EFFECT OF WELD ANGLES ON BUTT WELD JOINT STRENGTH

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Abstract—
The pipe welding failures are majority in process industries. While working the weld can repair or making new weld. We will study the V-groove geometry and finding out one geometry. The V-groove geometries we will make different models on pipe varying included angle from 45^0,50^0,55^0,60^0. Currently the V-geometry included angle using up to 45^0, but from studying the Indian Welding Journal, Indian Welding Society it is observed that if included angle increased up to 60^0 angular distortion decreases. This concept were using for regular V-groove but in this project using the V-groove with slotted portion at middle site of geometry. Because from studying different papers it is compared between different V-groove geometry that is new weld ,aged weld, full repair, partial repair-I, partial repair-II. So from these geometry selecting the partial repair-I that is V-groove with slotted portion at middle site of geometry. Because this is gives more strength as well as life time. But this is only for 45^0 angle and for only V-groove not more than that. In this project will finding for 45^0,50^0,55^0,60^0. The tensile test has conducted to check that maximum tensile force sustain capacity. Also to check the welding quality and other parameters conducting the ultrasonic test as well as magnetic particle inspection test. To know the life time then calculating life time by conducting fatigue test. For all these tests make the four specimens for each test. From all these tests it is observed that tensile strength increased up to 76.64% for 60^0 angle as compared to 450 angle. Also fatigue life strength increased up to 46.15% for 60^0 angle as compared to 45^0 angle. No any defect found in the weld area that is welding quality is very good. So 60^0 angle is better than 45^0 angle.

Keywords— Strength, fatigue life, welding V-groove included angle, Bending, Welding positions.

I. INTRODUCTION

The life time of a welded joint depends on a number of parameters. These may vary widely and lead to reduction of the creep life. In the present study the creep process in a welded joint in order to study the effect of (i) the material properties in the weld metal and the heat affected zone (HAZ) as well as (ii) the load on life.

The different geometries are used for weld repair as well as new weld. This is selecting from them having more life time. Then, we will go to change the angle to 60^0 and experiment the results.

Failure of weld joints majority due to the crack generation in heat affected zone (HAZ). Now, study is done on up to angle 45^0 not more than in terms of strength basis. Still there is failure of weld. [1]

From studied, that in doing this project Cracks- Arc strike cracking, Cold cracking, Hot cracking, Longitudinal crack, Reheat cracking, Root and toe cracks, Transverse crack, Distortion, Inclusions, Lack of fusion and incomplete penetration these types of cracks are observed.[2]

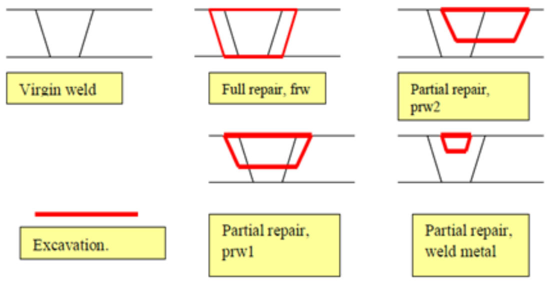

Figure 1: Typical excavations used in weld repair, (PowerGen plc, Innogy plc, British Energy plc.) [3]

The results obtained have clearly shown the significant increase of the total life, as the end load increases, particularly when the time to repair is close to the failure life of the original weld. Note, however, that at this stage, assessment of the homogeneous component needs to be considered. Therefore partial-I geometry is selected. [4]

II. OBJECTIVE OF PROJECT

The purpose of this work is to study the different V-groove geometry used in the pipe welding. To increases the life of weld.

Following are the objectives of the project work,

1) To study the effect of included angle in V-groove geometry, on pipe welding.
2) To find out the behavior of the different included angle in V-groove geometry, in terms of tensile strength.
3) To find out the life cycles of the different included angle in V-groove geometry.
4) To verify that, as included angle increases the strength also increases and life cycles also increases.

   To suggest the best suitable geometry and included angle in V-groove, particular in pipe welding application.

III. TESTING PROCEDURE AND RESULTS

A. Specimen Preparation for Tensile Testing-

i) Tensile Requirements for the Steel

Longitudinal tension test specimens taken from the steel shall conform to the requirements as to tensile properties. At the manufacture's option, the tension test specimen for sizes 8 5/8 in. (219.1 mm) in outside diameter and larger may be taken transversely.[5]

ii)Production Test Specimens and Methods of Testing

(1) The test specimens and the tests required by these specifications shall conform to those described in Test Methods and Definitions A 370.

(2) The longitudinal tension tests specimens of the steel shall be taken from the end of the pipe in accordance with Figure 2, or by agreement between the purchaser and the manufacturer, or may be taken from the pipe or plate, at a point which will be approximately 900 of arc from the weld in the finished pipe.

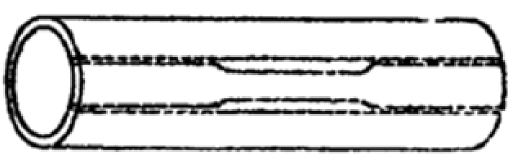

Figure 2: Location from Which Longitudinal Tension Test Specimens are to be cut from large diameter pipes

(3) If the tension test specimen is taken transversely, the specimen shall be taken in accordance with Figure 3.

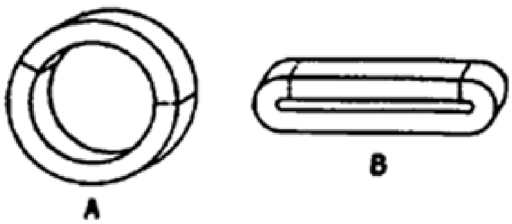

Figure 3: Location of Transverse Tension Test Specimen in Ring Cut from Tubular Steel Products

(4) The specimens for the reduced –section tension test of production welds shall be taken perpendicularly across the weld at the end of the pipe. The test specimens shall be straightened and tested at room temperature.

(5) Reduced-section tension test specimens shall be prepared in accordance with Figure 4. [5]

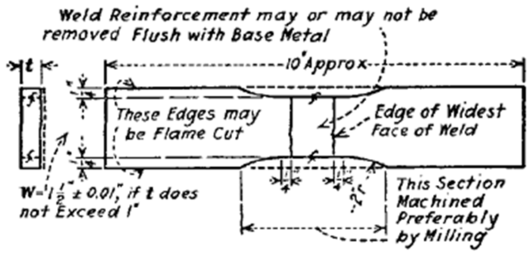

Figure 4: Reduced-Section Tension Test Specimen

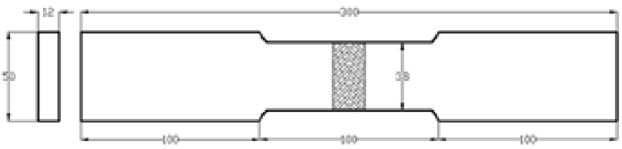

Figure 5: Tensile Test Specimen (As per ASTM Vol. XI)

B. Specimen Preparation for Fatigue Testing-

A method for determining the behavior of materials under fluctuating loads. A specified mean load (which may be zero) and an alternating load are applied to a specimen and the number of cycles required to produce failure (fatigue life) is recorded. Generally, the test is repeated with identical specimens and various fluctuating loads. Loads may be applied axially, in torsion, or in flexure. Depending on amplitude of the mean and cyclic load, net stress in the specimen may be in one direction through the loading cycle, or may reverse direction. Data from fatigue testing often are presented in an S-N diagram which is a plot of the number of cycles required to cause failure in a specimen against the amplitude of the cyclical stress developed. The cyclical stress represented may be stress amplitude, maximum stress or minimum stress. Each curve in the diagram represents a constant mean stress. Most fatigue tests are conducted in flexure, rotating beam, or vibratory type machines. Fatigue testing is generally discussed in "Manual on Fatigue Testing," ASTM STP 91-A, and "Mechanical Testing of Materials," A.J. Fenner, Philosophical Library, Inc. ASTM D-671 details a standard procedure for fatigue testing of plastics in flexure.

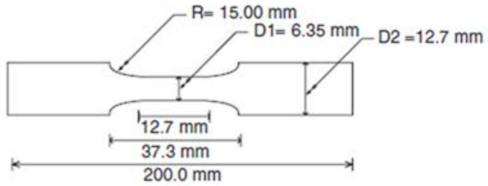

Figure 6: Specimen for cyclic loading [6]

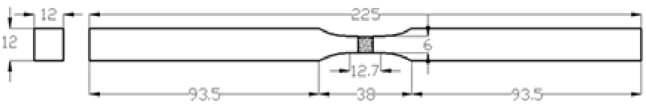

Figure 7: Fatigue Test Specimen (As per E606-92)

C. Tensile Testing- Procedure

i) Determine the mean diameter of the nominal 0.505 inch specimen & record.

ii) Mark a 2-inch gage length on the specimen using the gage punch & hammer.

iii) Insert the specimen in the Universal Testing Machine (UTM) and attach the extensometer. Carefully follow the manufacturer's directions for attachment of the extensometer. Select a load range for the UTM that will accommodate the maximum anticipated load during the test.

iv) Apply the load slowly, obtaining simultaneous readings of load from the UTM and elongation from the extensometer. When the extensometer nears its range, remove. Then continue monitoring the elongation of the specimen using the mechanical dividers and machinist scale in 0.05 inch increment until fracture occurs. Attempt to obtain the load at fracture.

iv) After failure, fit the broken halves together and measure the final "gage" length, and the smallest diameter.

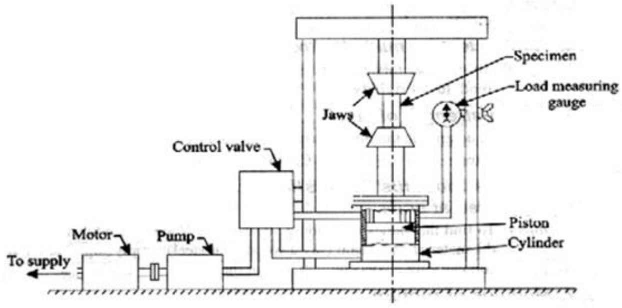

Figure 8: Schematic diagram of experimental Setup for Tensile test

D. Fatigue Testing- Procedure

i) First attaching the first specimen (K-0) into the holder properly at the center of the machine.

ii) Attaching the 8 kg weight at the lever which is at the bottom side of the machine.

iii) Then starting the motor and measuring the cycles through counter. Measuring up to the failure of specimens.

iv) Same procedure is repeated for remaining specimens (K-1), (K-2), (K-3).

Figure 9: Process Setup for Fatigue Test, Civil Engineering Lab, Pravara Rural Engineering College, Loni.

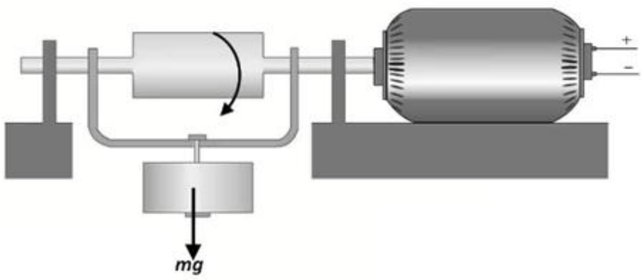

Figure 10: Schematic diagram of experimental setup of Fatigue test machine

Table 1: Specimens dimensions

Sample No.	Included angle (θ/2)	Included angle (θ/2)	Total Included angle (θ) degree	Slot (S) mm	Height (h1) mm	Height (h2) mm
1 (K-0)	22.5	22.5	45^0	2	5	5
2 (K-1)	25	25	50^0	2	5	5
3 (K-2)	27.5	27.5	55^0	2	5	5
4 (K-3)	30	30	60^0	2	5	5

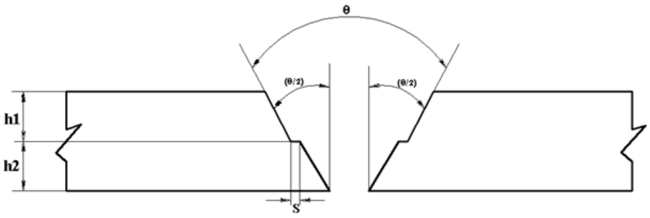

Figure 11: Geometry dimensions as per standard of ASTM

E. Results-Comparison of results after tensile test for true area

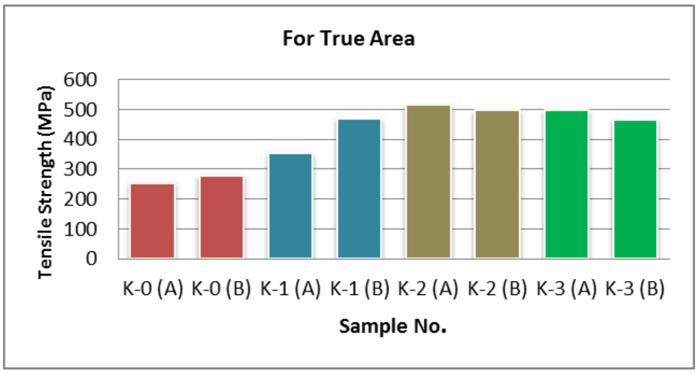

Figure 12 Shows the Tensile strength for True area

From experimental results, it is observed that, the tensile strength for true area has been increased as included angle increases. The optimum strength for sample K-2(A) i.e. for 55^0 angle. The strength for 60^0 angle obtained less as compared to 55^0; due to variation in area while cutting the specimen, therefore there are changes in the strength. Also it is observed that maximum specimen were break in weld area.

F. Results-Comparison of results after tensile test for engineering area

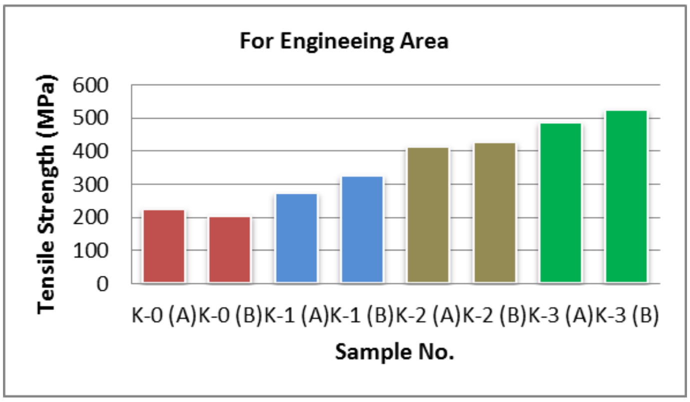

Figure 13 Shows the Tensile strength for Engineering area

From the above experiments it is observed that,

1. The strength for specimens of included angle 45^0, 50^0, 55^0 and 60^0 in increasing continuously, as angle increases strength will be increases.
2. The tensile strength has increased by 34.08% for 50^0 included angle as compared to 45^0 included angle.
3. The tensile strength has increased by 49.75% for 55^0 included angle as compared to 50^0 included angle.
4. The tensile strength has increased by 17.95% for 60^0 included angle as compared to 55^0 included angle.
5. The tensile strength has increased by 136.86% for 60^0 included angle as compared to 45^0 included angle.

G. Fatigue test results-

From the experimentation is found that, the fatigue life of specimens increased from 45^0 angle to 60^0 angle. Also it is conclude from fatigue result that, life time increases as included angle increases.

i. The life cycle has increased by 30.76% for 50^0 included angle as compared to 45^0 included angle.

ii. The life cycle has increased by 3.48% for 55^0 included angle as compared to 50^0 included angle.

iii. The life cycle has increased by 8% for 60^0 included angle as compared to 55^0 included angle.

iv. The life cycle has increased by 46.15% for 60^0 included angle as compared to 45^0 included angle.

v. Finally the life cycles of the welded pipes is also increased from 45^0 to 50^0, 50^0 to 55^0 and 55^0 to 60^0.

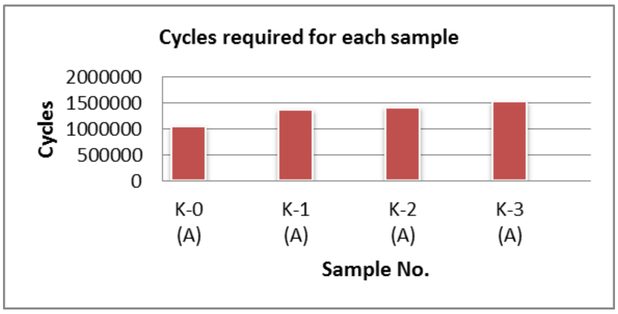

Figure 14 shows the cycle for each sample

IV. Conclusions

From the results of this present investigation and the discussion presented in the earlier chapters, the following conclusions are drawn.

i) ._The tensile strength has increased by 136.86% for 60^0 included angle as compared to 45^0 included angle.

ii) It is observed that, by changing included angle, there is not any the effect on bending of pipe.

iii) The electric arc welded specimens were properly weld, because no any defects found in ultrasonic and magnetic particle tests.

iv) The life cycles for specimens of included angle 45^0, 50^0, 55^0 and 60^0 in increasing continuously, as angle increases strength will be increases.

v) The life cycle has increased by 46.15% for 60^0 included angle as compared to 45^0 included angle.

vi) Finally the life cycles of the welded pipes is also increased from 45^0 to 50^0, 50^0 to 55^0 and 55^0 to 60^0.

Acknowledgment

And finally this day has come. I am presenting the paper with great pride. There are too much efforts of gardener to yield the beautiful flowers. So we should not forget him while praising flower. It is a matter of gratification for me to pay my respects and acknowledgements to all those who have imparted knowledge and helped me to complete my report.

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