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Evaluation of Mechanical Properties in Reverse and Straight Polarity in Arc Welding

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ABSTRACT:This research paper is about effect of different polarities on weldment properties . Arc welding is one type of fusion welding process where base metals are fused by applying heat in order to form coalescence. Required heat is supplied by an electric arc constituted between positive and negative terminals of an electric circuit inbuilt with a power source. For welding purpose work metal is made one terminal and the electrode is made another, and thus arc constitutes in between them in the external circuit.
We evaluated the mechanical properties of the material by conducting various tests such as tensile test on the Universal testing machine, hardness test on the hardness test machine and penetration test. After conducting the tests we found that with Reverse polarity circuit the values are as follows 43 for rockwell hardness and 0.166KN/mm^2 of ultimate tensile strength and with straight polarity circuit the values are as follows 40 for rockwell hardness and 0.15KN/mm^2 of ultimate tensile strength and from the values we conclude that the hardness and ultimate strenght of material joined by Reverse polarity circuit is greater than the material joined by straight polarity.
KEYWORDS: Arc welding, Mechanical properties, Straight Polarity Electrode, Reverse polarity.

I. INTRODUCTION

"Straight" and "reverse" polarity are terms common for "electrode-positive" and "electrode-negative" polarity. Electrode-positive (reverse) polarity welding currents make deeper penetration. Electrode-negative (straight) polarity provides a faster deposition rate and melt-off. The weld can also be affected by different shielding gases.

AC means alternating current, and DC means direct current. AC changes the direction of its flow, and DC has only one direction. So DC welding machines and electrodes have constant polarity, while AC machines have changed polarity, 120 times per second with the current of 60 hertz.

DC is used widely in shielded metal arc welding (SMAW) as it has multiple benefits. While welding with DC, you get a more stable and smoother arc, can strike it more easily and have less spatter and fewer outages. Also, overhead and vertical up welding is less complicated. However, AC is a better choice for beginners, students, for example, as it is usually used with entry-level low-cost machines. AC is also commonly used in shipbuilding welding and other conditions where the arc can blow from one side to another.

II. LITERATURE SURVEY

[01].Effect of Welding Polarity on Mechanical Properties of Submerged Arc Welded Railway Vehicle Wheels

when a railway vehicle moves on a curved rail, sliding contact between the rail head side and wheel flange causes wear on the wheel flange. Traditionally, a wheel with thinned flange is machined to get a minimum flange thickness specified for structural safety. This operation reduces the rim thickness and shortens the life of the wheel. In the present study, the thinned flanges were hard-faced by submerged arc welding. A welding wire, which has good weldability to the base material of the wheel and does not generate thermal cracking, was developed. The effects of welding polarity on the microstructure, hardness, friction coefficient, and wear characteristics of the welded wheel were studied. The hardness of the wheel welded with reverse polarity was similar to that of welded with straight polarity. The wear rates of the wheel disc welded with reverse polarity and its counterpart rail disc were 11% and 27% lower than those welded with straight polarity. Delamination wear due to subsurface crack propagation and

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oxidation wear were mixed. The hardness of the rail before the wear test was in the range of 250–300 HV. After the wear test, it soared to 500 HV.[1]

[02].Author view on Welding Polarity Effects on Weld Spatters and Bead Geometry of Hyperbaric Dry GMAW

Weldingpolarity has influence on welding stability to some extent, but the specific relationship between welding polarity and weld quality has not been found, especially under the hyperbaric environment. Based on a hyperbaric dry welding experiment system, gas metal arc welding(GMAW) experiments with direct current electrode positive(DCEP) and direct current electrode negative(DCEN) operations are carried out under the ambient pressures of 0.1 MPa, 0.4 MPa, 0.7 MPa and 1.0 MPa to find the influence rule of different welding polarities on welding spatters and weld bead geometry. The effects of welding polarities on the weld bead geometry such as the reinforcement, the weld width and the penetration are discussed. The experimental results show that the welding spatters gradually grow in quantity and size for GMAW with DCEP, while GMAW with DCEN can produce fewer spatters comparatively with the increase of the ambient pressure. Compared with DCEP, the welding current and arc voltage waveforms for DCEN is more stable and the distribution of welding current probability density for DCEN is more concentrated under the hyperbaric environment. When the ambient pressure is increased from 0.1 MPa to 1.0 MPa, the effects of welding polarities on the reinforcement, the weld width and the penetration are as follows: an increase of 0.8 mm for the weld reinforcement is produced by GMAW with DCEN and 1.3 mm by GMAW with DCEP, a decrease of 7.2 mm for the weld width is produced by DCEN and 6.1 mm by DCEP; and an increase of 3.9 mm for the penetration is produced by DCEN and 1.9 mm by DCEP. The proposed research indicates that the desirable stability in the welding procedure can be achieved by GMAW with DCEN operation under the hyperbaric environment.[2]

III. EXPERIMENTATION

Tests performed to Evaluate the properties of welding:

1.Liquid penetration test
2.Hardness Test (Rockwell Hardness Test)
3.Tensile Strength Test (UTM)

Liquid Penetration Test :

- As shown in the figure,in a first step the object to be inspected must be cleaned thoroughly
- After thorough cleaning of the surface a red liquid (dye penetrant) is dispersed on the inspection area. Due to capillary action the liquid penetrates into existing cracks
- After a penetration time of approximately 10 minutes the surface is carefully cleaned again. The penetrant must remain in the cracks
- Then a white developer is sprayed as a thin film on the surface which “sucks” the penetrant out of the crack . This usually takes approx.10 minutes again.
- Due to the high contrast between the red penetrant and the white developer, cracks are clearly indicated.
- The three chemicals (red dye penetrant, cleaner and developer) form one test system

Hardness Test (Rockwell Hardness Test) :

Hardness is a characteristic of a material, not a fundamental physical property. It is defined as the resistance to indentation, and it is determined by measuring the permanent depth of the indentation.

Hardness testing as shown in the figure is a non-destructive test method that involves applying a constant load via a rounded or pointed object, under controlled conditions, to create an indentation in a metal surface. This is then measured to determine the hardness of the material.

Hardness test conducting on Hardness testing machine

Tensile Strength Test :

A tensile test applies tensile (pulling) force to a material and measures the specimen'sresponse to the stress. By doing this, tensile tests determine how strong a material is and how much it can elongate. Tensile tests are typically conducted on electromechanical or universal testing machines, are simple to perform, and are fully standardized.

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Specimen before conducting tensile test

Specimen after conducting tensile test

IV. OBESERVATIONS FROM THE TESTS CONDUCTED

Straight polarity

In straight polarity, the electrode is having a negative terminal while the workpiece is connected to the positive terminal of the direct current power source. So the electrons move from electrode to workpiece with high velocity.

4.1.1 Penetration Testing

In penetration test the weld material is applied with the penetrant which expose the internal defects in the weld joint.

In the below fig we absorbs some defects on the weld joint after applying the developer through which red penetrant shows the defect.The defects we observed in the weld joint made by straight polarity arc welding are :

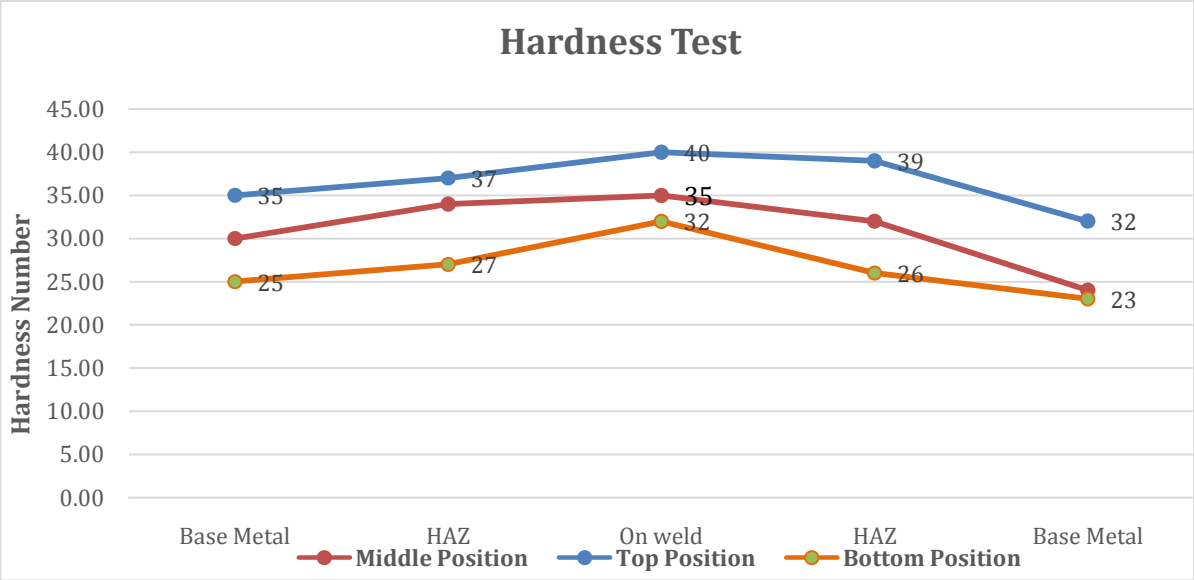
1.Improper penetration
2.Undercut
3.Spatter

Hardness Test

Hardness Test is carried on Rockwell Hardness testing machine in which a diamond point indentor is indented on the workpiece with 60kgf load.

The results are as follows:

SL.NO	BASE METAL	HEAT AFFECTED ZONE	ON WELD ZONE	HEAT AFFECTED ZONE	BASE METAL
1	35	37	40	39	32
2	30	34	35	32	24
3	25	27	32	26	23



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Tensile Test

Tensile Test is carried on Universal Testing Machine to find out the tensile strength , Elastic Modulus, Strain and Poison's Ratio

Observation Table:

	GAUGE LENGTH(mm)	WIDTH(mm)	THICKNESS(mm)
BEFORE TEST	186	50	6
AFTER TEST	210	47	5

Tensile test calculations:

Tensile Test is carried on Universal Testing Machine to find out the tensile strength , Elastic Modulus, Strain and Poison's Ratio

S.NO	LOAD (P) KN	AREA (A) mm^2	CHANGE IN GAUGE LENGTH (ΔL) mm	STRESS(Σ) KN/mm^2	STRAIN (€)	YOUNG'S MODULUS (E) KN/mm^2	POISON'S RATIO (μ)
1.	50	300	24	0.15	0.098	1.53	0.24

Load vs Elongation

S.NO	LOAD (KN)	ELONGATION (mm)
1.	0	0
2.	5	3
3.	10	5
4.	15	7
5.	20	9
6.	25	12
7.	30	15
8.	35	18
9.	40	21
10.	45	23
11.	50	25

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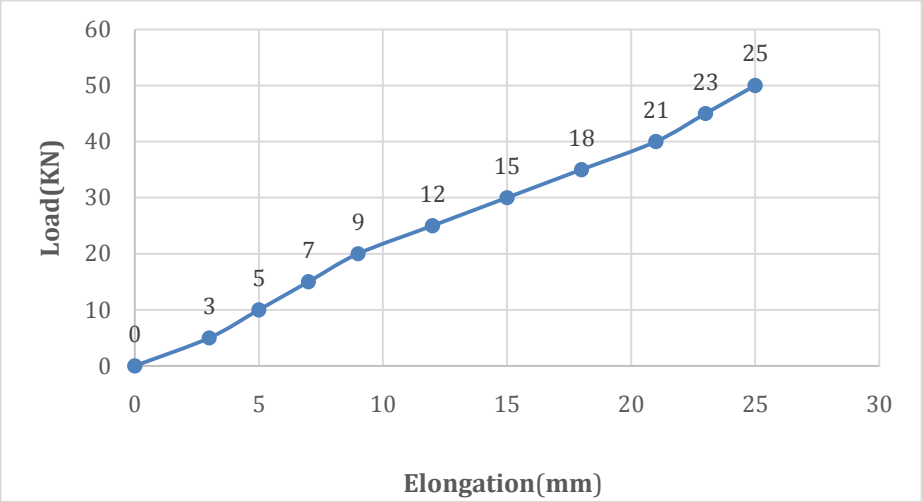
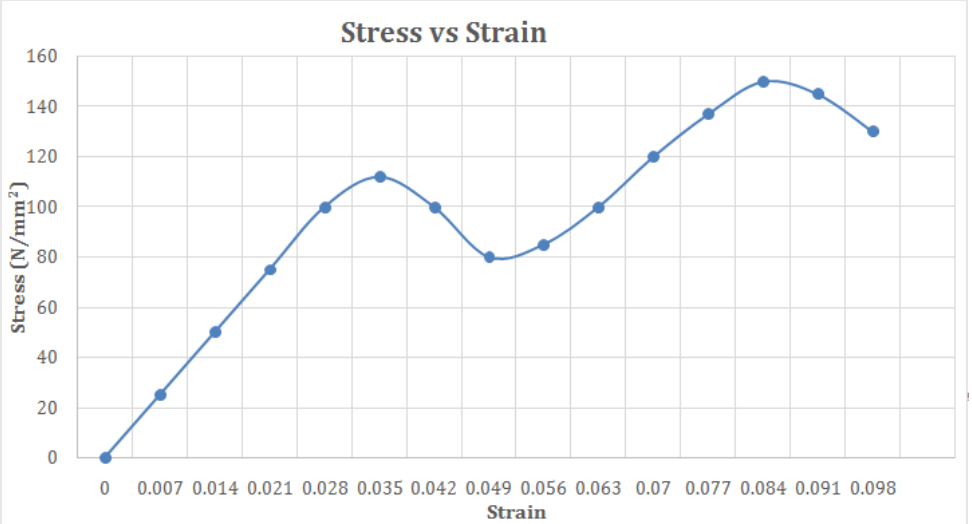


Graph load vs Elongation

Strain vs strain:

S.NO	STRAIN	STRESS(N/mm²)
1	0	0
2	0.007	25
3	0.014	50
4	0.021	75
5	0.028	100
6	0.035	120
7	0.042	100
8	0.049	90
9	0.056	98
10	0.063	114
11	0.070	130
12	0.077	150
13	0.084	166
14	0.091	155
15	0.135	140



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Reverse polarity

In Reverse polarity, the electrode is having a positive terminal while the workpiece is connected to the negative terminal of the direct current power source. The electrons switch directions and go from the base plate to the electrode. Consequently, more heat generates at the base plate as compared with the straight polarity.

Penetration Testing

In penetration test the weld material is applied with the penetrant which expose the internal defects in the weld joint.

we observe some defects on the weld joint after applying the developer through which red penetrant shows the defect.

The defects we observed in the weld joint made by straight polarity arc welding are :

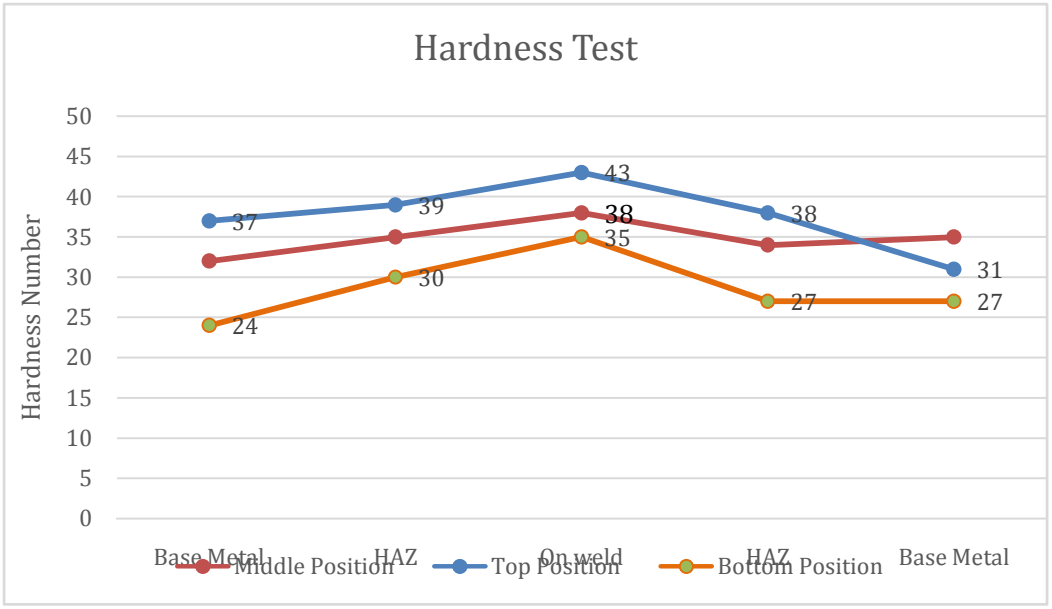
1.Improper penetration

2.Undercut

Hardness Test

Hardness Test is carried on Rockwell Hardness testing machine in which a diamond point indentor is indented on the workpiece with 60kgf load.

S.NO	BASE METAL	HEAT AFFECTED ZONE	ON WELD ZONE	HEAT AFFECTED ZONE	BASE METAL
1.	37	39	43	38	31
2.	32	35	38	34	35
3.	24	30	35	27	27



Tensile Test:

Tensile Test is carried on Universal Testing Machine to find out the tensile strength , Elastic Modulus, Strain and Poison's Ratio..

	GAUGE LENGTH (mm)	WIDTH (mm)	THICKNESS (mm)
BEFORE TEST	185	50	6
AFTER TEST	210	48	5

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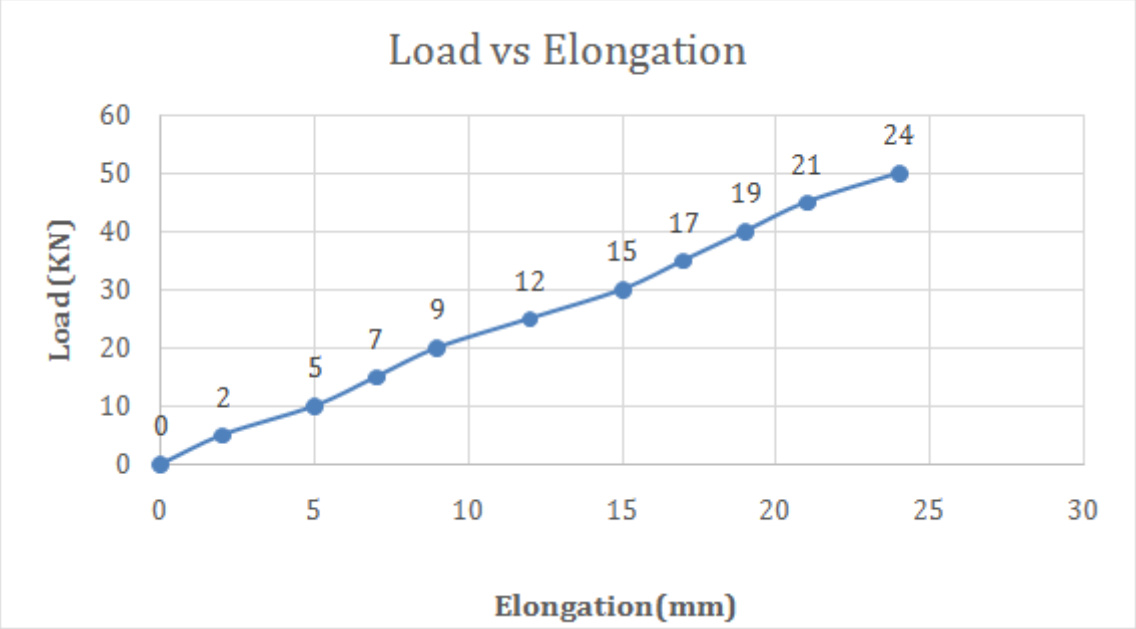
S.NO	LOAD (P) KN	AREA (A) MM²	CHANGE IN GAUGE LENGTH (ΔL) mmm	STRESS (Σ) KN/mm²	STRAIN (€)	YOUNG' MODULUS (E) KN/mm²	POISON'S RATIO (μ)
1.	50	300	25	0.166	0.135	1.22	0.27

S.NO	LOAD (KN)	ELONGATION (mm)
1.	0	0
2.	5	2
3.	10	5
4.	15	8
5.	20	10
6.	25	13
7.	30	15
8.	35	17
9.	40	20
10.	45	22
11.	50	24

Load vs Elongation:



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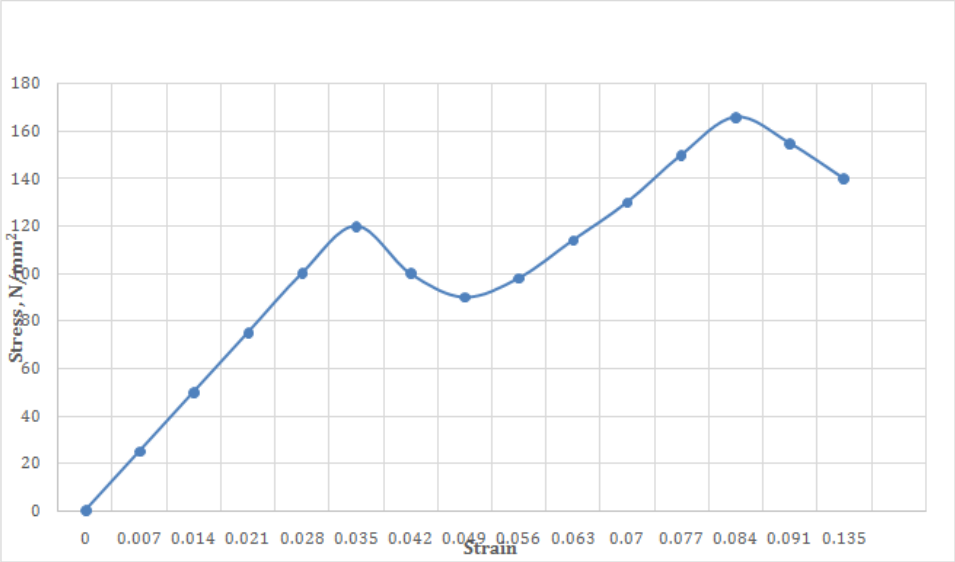
S.NO	STRAIN	STRESS (KN/MM^2)
1.	0	0
2.	0.007	25
3.	0.014	50
4.	0.021	75
5.	0.028	100
6.	0.035	112
7.	0.042	100
8.	0.049	80
9.	0.056	85
10.	0.063	100
11.	0.07	120
12.	0.077	137
13.	0.084	150
14.	0.091	145
15.	0.098	130



Comparison between mechanical properties of material for Straight polarity and Reversepolarity

S.NO	STRAIGHT POLARITY	REVERSE POLARITY
1.	HARDNESS VALUE 40	HARDNESS VALUE 43

2.	ULTIMATE TENSILE STRENGTH 0.15KN/MM^2	ULTIMATE TENSILE STRENGTH 0.166KN/MM^2
3.	POISSON'S RATIO 0.24	POISSON'S RATIO 0.27
4.	STRAIN 0.098	STRAIN 0.136
5.	YOUNG'S MODULUS 1.5KN/MM^2	YOUNG'S MODULUS 1.22KN/MM^2

V. CONCLUSION

After evaluation of mechanical properties in Straight polarity and Reverse Polarity in Arc welding it is concluded that materials that are joined with revese polarity Arc welding process has greater hardness than the materials that are joined with straight polarity Arc welding process and the ultimate tensile strength of material joined with the reverse polarity is greater than the material joined with the straight polarity arc welding process.

REFERENCES

[1]. Goo, B.C.; Lee, Y.J. Railway vehicle wheel restoration by submerged arc welding and its characterization. Science 2020, 2, 33.

[2]. Aloraier, A., Al-fadhalah, K., Paradowska, A. et al. Effect of welding polarity on bead geometry, microstructure, microhardness, and residual stresses of 1020 steel. J Schechter, M.; and Levin, M., 1998, "Camless Engine," SAE Paper No. 960581