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Presentation on

"Experimental investigation on the effects of process parameters of GMAW and transient thermal analysis of AA7075 T6 "

By

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CONTENTS

Abstract

- Aluminium alloy 7075 T6 weld plate.
- Effects of process parameters.
- Predict bead geometry, mechanical properties and temperature study.
- Heat flows in welding process.
- Transient thermal analysis

Introduction

- History of aluminium alloys
- Properties influencing weld joint:
  - High thermal conductivity
  - High solidification shrinkages
  - Oxide formation at the surface
  - High coefficient of thermal expansion
  - High solubility of hydrogen when in the molten state
- enges in aluminium alloy weld joint

Literature Review

Sr.No.	Name of Author	Title of Paper & Journal	Summary
1	A. G. Kamble et al	Experimental investigation on the effects of process parameters of GMAW and transient thermal analysis of AISI321 steel	They have studied that Gas metal arc welding (GMAW) develops an arc by controlling the metal from the wire rod and the input process parameters. The deposited metal forms a weld bead and the mechanical properties depend upon the quality of the weld bead.
2	A. G. Kamble et al	Effects of process parameter of GMAW on bead geometry, tensile strength, hardness, microstructure and thermo-mechanical analysis of AISI202 steel .	They have studied that Gas metal arc welding (GMAW) develops an arc by controlling the metal from the wire rod and the input process parameters. The deposited metal forms a weld bead and the mechanical properties depend upon the quality of the weld bead.
3	M. Pal Pandi et al	Thermal analysis on butt welded aluminium alloy AA7075 plate using FEM	Thermal analysis on AA 7075 6 mm thickness plate butt weld by using FEM to study effect of process parameter on thermo-mechanical response is studied. It is observed that as the welding speed increases the stresses induced in plate decreases.

Sr.No.	Name of Author	Title of Paper & Journal	Summary
4.	P. Praveen et al	Meeting challenges in welding of aluminium alloys through pulse metal arc welding	They studied that aluminium weld joint using pulsed current gas metal arc welding process and investigated that it is difficult to weld the aluminium alloys and challenges faced by manufacturers are to join different varieties of aluminum alloys and reduce cracks in welds and weld repairs
5	K. Rajasuthan *et al*	A study of welding parameters on mechanical properties of gas metal arc welding and gas tungsten arc welding: a review	Comparative study of AA 2014 and 7075 under the effect of butt welding process has been done . It is observed that as heat flux increases stress acting on plate increases, as the welding speed increases the stresses induced in plate decreases
	.I.S et al	Thermal analysis on a weld joint of aluminium alloy in gas metal arc welding	In this AA6061 plates cut into two plates of 100 mm × 125 mm. The sheets are welded together by GMAW process . It is observed that arc voltage and welding speed affects on the temperature distribution. Heat input to weld pool is transfer rapidly firstly in the thickness direction of sheet and then in the width direction

Problem Definition

- Aluminium alloy 7XXX series alloy are used in the Aerospace industry, transportable bridge girders, military vehicles, road tankers and railway transport systems
- Al-Zn-Mg-Cu high strength alloy develop good stress-corrosion cracking resistance in sheet products.
- Thickness of plate is 10 mm
- GMAW process

Objective

- To study and investigate the suitable welding process
- To study and identify the important input welding process parameters
- To compare the experimental bead geometry (B_W, B_H, B_P) with Minitab 17.3.1. software results
- To study the effects of input process parameters
- To study transient thermal analysis at different at different condition.

Methodology

Scheme of Investigation

- Selection of base material.
- Identify the importance of GMAW welding process parameters.
- Perform the preliminary test.
- Find the upper and lower limits (i.e. range) of identified process parameters.
- Select the design of matrix.
- Conduct the experiments as per the selected design of matrix.
- Record the quality characteristics.
- Find the optimum condition for the MIG welding.
- Identify the significant factors.
- ient thermal analysis of optimum condition.

Sample preparation

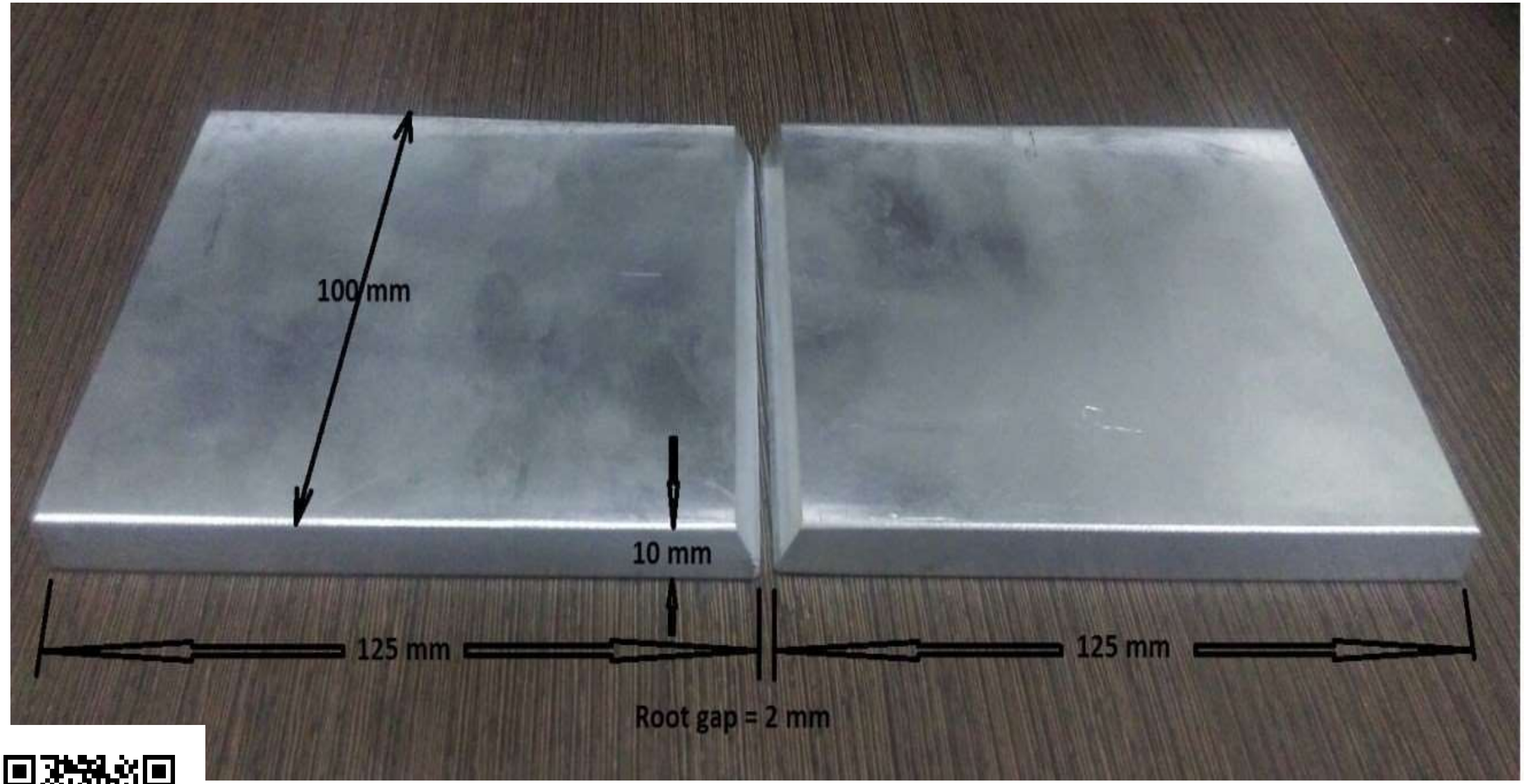


Fig. Actual sample for weld joint

Input Process Parameters

$$X = \frac{2\,(2X - (X_{max} - X_{min}))}{X_{max} - X_{min}}$$

Process		Limits				
Parameters	Notation	-2	-1	0	1	2
Current (Amp.)	A	160	180	200	220	240
Wire Feed Rate (m / min.)	F	9.5	11	12	13	14
Welding Speed ([illegible]/Sec)	S	6.3	5.6	5	4.5	4.2
[illegible] Flow ([illegible]in)	G	16	17	18	19	20

Experimental Setup

ig: LORCH MIG Setup

Fig: Shielding Gas Cylinder (100% argon)

Fig: Fixture for weld plates

Fig: Mounting and clamping of weld plates

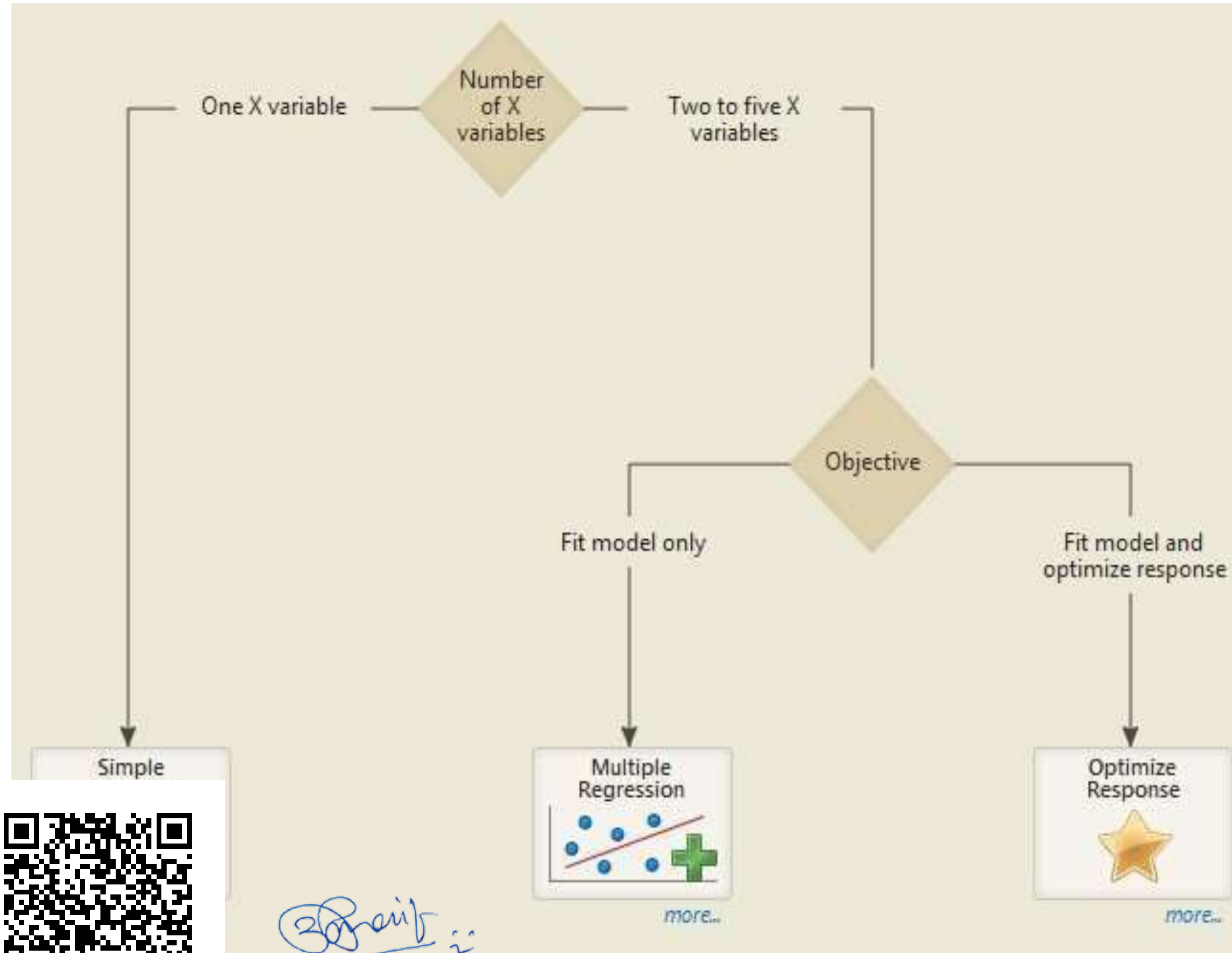
Fig: Actual Sample after performing all passes weld joint at input process parameters
(V=25.2 v, I=200 A,
F=11.7 cm/min,
G=18 lit/min,
S=6.84 mm/sec)

Experimental Results

	Welding Parameters					Bead Geometry		
Experiment No.	Voltage in volt	Current in ampere	Wire Feed Rate in mm/min	Gas Flow Rate in lit/min	Welding Speed in mm/sec	Width in mm	Height in mm	Penetration in mm
1	24.5	180	10.6	17	5.55	15.7	3.1	9
2	24.5	180	10.6	19	5.55	13.5	3.5	9.5
3	25.8	220	10.6	17	5.55	16.2	3.6	8.5
4	25.8	220	10.6	19	5.55	16	3.5	8.6
5	24.5	180	10.6	17	4.34	16	4.1	8.7
6	24.5	180	10.6	19	4.34	15.1	3.8	8.9
7	25.8	220	10.6	17	4.54	13.5	3.6	8.6
8	25.8	220	10.6	19	4.16	15	4	8.1
9	24.5	180	12.8	17	4.34	16.2	3.8	9
10	24.5	180	12.8	19	5.26	15.3	4.1	7.8
11	24.4	220	12.8	17	5.71	15.5	3.1	8.9
12	24.4	220	12.8	19	5.55	15.5	4	8.5
13	24.5	180	12.8	17	6.66	13.3	3.3	8.7
14	24.5	180	12.8	19	5.55	13.9	3.8	8.8
15	25.8	220	12.8	17	4	16.2	3.4	9
16	25.8	220	12.8	19	4.54	15.5	3.8	8.4
17	25.2	200	9.5	18	4.54	15.2	3.6	8.9
18	25.2	200	13.9	18	4.54	14.2	3.5	8.9
19	25.2	200	11.7	18	6.84	14.8	3.7	10
20	25.2	200	11.7	18	4	15.5	3.4	9.5
21	23.7	160	11.7	18	5	16.2	4.2	9.2
22	26.5	240	11.7	18	4.16	15.1	3.8	9.3
[illegible]	25.2	200	11.7	16	6.66	15.5	3.7	9.8
[illegible]	25.2	200	11.7	20	4.34	16.1	4.1	9.5
[illegible]	25.2	200	11.7	18	5	16.2	3.8	9.8
[illegible]	25.2	200	11.7	18	4.16	15.8	3.5	9.8
[illegible]	25.2	200	11.7	18	5	16.2	3.8	10
[illegible]	[illegible]	200	11.7	18	4.76	15.8	3.6	10

Table: Experimental Process Parameters and Bead Geometry

MINITAB 17.3.1



Types of regression analysis

A) Simple Regression Analysis

a) Linear Regression analysis

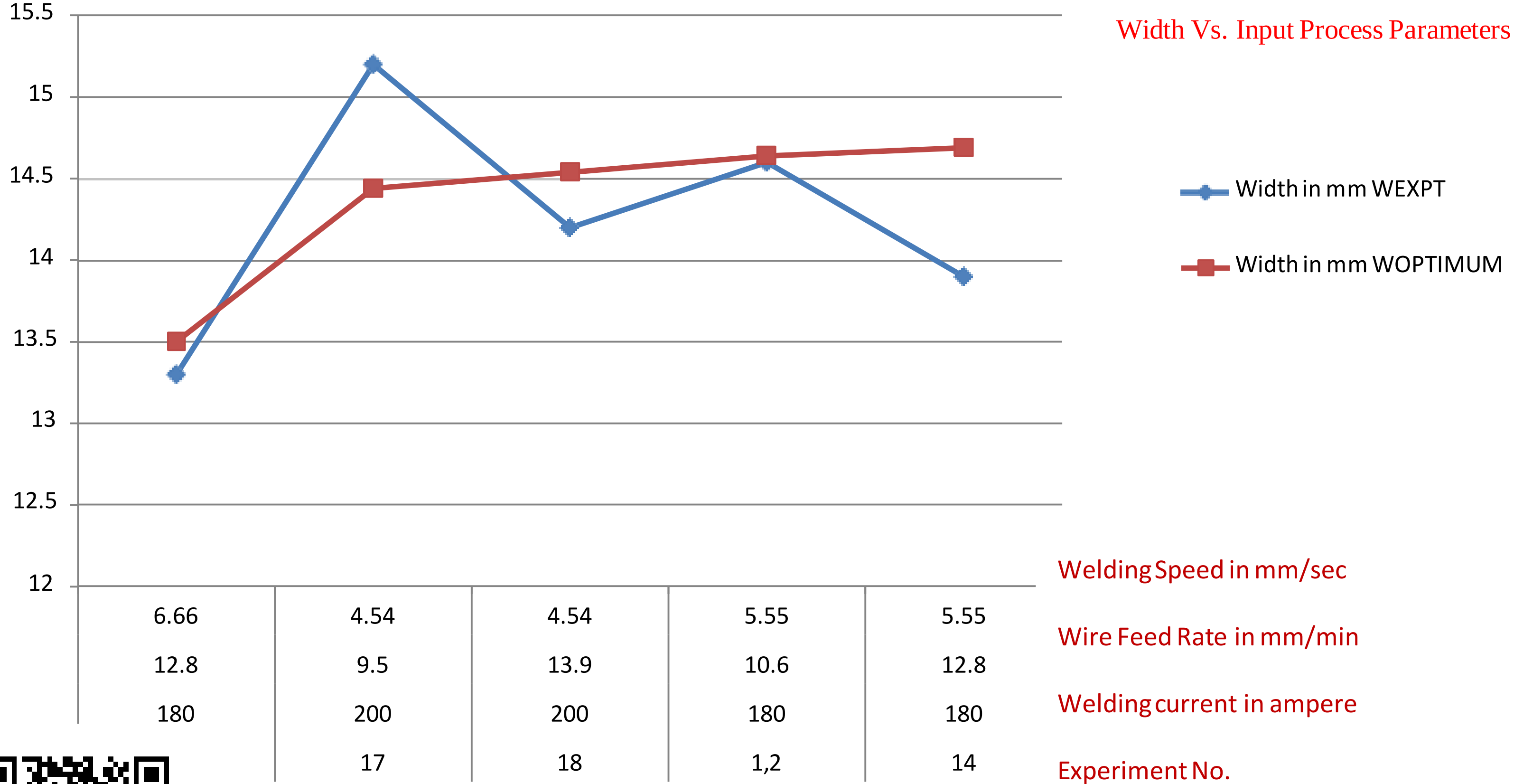
b) Quadratic regression analysis

B) Multiple Regression Analysis

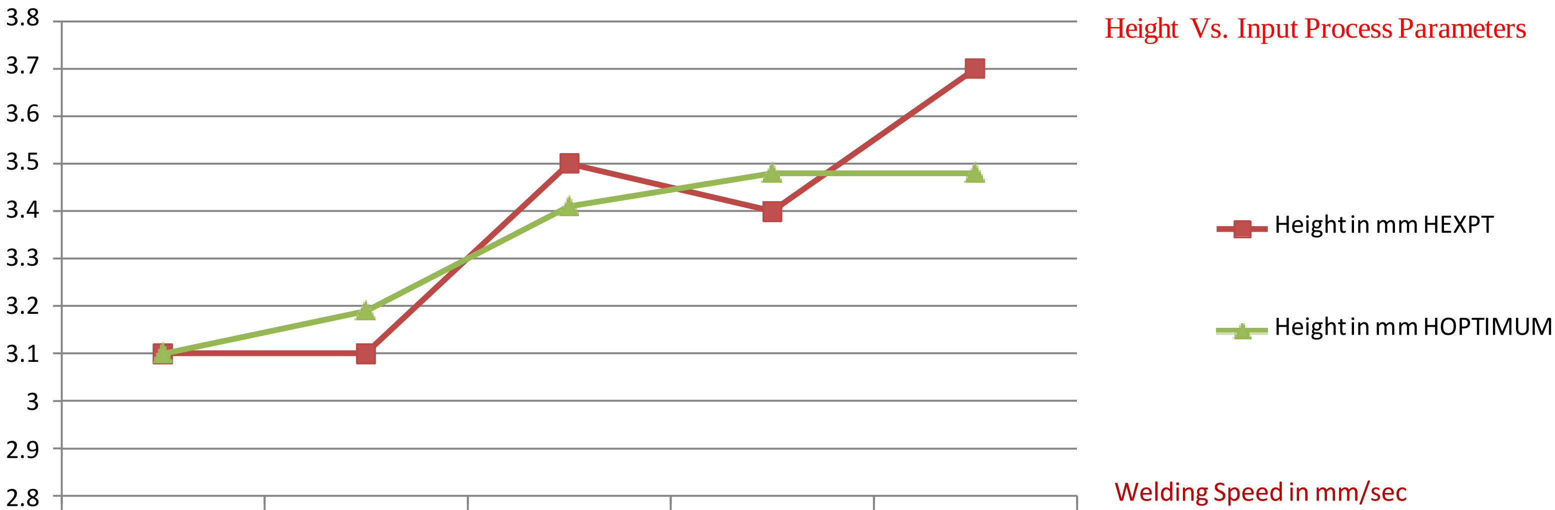
a) For fit model

b) Optimized response and fit model

Comparison between Experimental bead width and predicted width for optimization

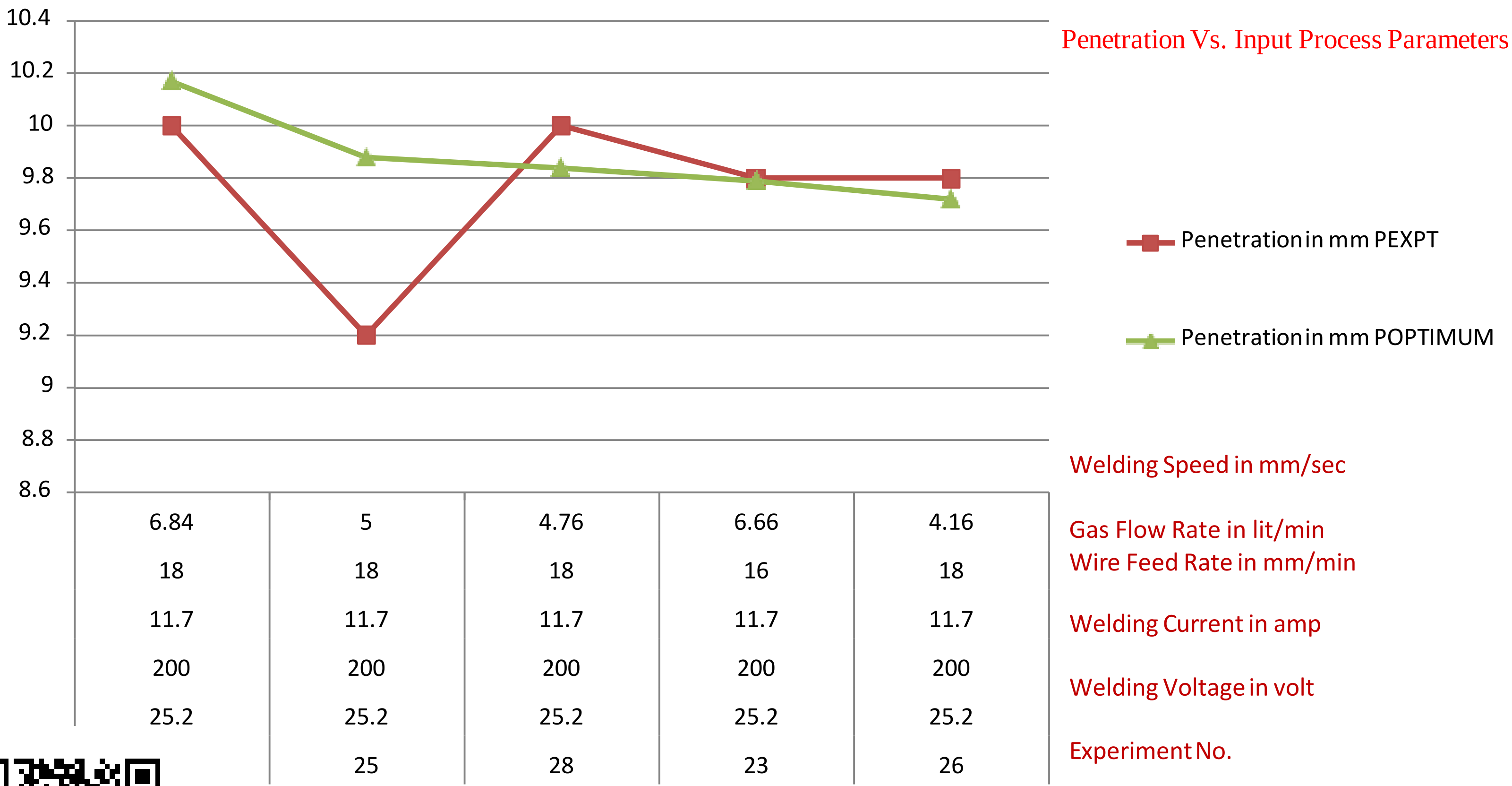


Comparison between Experimental bead height and predicted height for optimization



Welding Speed in mm/sec	5.71	5.55	5.55	4	6.66
Gas Flow Rate in lit/min	17	17	19	17	16
Wire Feed Rate in mm/min	12.8	10.6	10.6	12.8	11.7
Welding Current in amp	220	180	180	220	200
Welding Voltage in volt	24.4	24.5	24.5	25.8	25.2
Experiment No.		1	2	15	23

Comparison between Experimental bead penetration and predicted penetration for optimization



Testing for tensile properties

Experiment No.	Joint type	UTS in MPa	Elongation in %	Gauge Length in mm
2	P-GMAW	155.54	1.60	50.8
7	P-GMAW	85.03	2.20	50.8
21	P-GMAW	104.16	2.00	50.8
22	P-GMAW	71.41	1.60	50.8
	Base Metal	230.85	1.77	50.8

Tensile properties of weld joint

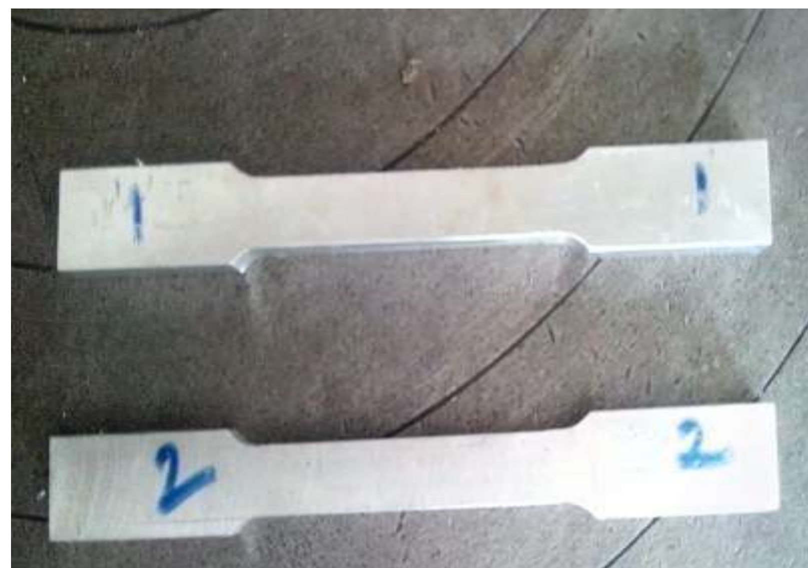
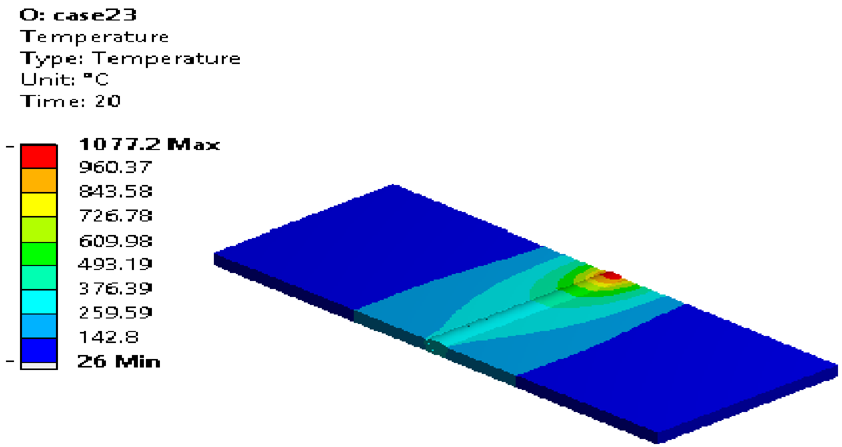
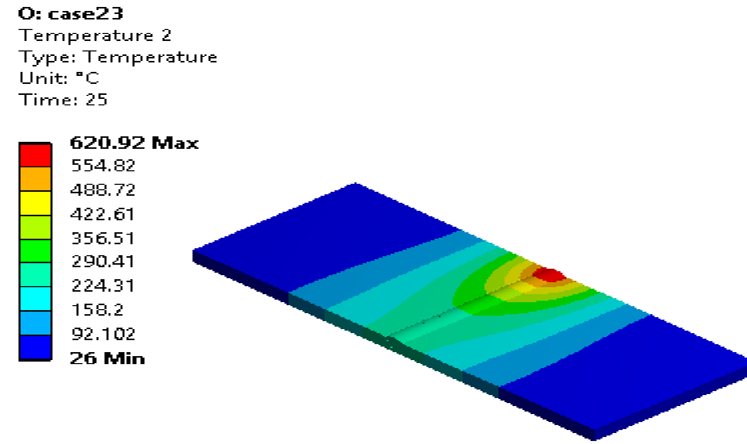
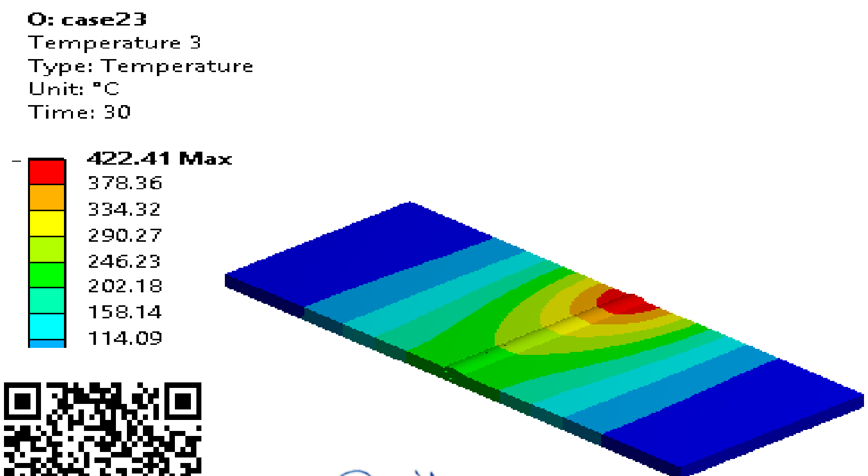


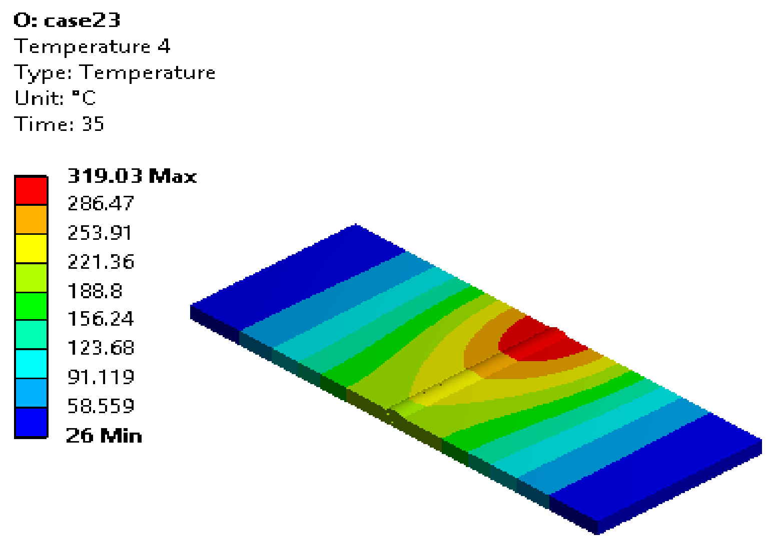
Fig.28: Tensile Specimen as per ASTM E 8

Transient thermal analysis of optimized condition

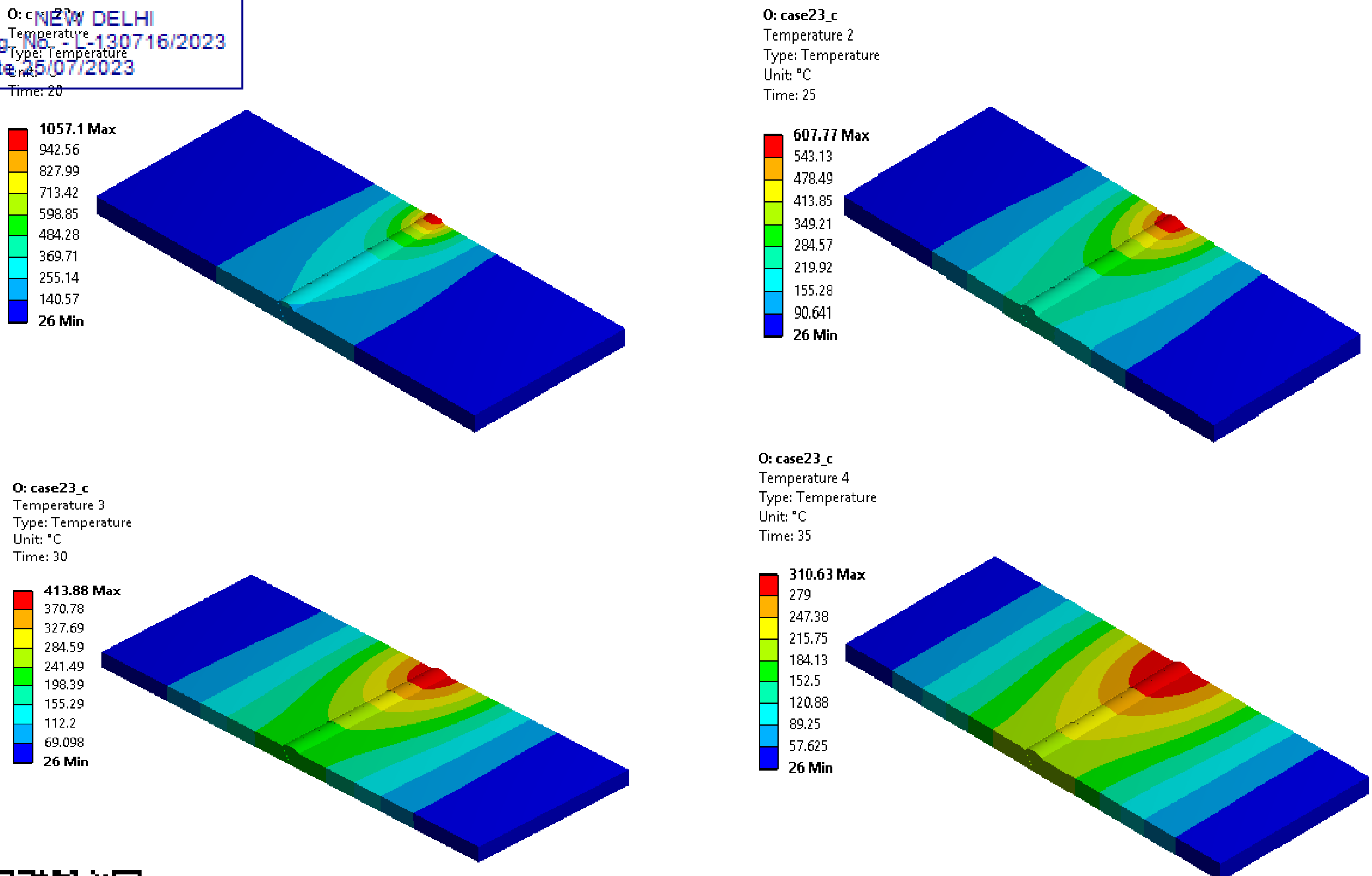






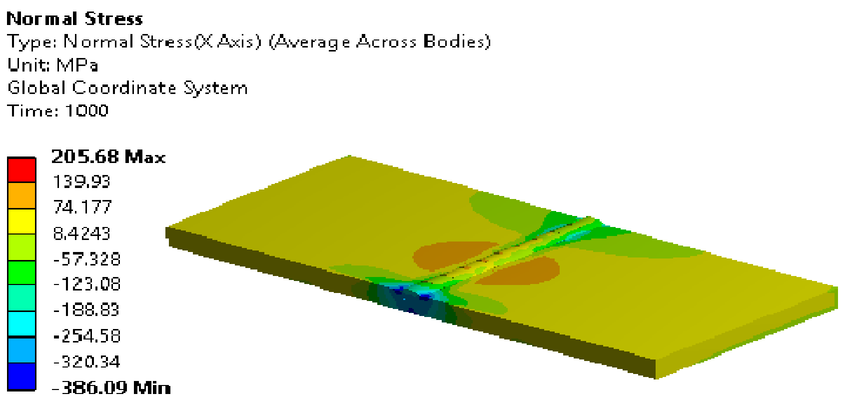


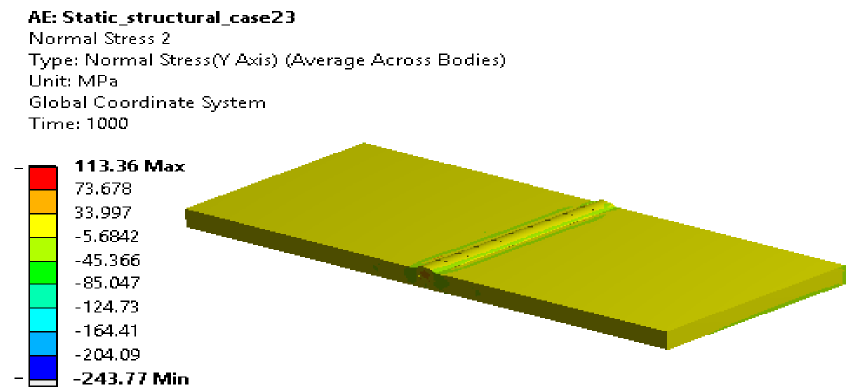
nperature distribution along plate due to conduction at different time

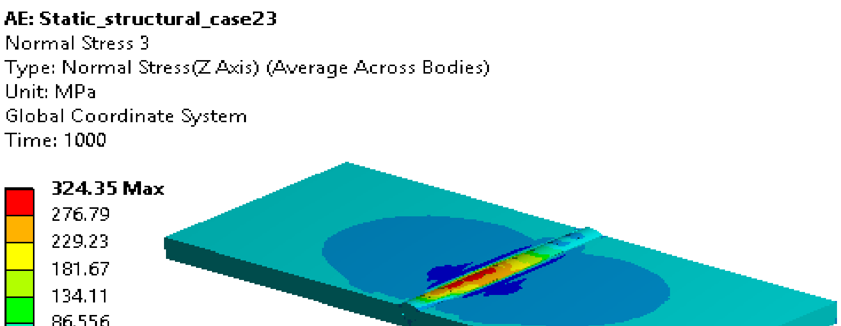


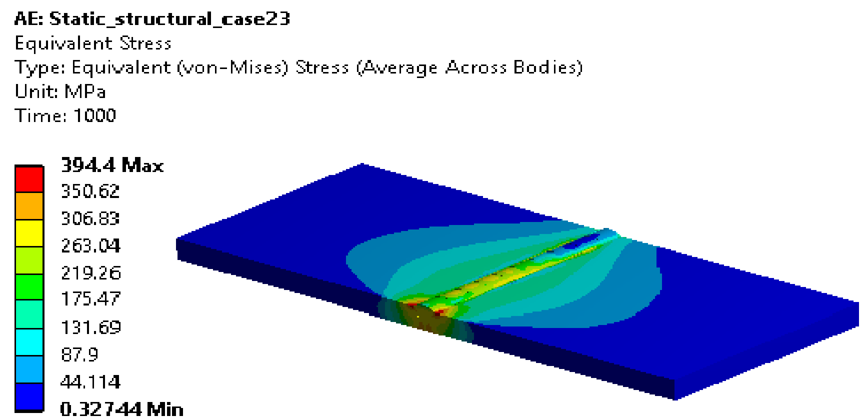
erature distribution along plate due to conduction, convection and radiation at different time

Residual stress component of weldment









Discussion

- Effect of input process parameters on bead width.
- Effect of input process parameters on bead height.
- Effect of input process parameters on bead penetration.
- Effect of input process parameters on mechanical properties.
- Transient thermal analysis for temperature and residual distribution.

CONCLUSION

- To enhance the bead geometry of the weld region and the mechanical properties of the weld region the bead penetration must be high and the bead width, bead height must be minimized.
- Higher the bead penetration higher is the mechanical property of the weld joint.
- The experimental bead geometry was compared with Minitab results which were found nearer.
- Mechanical properties i.e. UTS, elongation increases at the weld joint.
- It is observed that high temperature exits in the welded zone and temperature is distributed along the length of the weldment in conduction. The convection takes place in the middle part of the weldment

eratures are not affected by convection much because heat er due to conduction is very high in case of aluminium when ared with convection and radiation

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Thank You