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An Experimental Investigation of effect of Weld Geometry on Natural Frequencies of Welded Plates

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ABSTRACT

Welding techniques are one of the most important and most often used methods for joining pieces in industry. Welded joints are used in almost every industries depend on various applications and where the permanent joints with high strength are necessary. Some of the applications are where welded joints used are the structural supports, automotive joints, piping industries, pressure vessels etc. The latest trends in the industries are focusing on the high strength, high rigidity welded joints for different metals with the advancement in the welding design and geometry. Any information about the shape, size and residual stress of a welded piece is of particular interest to improve quality now days.In this paper an experimental investigation is carried to find dynamic performance of different weld joint by using FFT analyzerand same is proved by using ANSYS.In this work initially two weld plates are joined by continuous full weld, as a basic working condition. For next experimentation different weld geometry and patterns are used to find out the effect of it on natural frequencies. Also different materials are used to see that is there any effect of it on the dynamic behavior of welded joint.

Keywords

FEM (Finite Element Analysis),SS (Stainless Steel), MS (Mild Steel), Hex Dominant method, Bonded Contact, FFT

INTRODUCTION

Structures consisting of thin welded plates have now also found wide application in modern industry. The welding usually has small part of total weight of the structure, substantially influence their strength and performance under different load conditions. Recently studied the free vibration analysis of welded plates and shells, it was found that weld geometry and distribution and materialhave great effect on the natural frequencies and mode shapes of theplate. Many researches have been published regarding joining strength and natural frequency of welds.

Due to the increased customer expectations and the more restrictive legal regulations, the vibrational and acoustical behaviour of a product has become an important criterion in the product design process. The use of deterministic methods like standard FEM, limited to so called low frequency range but when problem is large compared to the free field wavelength computational effort of the element based techniques increases exponentially with frequency.

The main objective of this investigation is to study the effect of weld geometry on natural frequency of square welded plates. Experiment models were tested to predict the dynamic behaviour of welding plates and toFinite element modelling was adopted backup the results obtained by FFT analysis.Different materials are used to find the effect of material on natural frequencies of different geometry of welded plates.

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EXPERIMENTATION

Experimental tests were designed in order to measure the natural frequency and mode shape of the plates with different weld geometries. The material used for this experiment testing is Mild Steel (MS). The welded plate is fixed assuming one end fix condition i.e. cantilever beam arrangement. Two welding geometries has be considered for experimentation a) Two Square Plates 100mm x 100mm x 6mm b) Offset Plate withdimension75mm x 100mm x 6mm and 125mm×100mm×6mm.Figure no.2 shows the experimental setup of testing. Plates are welded in three different conditions.i) Full weld ii) Three point weldiii) Two point weld. Figure no.1 shows the schematical representation of different condition used for experimentation.Instrumentation used for modal analysis a) FFT analyzer b) Accelerometer c) Exciter d) Impact hammer.

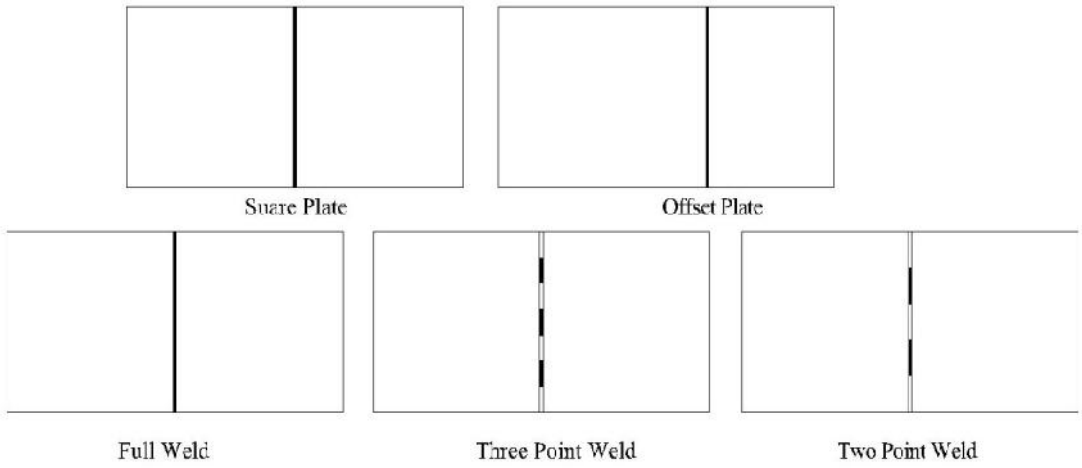

Fig 1: Schematical representation of different condition used for experimentation.

Fig 2: Experimental setup of FFT testing.

The FFT analysis is carried on Mild Steel material (MS) with different geometric condition in both square weld position and in Offset weld position.For 10 mode shapes natural frequency is found out. Testing of these two plates is done to find out natural frequency of the plates.Graph no.1 shows the results obtained for Square welded plates and Graphno.2 shows the results obtained for offset welded plate in full weld, three weld and two weld condition.

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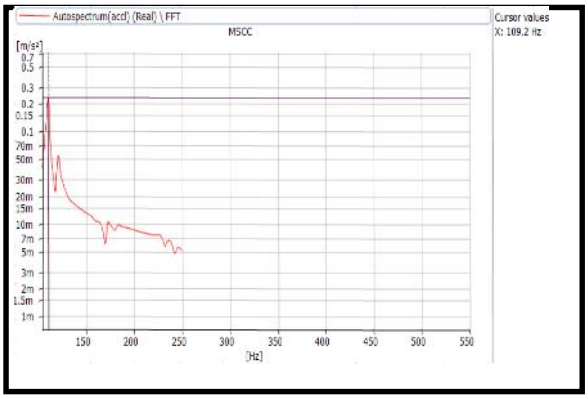

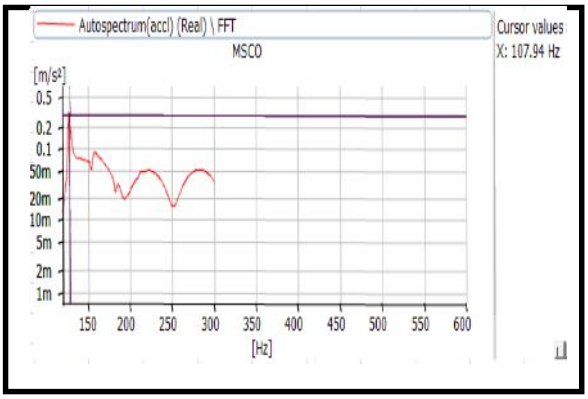

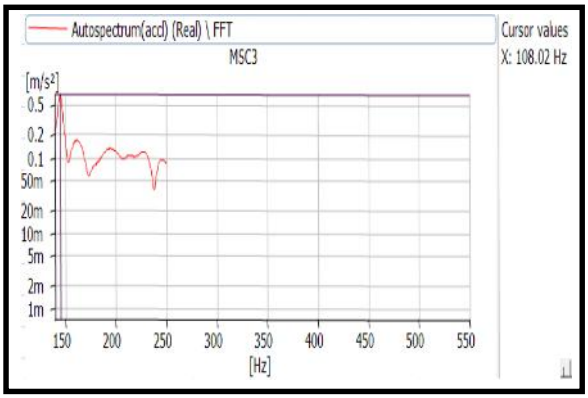

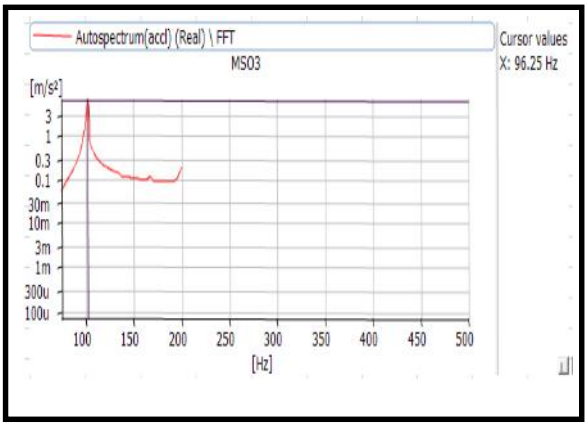

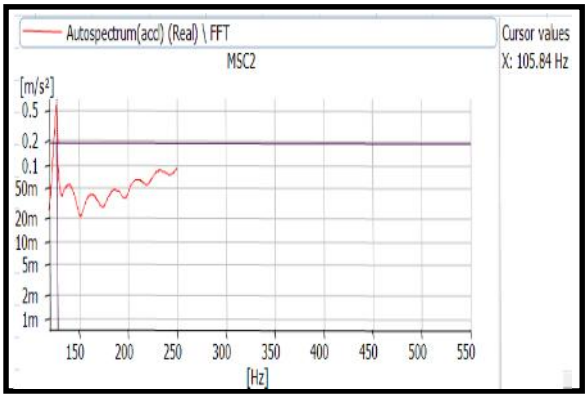

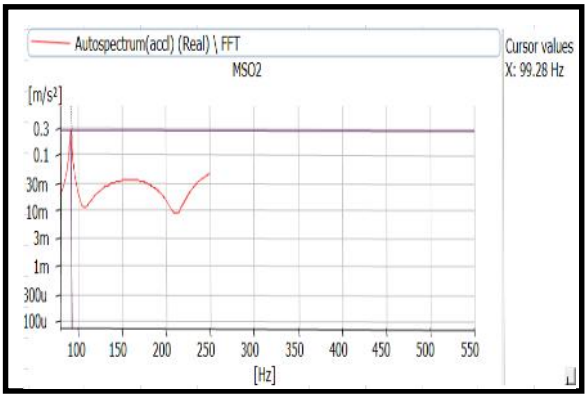

Graph No.1: FFT results of Square welded plates

Graph No.2 FFT results of Offset welded plates

All the results obtained from FFT analysis is summarized in the Table 1.

Table 1.Comparison of FFT results for Square and Offset weld Plates

Sr.No	No. of welds	Mild Steel (MS)	
		Square Plate	Offset Plate
1	Full Weld	109.20	107.94
2	Three Weld	108.02	96.25
3	Two Weld	105.842	99.28

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FEM ANALYSIS

The plates are modeled in Ansys 14.0 and material assignedfor these plates is steel. Case i): Full welding this case two adjacent faces of platesare full welded for that the bonded contact is given inbetween two mating faces. For 10 mode shapes naturalfrequency is found out. Analysis of these two plates is doneto find out natural frequency of the plates. First of all twoplates are modeled in the geometry as shown in Figure no.3.Mild Steel material is assigned to these two plates. Also these plates are joined by weld over the length so the weld joint in Ansys is done by giving bonded contact shown in Figure no.3. The material properties assigned during this analysis work are given in Table 2.

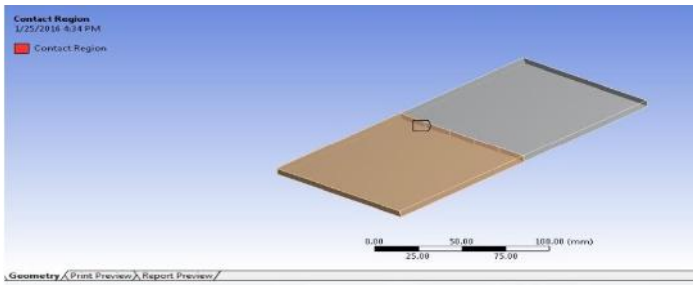

Fig 3: Geometry of the two plates and weld joint considered in Ansys

Table 2. Mild Steel Material property

Sr.No.	Property	Mild Steel Material
1	Young's Modulus	2.1 x e11
2	Poisons Ratio	0.303
3	Density	7850

Then modal analysis is done in which 10 modes are selected. Plates are meshed with hex dominant method and body sizing is kept 3 mm. One end of the plate is fixed by giving fix support Results for modal analysis of two square welded plates with full weld, Three weld and Two weld for Mild Steel is shown in Figure no .4

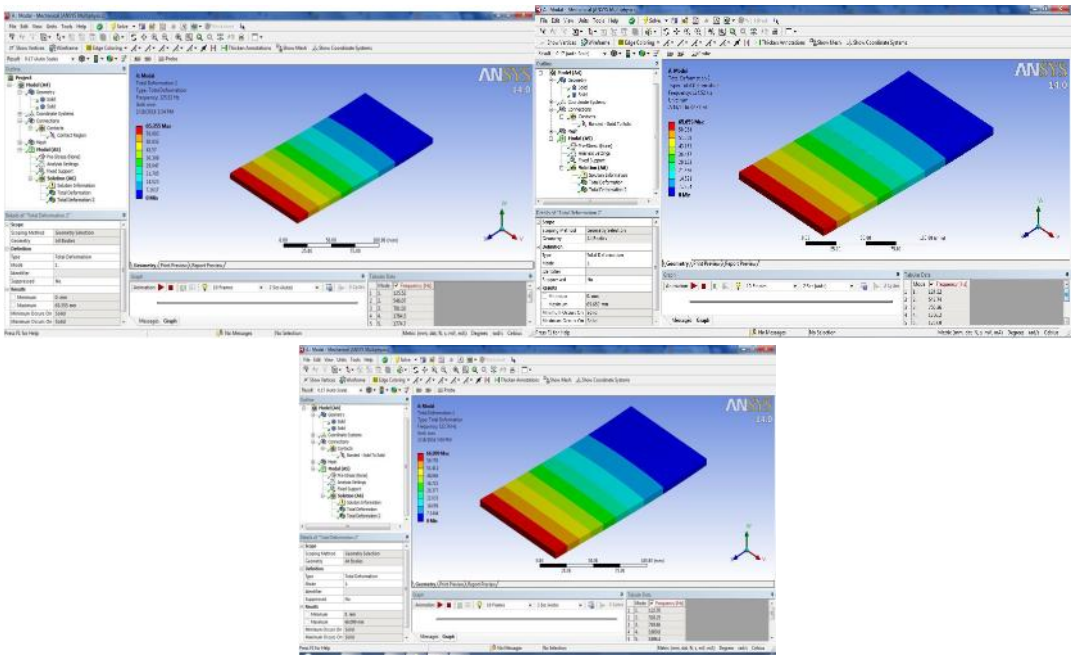

Fig . Modal analysis of MS for Full weld , Three Weld and Two weld Condition.

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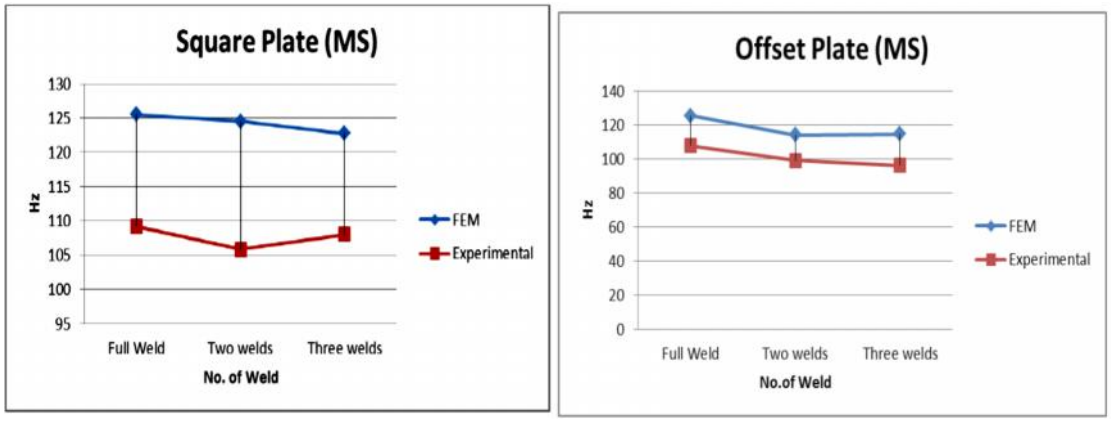
Similar process is followed for Offset welded plates and the results of both Square welded plates and offset welded plates are given in Table 3

Table 3.Comparison of Ansys results for Square and Offset weld Plates

Sr.No	No. of welds	Mild Steel (MS)	
		Square Plate	Offset Plate
1	Full Weld	125.52	125.52
2	Three Weld	122.76	114.59
3	Two Weld	124.52	114.12

The results obtained from FFT analysis and through Ansys for both Square and Offset welded plates are compared and shown in graph no.3



Graph No.3: Graphical Representation of Results for Square and Offset Plates

In Graph no.3 the comparison is done between Finite element results and experimental results. From this it is found that nature of pattern of frequency change is similar .The difference between experimental values and finite element values are in the range of 10 to 12 %. Similar comparison is done for mild less steel with plates welded in offset condition and plotted in the graph.

CONCLUSION

As the weld length changes the stiffness between the plate decreases. So as to change the natural frequency of the welding plates, their stiffness is reduced by minimizing the weld length.From the experimental and ANSYS results by changing the length of weld plate stiffness and mass of the plate geometry changes. But effect of mass is considerably very less as compared to stiffness. In general the change in assembly conditions affects significantly on vibrations characteristics of plate. From table no.1 and 3 it can see that the natural frequency for square plates two welds natural frequency of Mild steel plates decreases by 0.38%, for three weld Mild Steel 2.19%.Simillerly for offset plates natural frequency for two weld decreased by 8.76%, for three weld 8.70%.

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