DISTORTION IN EN-8 PLATES HAVING DIFFERENT THICKNESS AND CROSS SECTIONS USING MANUAL ELECTRIC ARC WELDING

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Abstract - Welding is a process of joining two or more similar or dissimilar material with the application of heat with or without the application of filler material and pressure in which heat is supplied either electrically or by means of a gas torch. Welding is an important process for fabrication of engineering components.

It has vast applications in ship buildings, constructions, aerospace, automobile industries, etc. There are different welding defects due to which weldments fails under service conditions and cause damage to the property and loss of human lives. In this work we are going to study one of the most important welding defects known as Distortion. Distortion is the change in shape and variation between the positions of the two plates before welding and after welding. Distortion occurs due to good amount of temperature difference at different points along the joint and thus at any instant certain area of base metal expands and other including weld bead contract.

In this work we are going to study how much distortion occur in medium carbon steel that is EN-8 Plates of various cross-sections and thickness. This study is done by experiment and justify the result using ANOVA.

***Key Words*: Distortion, Mild Steel, EN-8, Butt Joint, Arc Welding & Single V Groove, ANOVA**

1. INTRODUCTION OF DISTORTION

The term distortion means deviation from desired or actual shape and size. In welding terminology distortion means the local residual deformation resulting from welding which changes the dimension and shape of the work-piece joined.

While doing welding when the welding operator used eye shield and electrode holder, commenced welding a job, starting and finishing at any place. After completion of the job if it was found distorted and it was taken for granted that it could not be avoided. The impression was all welding caused distortion. That why think of it.

This was purely ignorance, because distortion can be controlled and minimized by approaching the job holding in the correct manner.

At present era, welding can be done with minimum distortion. For example, different machines beds are being fabricated out of rolled steel sections and plates can be welded within a tolerance of 1 mm. The most important factors in the production of a successful and economical weldment or broken part repair is the minimization of distortion. Excessive distortion increase the job cost due to expense of rectification or may cause the job careless.

Thus welding deformation not only complicates the fabrication of welded structure but also minimize its fitness for the job for which it is designed. Moreover in welding causes locked up stress or residual stress in the weld zone which on one hand contributes to weld cracking and on the other size it is suspected to have an important effect on the brittle fracture of the welded structures. This may also reduce the load carrying capacity of the member. Hence the prediction of distortion and its thorough analysis is called for.

2. EXPERIMENTAL FRAMEWORK

Though studies of distortion have been carried out by so many authors, still there is general lack of experimental data on different types of distortion such as transverse and longitudinal, shrinkage, angular distortion, bowing particularly for butt weld (v-groove) joint. However angular distortion has been studied but effect of different welding parameters on this type of distortion in butt weld cross-section is not fully clarified. Moreover availability of data on other types of distortion is so scare that verification of theoretical prediction is difficult. Hence it is necessary to perform some more experimental investigation on them.

So experimental were designed for measuring the following distortion of butt weld joints having different types of weld details and different thickness(e.g. 6 mm, 7 mm & 8 mm) of the plates.

1 Longitudinal shrinkage
2 Transverse shrinkage

2.1 Test plate preparation

Thirty six numbers of different thickness (e.g. 6 mm, 7 mm & 8 mm) test plates were cut by power hacksaw from a rolled Indian standard plate, ISP 16, having material specification mild steel (IS 226) and EN-8.

2.2 Photograph of the experiments

There are some photographs of EN-8 Plate of dimension 100mmX50mmX8mm. The thickness of the plates has to be made as mentioned in the photographs. V grooves are also to cut on these plate as mentioned in the photographs. These pictures are taken after cutting the plates from the length of Flat

FIG 2.1- EN-8 SPECIMEN OF DIFFERENT THICKNESS

FIG 2.2-WELDING OF EN8 PLATE

3. Results

3.1 Transverse shrinkage distortion Measurement

The values obtained for transverse shrinkage for all the jobs i.e. P_1, P_2 , P_3 P_4 ,P_5 , P_6 , P_7 , P_8 , P_9 .

TABLE 3.1- TRANSVERSE SHRINKAGE IN PLATES OF EN-8.

Plate thickness in mm.	Weld section in degree	Average transverse shrinkage in mm.
8	60^0	0.991
7	60^0	0.730
6	60^0	0.471
8	90^0	1.331
7	90^0	0.801
6	90^0	0.713
8	120^0	1.803
7	120^0	1.365
6	120^0	1.131

3.2. Longitudinal shrinkage distortion Measurement

The values obtained for longitudinal shrinkage are given below in Table No. 3.2 for all the work-pieces (i.e. P1 to P9).

TABLE 3.2-TABLE OF AVERAGE LONGITUDINAL SHRINKAGE IN PLATES OF EN-8

Plate thickness in mm.	Weld section in degree	Average longitudinal shrinkage in mm
8	60^0	1.012
7	60^0	0.631
6	60^0	0.690
8	90^0	1.494
7	90^0	1.125
6	90^0	1.096
8	120^0	1.916
7	120^0	1.741
6	120^0	1.17

4. Mathematical model for the experiments

4.1 Anova testing for the distortion in EN8 plate

In the response table we take the factor 1 as the plate thickness and factor 2 as grove angle, and two different response as deflection and shrinkage for EN8 plate. The table drawn below.

TABLE 4.1 ROSPONSE TABLE FOREN8

Factor 1	Factor 2	Response 1	Response 2
A:A	B:B	Deflection (EN 8)	Longitudinal shrinkage (EN 8)
		mm	mm
1	0	2.2887	1.494
0	-1	2.1758	0.631
-1	1	1.5675	1.096
-1	-1	1.8518	0.69
0	0	1.9728	1.125
1	-1	2.8213	1.012
-1	0	1.7819	1.175
1	1	1.7898	1.916
0	1	1.6662	1.741

4.2 Analysis of variance Quadratic model for deflection in EN8

TABLE 4.2- QUADRATIC MODEL TABLE

Source	Sum of Squares	F-value	p-value	
Model	1.19	69.80	0.0027	significant
A-A	0.4809	140.94	0.0013	significant
B-B	0.5553	162.77	0.0010	significant
AB	0.1396	40.91	0.0077	significant
A^2	0.0123	3.62	0.0433	significant
B^2	0.0026	0.7485	0.4506	significant
Residual	0.0102			
Cor Total	1.20			

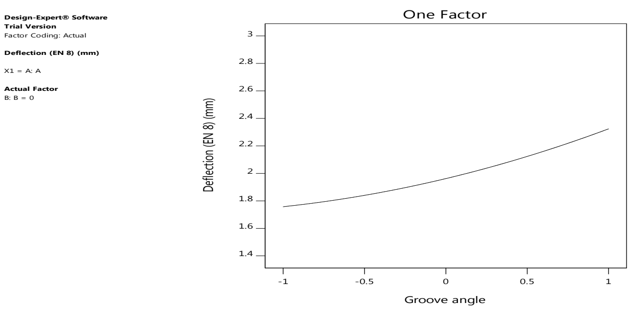
Factor coding is in the form of plate thickness and groove angle

The Model F-value of 69.80 implies the model is significant. There is only a 0.27% chance that an F-value this large could occur due to noise.

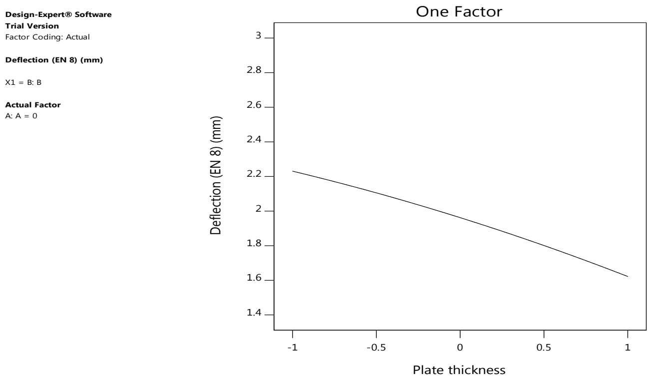
P-values less than 0.0500 indicate model terms are significant.

4.3 ONE FACTOR

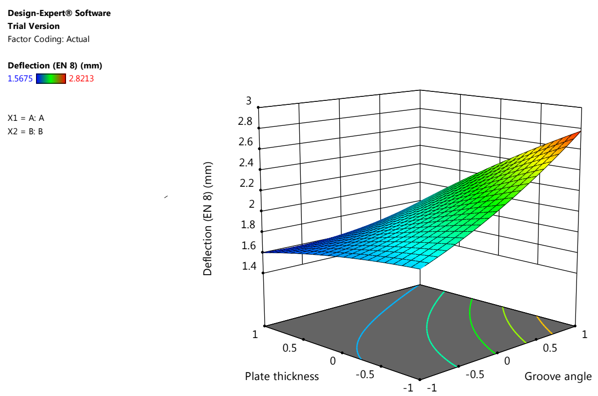
1) One factor means, effect of groove angle on deflection of EN8. In the graph for the case of EN8 deflection increase with the increase in groove angle. But when we take the factor as plate thickness the deflection decrease with the increase of plate thickness



GRAPH4.1- PLOT FOR THE DEFLECTION IN EN8 FOR GROOVE ANGLE VERSES DEFLECTION



GRAPH4.2- PLOT FOR THE DEFLECTION IN EN8 FOR PLATE THICKNESS VERSES DEFLECTION



GRAPH4.3- PLOT FOR THE DEFLECTION IN EN8 FOR GROOVE ANGLE, PLATE THICKNESS VERSES DEFLECTION

5. CONCLUSIONS

Following conclusion are observed.

From the above tables and the graph it is very clear that for EN8 plate when the groove angle is increase the deflection in the plate is also increase, its observed from the graph that the deflection is minimum for the notch angle 60 degree and it is maximum for 120 degree.

From the above tables and the graph it is very clear that for EN8 plate when the plate thickness is increase the deflection in the plate is decrease, its observed from the graph that the deflection is minimum for 8MM plate and maximum for 6MM plate.

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