STUDY AND ANALYSIS OF V- GROOVE PIPE WELDING JOINT

A. T. Indalkar[1], A. K. Biradar[2], S. R. Wankhede[3].

[1]*P. G. Student, Department of Mechanical Engineering, B. R. Harne. - Vangani, Maharashtra, India*
[2]*Assistant Prof. Department of Mechanical Engineering, B. R. Harne. - Vangani, Maharashtra, India*
[3]*Assistant Prof. Department of Mechanical Engineering, Y.T.I.E.T – Chandhai, Maharashtra, India*

ABSTRACT

Welding? It is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, so that bonding takes place at their original boundary surfaces. When two parts to be joined are melted together, heat or pressure or both is applied and with or without added metal for formation of metallic bond. With ever increasing demand for both high production rates and high precision, fully mechanized or automated welding processes have taken a prominent place in the welding field. The purpose of this work is to study the behaviour of the different included angle in V-groove geometry of pipe welding on the basis of tensile strength ,bend strength ,fatigue strength of weld joint.

Keyword: *V- Grove Joint, Crack Inspection Test, UTM Test etc.*

1. 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 degree and experiment the results. The temperature distribution is not uniform as the weldment is locally heated by the welding heat source and changes as welding progresses. During the welding cycle, complex strains occur in the weld metal and the base metal regions near the weld. The strains produced are accompanied by plastic upsetting. As a result, residual stresses remain after welding is completed, and shrinkage and distortion are also produced. Correcting unacceptable weld distortion is extremely costly and in some cases impossible. In addition, excessive shrinkage and distortion causes mismatch of joints thus increasing the possibility of welding defects. Excessive lateral distortion decreases buckling strength of structural members that are subjected to compressive loading. Submerged Arc Welding is a widely used fabrication process in industry due to its inherent advantages such as high deposition rate, smooth and uniform weld finish with no spatter, high weld metal quality and high welding speed. In arc welding processes, due to rapid heating and cooling, the work piece undergoes an uneven expansion and contraction in all the directions. This leads to distortion in different directions of the work piece and non-uniform transverse shrinkage along the depth of the plates welded. Angular distortion or out-of-plane distortion is one such defect that makes the work piece distort in angular directions around the weld interface [1].

Conventional design methodologies either ignore or use empirical techniques to evaluate the effects of welding on the structural integrity and dimensional control of welded structures. To efficiently assess the effects of welding on structural performance and effectively implement various mitigation techniques to control or counteract welding distortion, a methodology for predicting the distortion due to welding is necessary. Distortions induced by welding have been regarded as a critical issue in terms of performance, quality, and productivity. Many techniques have been developed to minimize the distortions induced by welding, such as external restraining, preheating, auxiliary side heating, heat sinking, and others.

2. LITERATURE REVIEW

This section covers the literature review for welding failure and its parametric study carried out by other researchers in the same field. This study can be helpful for improving the weld strength, also reduced in cost of weld failure.

Mahendramani et. al. [1] studied on angular distortion for various included angle 0º,30º,45º,60º degrees. The results obtained by experimental investigation will be of great useful to the designers to account for the angular distortion taking place during fabrication of various plates.

Hyde et. al. [2] studied some typical results obtained from finite element (F.E.) creep and continuum damage mechanics analyses for assessing weld repair performance. Results presented cover a range of analyses, taking account of the effects of repair profiles/ dimensions, geometry change during creep end (system) bading reheating effects in the weld metal of partial repair welds and initial damage level etc.

Sattari-Far et. al. [3] study the effect of the weld groove shape and pass number on residual stresses in butt-welded pipes. They study for 6mm and 10mm thickness pipe with V-groove dimensions are, angle 60º, thickness 10 mm and width 2mm.

Ren et. al. [4] studied the constraining effects of the weld and heat-affected zone (HAZ) material in welded tube numerical control (NC) bending process are key problem to be solved in the research, development and application of thin-walled welded tubes.

Oh et. al. [5] studied for bottom nozzle failure mechanism of water reactor pressure vessel (R.P.V.) under severe accident conditions and concluding that crack, like separations were revealed at the nozzle weld metal to R.P.V. interfaces indicating the importance of normal stress component rather than the shear stress in the creep rupture.

Shibli et. al. [6] studied for some characteristics of weld repair for creep applications. High temperature plant will be subject to creep and dependent on the operating regime and economic arguments, some stress and temperature cycling.

Hyde et. al. [7] studied the material properties used for the various zones of new, service- aged and repaired welds, were produced from creep test data at 640ºC. Damage distribution and accumulation with time within the HAZ were presented, from which the crack initiation times and position for these welds, under a closed-end condition and with additional axial (system) loading, were identified.

Nikbin [8] studied the effects of residual stress, the development and crack tip damage due to weldments cracking in fracture mechanics specimens at elevated temperatures. Authors concluded that there is lack of verifiable and reliable fracture mechanics properties data on weldment testing and analysis and the difficulties faced in the correct modeling and measurement of residual stress in weldment.

Seliger et. al. [9] studied the smooth and notched hollow cylinders for laboratory component tests for stress hypothesis, stresses in weld etc. Authors results out that, traditional creep expansion measurement using special “warts” or “pipes” at the outer surface for measurement of diameter or circumference, is the most cost effective method and its use is restricted to components like pipes and headers.

Hyde et. al. [10] studied finite element creep and damage analysis were performed for a series of new, service-aged, fully repaired and partially repaired circumferential welds in CrMoV main steam pipes under an internal pressure and a uniform axial stress, using simplified ax symmetric models.

Hyde et. al. [11] studied for aged weld with damage, full repair, partial repair-I and partial repair-II and by using Kacanov type creep damage law calculating stress and strain values. By using FE modeling concluding that, for realistic repair in similar welds, all damage regions should be excavated and for highest integrity repairs, full or partial-I repairs would exhibit better performance than the partial-II excavation design. These calculations are generally supported by current plant practices.

3.EXPERIMENTAL PROCEDURE:

3.1. Process Setup for Tensile Test:

The specimen is placed in the machine between the grips and an extensometer if required can automatically record the change in gauge length during the test. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held. However, this method not only records the change in length of the specimen but also all other extending / elastic components of the testing machine and its drive systems including any slipping of the specimen in the grips.

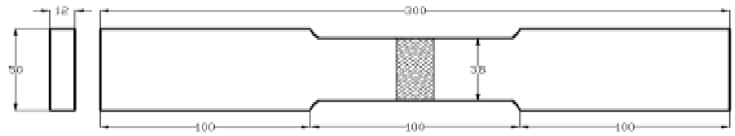

Fig 1. Tensile Test Specimen (As per ASTM Vol. XI)

Fig 2. Process Setup for Tensile Test

4. RESULTS AND DISCUSSION:

Tensile test was conducted in in "Shanmukha Laboratories"; the results are in the following form. From experimental data, for load Vs displacement graph, it shows that, at initial stage 2000N load applied on specimen(k-0) that time no displacement found in the specimen. As specimen material is mild steel the relation between load and displacement is proportional up to 45000 N loads. But after that due to ductile property of material there were no any large changes in displacement and at 30000 N it fails. similarly tensile test was conducted for specimen k-0,k-1,k-2,k-3 at 0º and 90º. Results are listed below-

4.1 Tensile Test of Sample No-1 (K-0) for 0º

Tensile Test Specimen at 0º		
Maximum Force	Tensile Strength	Failure Point
45,000 N	256.123 MPa	Break at Base Metal

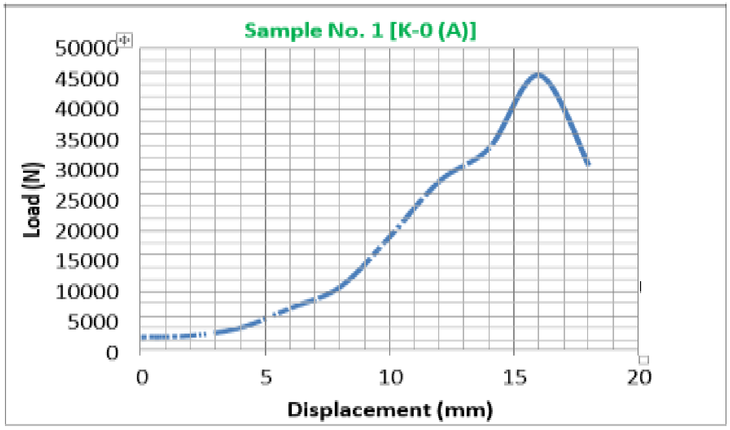

Fig. 3. Load Vs Displacement for sample No. 1 [K-0 (A)]

4.2 Tensile Test of Sample No-1 (K-0) for 90º

Tensile Test Specimen at 90º		
Maximum Force	Tensile Strength	Failure Point
41,100 N	280.639 MPa	Break at Base Metal

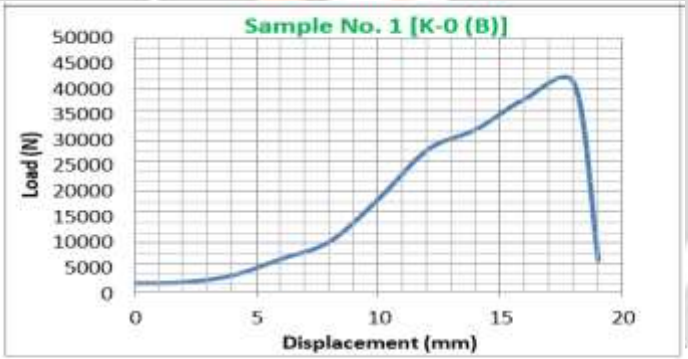

Fig. 4 . Load Vs Displacement for sample No. 1 [K-0 (B)]

4.3 Tensile Test of Sample No-2 (K-1) for 0º

Tensile Test Specimen at 0º		
Maximum Force	Tensile Strength	Failure Point
55,110 N	354.839 MPa	Break at weld

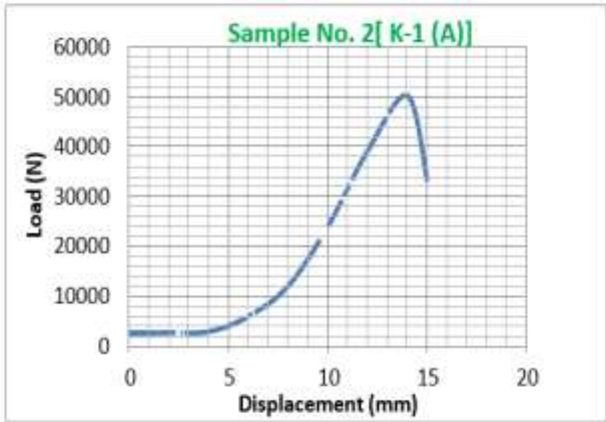

Fig. 5. Load Vs Displacement for sample No. 2 [K-1 (A)]

4.4 Tensile Test of Sample No-2 (K-1) for 90º

Tensile Test Specimen at 90º		
Maximum Force	Tensile Strength	Failure Point
65,280 N	468.495 MPa	Break at weld

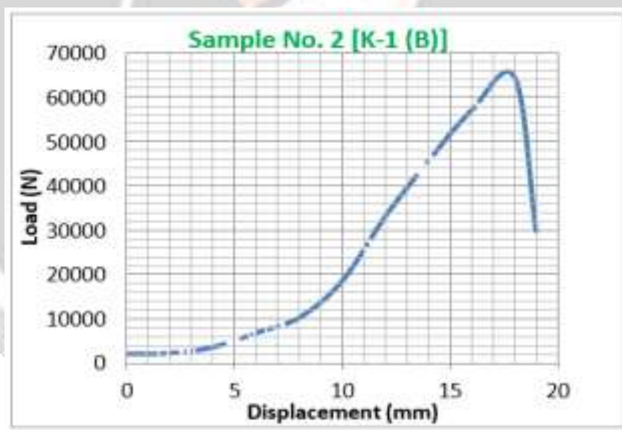

Fig. 6. Load Vs Displacement for sample No. 2 [K-1 (B)]

4.5 Tensile Test of Sample No-3 (K-2) for 0º

Tensile Test Specimen at 0º		
Maximum Force	Tensile Strength	Failure Point
86,120 N	495.560 MPa	Break at weld

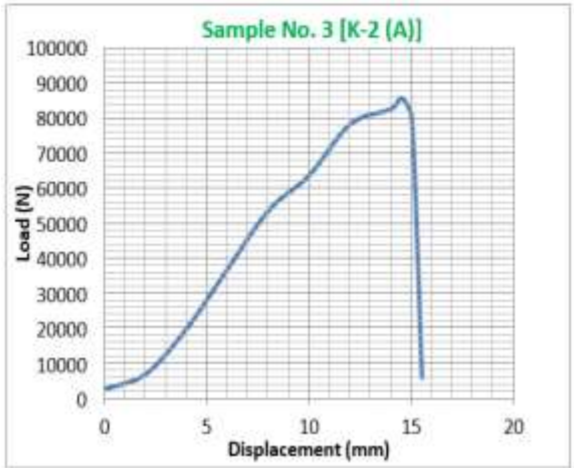

Fig. 7. Load Vs Displacement for sample No. 3 [K-2 (A)]

4.6 Tensile Test of Sample No-3 (K-2) for90º

Tensile Test Specimen at 90º		
Maximum Force	Tensile Strength	Failure Point
82,530 N	516.749 MPa	Break at weld

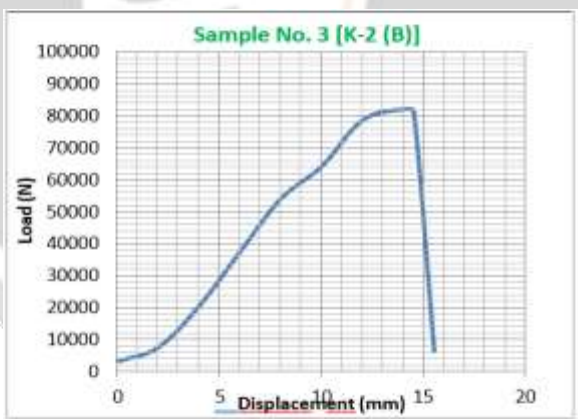

Fig. 8. Load Vs Displacement for sample No. 3 [K-2 (B)]

4.7 Tensile Test of Sample No-4 (K-3) for 0º

Tensile Test Specimen at 0º		
Maximum Force	Tensile Strength	Failure Point
1,05,330 N	464.489 MPa	Break at weld

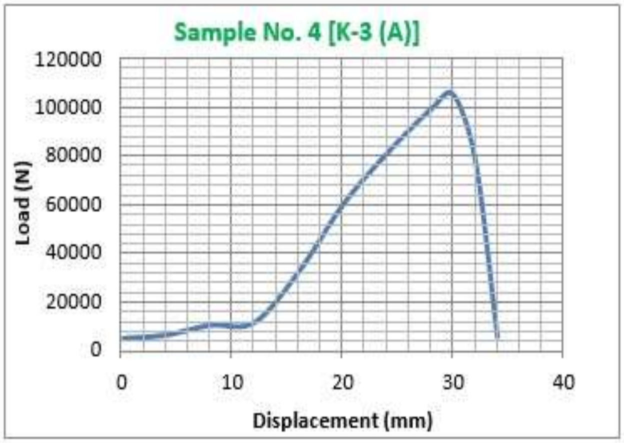

Fig. 9. Load Vs Displacement for sample No. 4 [K-3 (A)]

4.8 Tensile Test of Sample No-4 (K-3) for 90º

Tensile Test Specimen at 90º		
Maximum Force	Tensile Strength	Failure Point
97,350 N	496.524 MPa	Break at weld

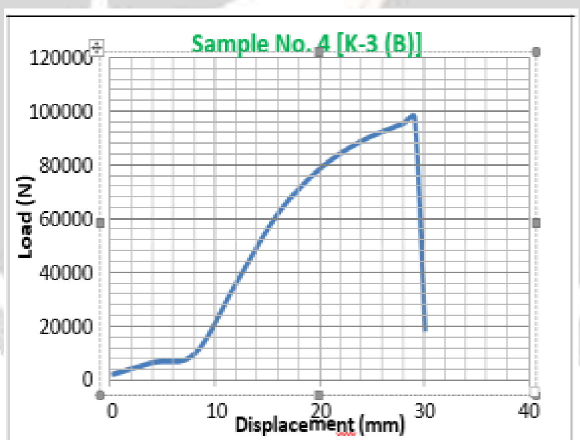

Fig. 10. Load Vs Displacement for sample No. 4 [K-3 (B)]

From experimental data, for load Vs displacement graph, it shows that, at initial stage 2000N load applied on specimen that time no displacement found in the specimen. As specimen material is mild steel the relation between load and displacement is proportional up to 97350 N loads. But after that due to ductile property of material there were no any large changes in displacement and at 19000 N it fails.

Table. 1. Comparison of results after tensile test for true area for all specimens

Sample No	Included Angle (Θ)	Number given to Specimen (for identification)		Specimen Cut from Pipe	Area of Specimen (mm^2)	Maximum Tensile Force (N)	Tensile Strength (MPa)	Break at
1	**45^0**	**K-0**	**(A)**	**At 0^0**	160.230	45,000	256.123	Base Metal
			(B)	**At 90^0**	160.150	41,100	280.639	Base Metal
2	**50^0**	**K-1**	**(A)**	**At 0^0**	155.310	55,110	354.839	Weld
			(B)	**At 90^0**	139.340	65,280	468.495	Weld
3	**55^0**	**K-2**	**(A)**	**At 0^0**	160.277	82,530	516.749	Weld
			(B)	**At 90^0**	159.710	85,616	498.154	Weld
4	**60^0**	**K-3**	**(A)**	**At 0^0**	226.766	97,350	496.524	Weld
			(B)	**At 90^0**	196.063	1,05,330	464.489	Weld

Remark: Satisfactory

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 55º angle. The strength for 60º angle obtained less as compared to 55º; 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.

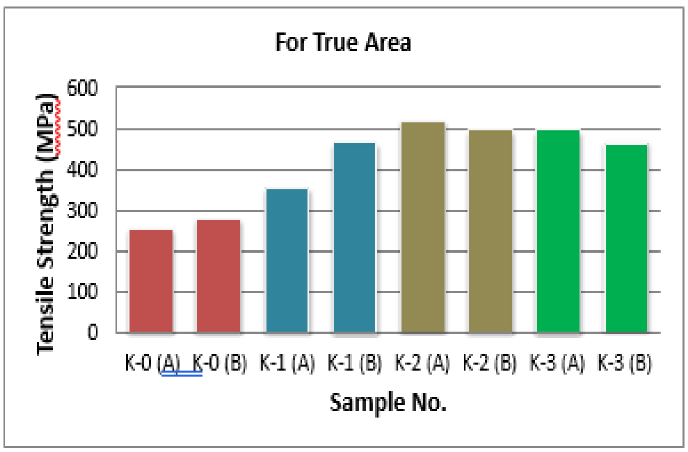

Fig. 11. Tensile Strength (MPa) Vs Sample No. for actual area

5. CONCLUSION:

From the results of this present investigation and the discussion presented in the earlier topics, the following conclusions is made. The tensile strength has increased by 136.86% for 60° included angle as compared to 45º included angle.

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