Incomplete fusion and its impact on weld quality of butt joint

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ABSTRACT - Welding is one of the most known traditional fabrication processes where one metal is melted in order to join two other pieces of metal. A weld jointis nothing but the coalescence of metals produced byheating them to a suitable temperature with/withoutthe application of pressure and filler material. Heating in the welding process in between two endsof the base metal and parent metal is not provide (or)allowed that may influence quality of metal and solubility of part and base metals at cold sence. In this work we want to study the effect of incompletefusion In fusion welding the metals are fused, if themetals are fused completely then only proper metal transfer, solubility of liquid metal and stable weld bead is possible If there is any incomplete fusion takes place there may be poor solubility metal transfer, on uniformity of weld bead. In this study we want to observe weld quality weld strength during incomplete fusion by creating the variable cold sence. To observe the impact of incomplete fusion the parameters where varied and conducted the experimentation the bead was made to observe the impact of incomplete fusion. The observations were found after conducting NDT (non-destructive defects, Fusion, test) and destructive test.

Keywords: Weld quality, Destructive .

I. INTRODUCTION TO INCOMPLETE FUSSION

As a welding monitor, with the goal for you to effectively direct your calling, it is essential to comprehend weld discontinuities. To completely comprehend weld discontinuities, we should initially inspect some welding wording. The term intermittence is characterized as an interference of the average design of a material, for example, an absence of homogeneity in its mechanical, metallurgical, or actual qualities. An irregularity isn't really an imperfection. A deformity then again is characterized as a brokenness, or discontinuities, that naturally or gathered impact (for instance, complete break length) render a section or item unfit to fulfill least relevant acknowledgment guidelines or particulars. The expression "deformity" assigns rejectability. Since in this article we are inspecting these peculiarities outside the necessities of a particular welding code or standard, and we won't examine their limits as far as these reports, we will utilize the term discontinuities.

Defecient combination is a weld irregularity where combination didn't happen between weld metal and combination faces or abutting weld dabs. This shortfall of combination might happen at any area inside the weld joint and might be available in filet welds and additionally groove welds. Inadequate combination might be brought about by the powerlessness, during the welding system, to raise the base material or recently kept weld metal to its liquefying temperature. It is generally expected found on one leg of a filet weld and is brought about by wrong welding point that takes into account a lopsidedness of hotness between the two sides of the joint. It might likewise be brought about by inability to eliminate oxides or other unfamiliar material from the outer layer of the base material to which the saved weld metal should intertwine.

Deficient joint entrance is depicted as a joint root condition in a depression weld in which weld metal doesn't reach out through the joint thickness. It is the disappointment of filler metal or base metal to totally fill the foundation of the weld. Some normal reasons for inadequate joint entrance are identified with groove weld plan or set up not appropriate for the welding conditions. These issues create in circumstances where the root face aspects are too huge, the root opening is excessively little, or the included point of a v-groove weld is excessively limited. These joint plan attributes limit the capacity of the weld to infiltrate through the joint thickness. To assist with forestalling this irregularity, care ought to be taken to guarantee the utilization of right joint plan and joint fit-up as per welding strategy necessities.

The full comprehension of these weld discontinuities will help the welding assessor to distinguish them and, all the more critically, help to keep them from happening underway.

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Incomplete fussion metals.

II. EXPERIMENTATION

1. Material selection:

Type of material : Mild steel (m.s)

Dimensions : 150mmx100mmx6mm (lxbxt)

Quantity : 2

MILD STEEL IS 2062 GRADE A PLATES CHEMICAL COMPOSITION

GRADE	C	Mn	S	P	Si
IS 2062	0.23	1.5	0.05	0.05	0.4

IS 2062 GR MS PLATES MECHANICAL PROPERTIES

Grade	Yield Strength			Tensile Strength	Elongation
IS 2062 GRA	<20mm	20mm-40mm	>40mm	410	23%
	250	240	230		

ELECTRODE (E6013)

The welding in all position can be easily done with good usability, good slag removability, and excellent bead appearance. Because it can be used in wider current ranges, it can satisfy wider weldings works. It is best suited for plates, vehicles, pipes, ship buildings, oil tanks and construction work.

TYPICAL CHEMICAL COMPOSITION OF WELD METAL (%)

C	Si	Mn	P	S
0.07	0.40	0.49	0.019	0.015

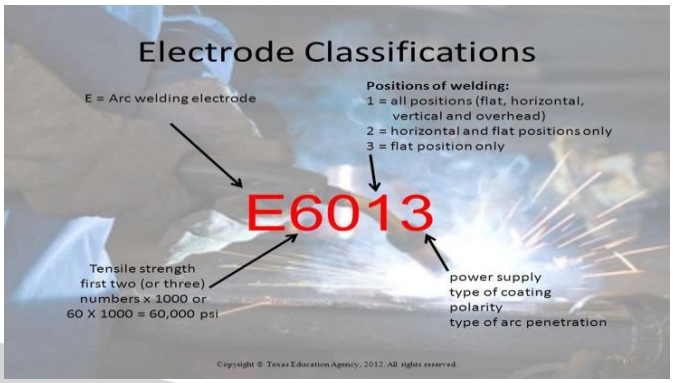
TYPICAL MECHANICAL PROPERTIES OF WELD METAL

Yield strength	Tensile strength	Elongation
466 N/mm2 47.5 N/mm2	499 N/mm2 50.9 N/mm2	27.4

RECOMMENDED CURRENT:Amp.(AC orDC)

Size	Dia Length	2.0	2.5	3.2	4.0	5.0
		250	350	350	400	400
Current range	F	30-60	50-90	90-140	120-170	160-230
	V,OH	30-60	50-90	90-140	100-160	120-200

ELECTRODE SPECIFICATIONS:



Electrode classifications:

E-electrode
60-tensile strength
1-position of welding
3-required power supply

TYPICAL CURRENT (AMPERAGE) RANGE

S.no	Electrode diameter	Electrode(6013)
1	2.5	45 to 90
2	3.2	80 to 130
3	4.0	105 to 180
4	5.0	150 to 230

III. METHODOLOGY

1. Selection of material
2. Preparation of job
3. Weld parameter V
4. Welding execution
5. Testing of welds
6. Finish the job

SELECTION OF MATERIAL

Two mild steel plates of dimensions of

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150mmx100mmx6mm.

They are cleaned and finished thoroughly, so that do not contain any irregularities and cracks on them.

Mild steel plates

PREPARATION OF JOB;

Each mild steel plate is grinded at one of its edges. So as to from a V-shaped groove, when both plates are placed together.

Grinding machine

V-groove planks have a chamfered edge,that when fit together,via a tongue and groove joint,in a v-shape in-between the boards.

The mild steel plates are shaped to form a v groove joint.

WELD PARAMETERS

Diameter of the electrode -2.5mmand 3.5mm Voltage – 25v

Amperage – 80amp,100amp

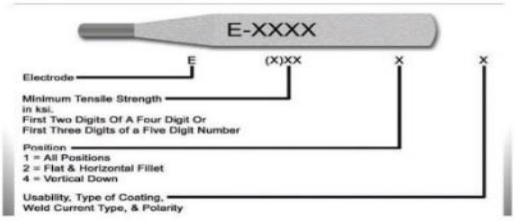
Gap between the roots of the mildsteel -2mm

M.S plates held together by supporting plate

- **SELECTION OF ELECTRODE:**

The type of electrode used depends on the specific properties required in the weld position

The corrosion resistance, ductility, high tensile strength, the type of base metal to welded, the position of the weld.



Electrode classification

WELDING EXECUTION:

This includes the welding of the mild steel plates together by shield metal arc welding.

Welding the mild steel plates

Workpiece after weld

Allow it to cool for some time. Remove the supporting plate by using grinder. Remove the spatters and irregularities on workpiece by using grinding machine.

Removing the support plate

Proceed the workpiece for testing the weld strength.

- **INVESTIGATION OF WELD STRENGTH**

There are many ways to investigate the weld strength.

The workpiece should not be destroyed, so we used non-destructive tests to investigate the weld strength.

Dye penetration test and magnetic particle test are done to investigate the weld strength.

- **DYE PENETRATION TEST**

Dye Penetrant test (DPT), also called Liquid Penetrant Inspection (LPT) is one of the oldest and simplest NDT methods, used to detect any surface-connected discontinuities such as cracks from fatigue, quenching, and

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grinding, as well as fractures, porosity, incomplete fusion, and flaws in joints.

This process of testing involves following steps:

1. Pre-cleaning
2. Application of penetrant
3. Dwell time
4. Excess penetrant removal
5. Application of developer
6. Inspection post cleaning

This test is done on both face side and root side of the v groove weld.

Required material for dye penetration test:

- Pre-cleaner
- Penetrant
- Developer
- Cotton waste
- A pen or an indicator to show the defects

Dye penetration test

PRE CLEANING

The surface of the specimen needs to be free of dirt, rust, scale, paint, oil, grease and be smooth enough to wipe of the penetrate without leaving the residue.

Pre-cleaning face side

APPLICATION OF PENETRANT

This is generally done by spraying penetrate from the aerosol spray or apply it with a brush on the weld. Specifications of penetrant.

Application of penetrant on face side

- **DWELL TIME**

The work piece is left aside for a while to allow the penetrant to penetrate into cracks and voids. This is typically 5-30 mins but should be never longer.

Dwell time on face side

- **EXCESS PENETRANT REMOVAL**

The excess penetrant is removed by wiping it with a cloth waste thoroughly.

This should be done until the penetrant is removed thoroughly.

Removal of excess penetrant on face side

- **APPLICATION OF PENETRANT**

A light thin coating of developer should be sprayed on the specified part being to be examined. A dual time needs to be observed to allow time for the die to exit the flaws and create an indication (flaw) in the developer. The dual time for the developer typically 10-15 mins

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Application of developer on face side

INSPECTION

The defects are identified and marked by indicator.

On the face side weld our specimen we found porosity, lack of penetration, excess penetration.

Defects on face side

POST CLEANING

The specimen should be clean to remove all developer after it has been evaluated

Post cleaning on face side

The same process of investigation is performed on root side of the specimen.

Dye penetratin on root side

Pre cleaning root side

Application of penetrant on root side

Application of developer on root side

Inspection of weld on root side

HARDNESS TEST

Hardness tends to the block of material surface to scratched spot,scratching

Rockwell hardness testing machine

S.No	Weld metal zone	HAZ zone	Base metal
1	69	68.2	65
2	71	71.1	70.8
3	63	51	61

Table. Hardness test of incomplete fusion

- **TENSILE TESTING**

Tensile test machine is the most commonly knows as universal testing machines and it is also knows as test machine which is specially used to evaluate the tensile strength of specimens.

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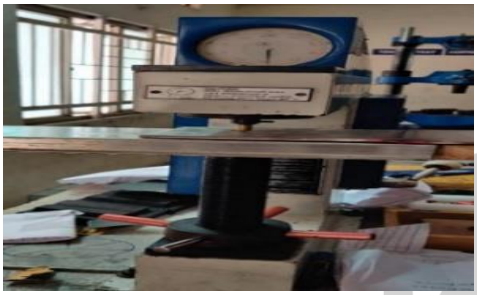
Universal testing machine(UTM)

Specimen after breaking

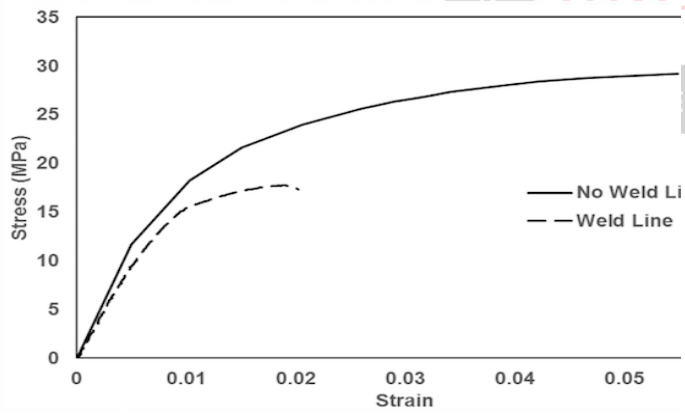


Rockwell hardness testing machine

Length	Thickness	Load	Deflection	Elongation	Tensile
190mm	6mm	26kN	10mm	195mm	29.7N\mm

Table Tensile test values of mild steel plates.

IV. GRAPH



V. CONCLUSIONS

In this mild steel were joined using shield metal arc welding with E6013 electrode.E6013 electrode is not suitable for joining mild steel plates byusing shield metal arc welding because we have seen defects like porosity, spatter and lack of penetration on weld joint. The tensile strength and bending test and liquid penetration test were investigated. The ultimate tensile strength of dissimilar metal weld joint is weak as per report

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