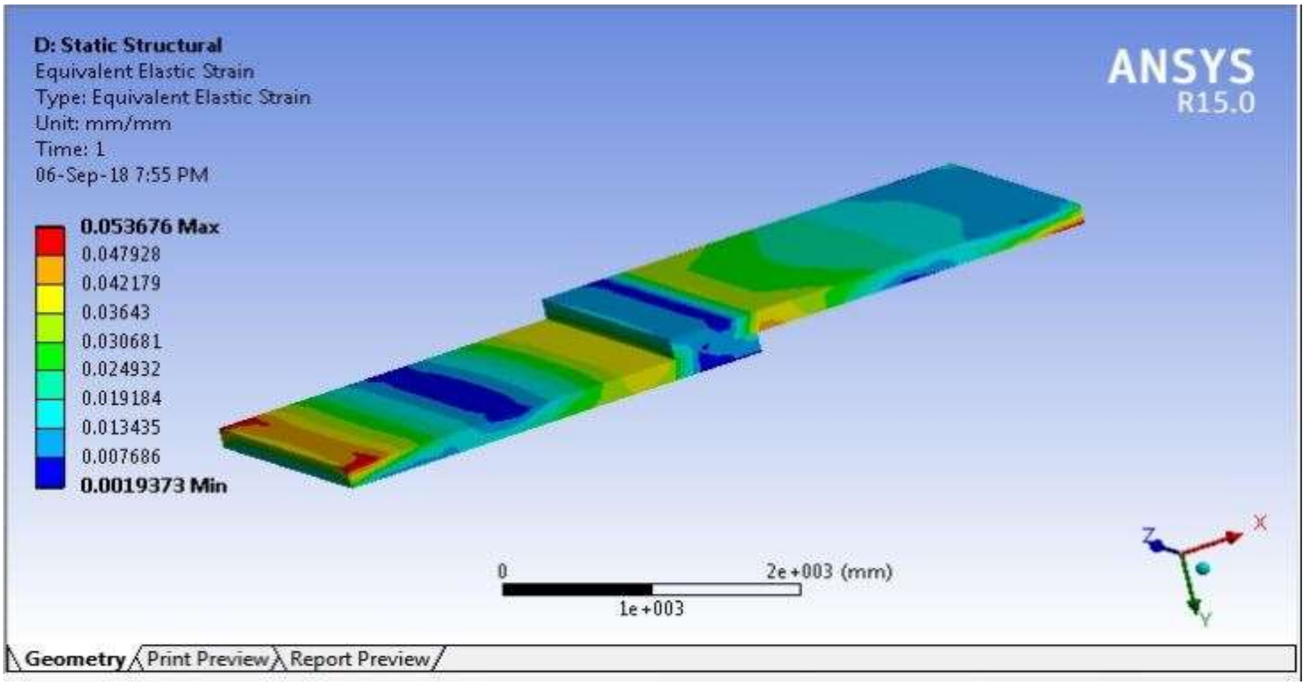

Fig 5.7: Strain for Weld Lap joint of 1018+1018 MS plates

Fig. 5.6 and Fig. 5.7 shows Force and Stroke graphs plot for the Lap weld joint of AISI 1018+1018 MS flat plates. In this case failure of weld joint happens at the connection of plate and weld that is at Weldment. When restraining force is applied on the free end of single transverse weld we get different stress pattern and then equivalent stresses are observed on weld as well as plate (Fig. 5.6). When restraining force of 241.98 KN is applied on system minimum stresses are induced. It shows that at minimum stress we can increase the axial tensile force, ultimate tensile strength is 211.4 Mpa, which increases load carrying capacity of system.

MATERIAL: AISI 1062+1062:

EQUIVALENT STRESS:

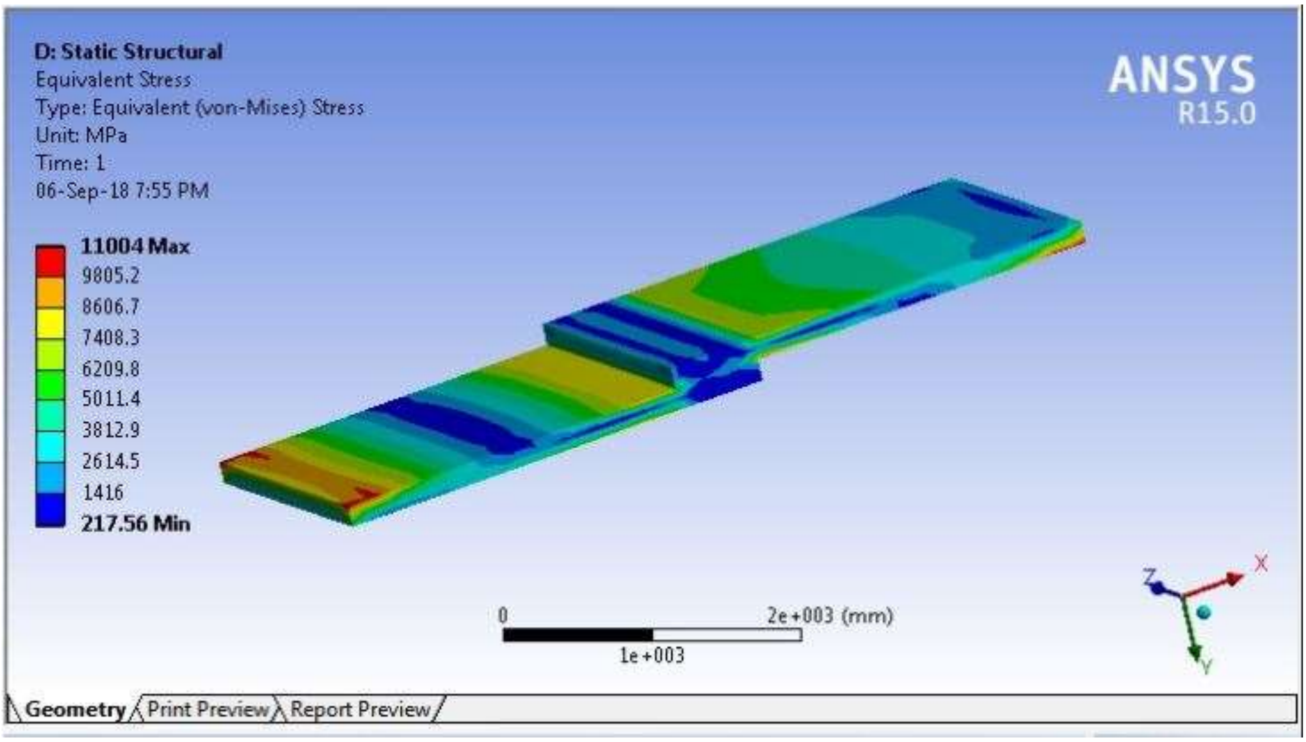

Fig 5.8: Stress for weld Lap joint of (1062+1062) MS plates

EQUIVALENT STRAIN:

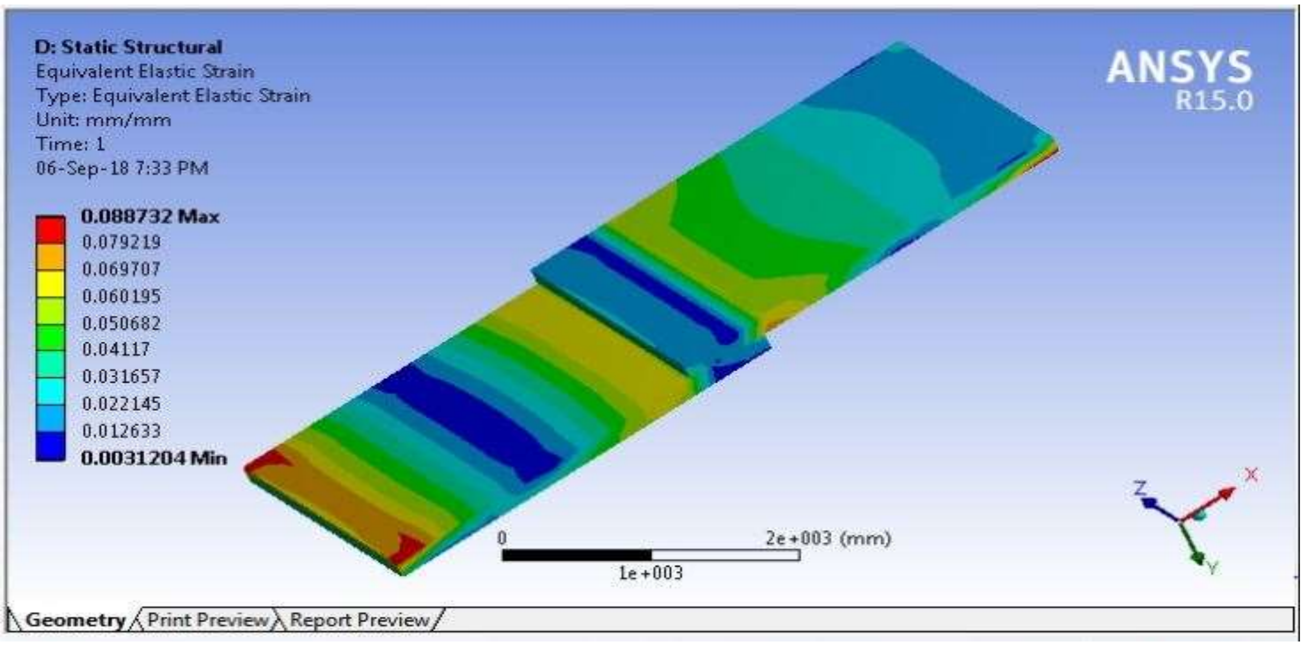

Fig 5.9: Strain for Weld Lap joint of (1062+1062) MS plates

Fig. 5.8 and Fig. 5.9 shows Force and Stroke graphs plot for the Lap weld joint of AISI 1062+1062 MS flat plates. In this case failure of weld joint occurs at the connection of plate and weld that is at Weldment. When restraining force is applied on the free end of single transverse weld we get different stress pattern and then equivalent stresses are observed on weld as well as plate (Fig. 5.8). When restraining force of 271.65 KN is applied on system minimum stresses are induced. It shows that at minimum stress we can increase the axial tensile force, ultimate tensile strength is 217.56 Mpa, which increases load carrying capacity of system.

From above table as value of force increases gradually slightly the Von Mises stress value increases and correspondingly deformation value is varying. It is observed during iterations the stress value is decreased after it crosses Ultimate strength value.

This work is also useful in the analysis of welded curved plate which are used in the boiler manufacturing, ship building. For producing complicated parts or welding of curved surfaces is done on workers experience, skill and knowledge. So still large scope available in this field.

Table 5.1: Simulation Results of MS Flat Plates

Samples	Tensile strength (Mpa)	Equivalent Eastic Strain
1018+1062	244.76	0.0801
1018+1018	211.4	0.0536
1062+1062	217.56	0.0887

6. CONCLUSIONS

Welds are regularly a basic piece of building structures. Residual stresses presented in the welded locales, because due to nonlinear thermal processes during welding. In some case Welding can been blamed for the failure of extensive building structures, however it ought to be noticed that failures have happened in bolted and riveted structures and in castings, forgings, hot moved plate and shapes, and also different sorts of development. From the experimentation following conclusions were drawn.

1 Ultimate stress and deformations were measured and compared with simulations. A quite good results were obtained between measurements and simulations.
2. Static Structural analysis of three Lap-joints is done in Ansys. By observing the Static structural analysis results, all the joints were withstanding to the applied pressures.
3.It is observed that in the experimental case the highest load applied i.e (271.65 KN, 244.73 KN, 241.98 KN) on the materials, where the material starts necking. But in analysis case the necking is not started at that loads it just deforms.
4.The analysis in ansys has some limitations it will not show the breaking point of the material.
5.However, it was also found that it is equally important how the Joints to be weld, when applying the proper boundary conditions the difference between the designs becomes very small. This model and the results show that ANSYS is able to simulate welding, though with some limitations and difficulties.

NOMENCULATURE

CATIA-V5	COMPUTER AIDED THREE DIMENTIONAL INTERACTIVE APPLICATION-VERSION 5
MS	MILD STEEL
AISI	AMERICAN IRON AND STEEL INSTITUTE
FEA	FINITE ELEMENT ANALYSIS
CAD	COMPUTER AIDED DESIGN
MM	MILLI METER
FEM	FINITE ELEMENT METHOD
AC	ALTERNATING CURRENT
DC	DIRECT CURRENT
MPA	MEGA PASCAL
KN	KILO NEWTON

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