Modal Analysis of Two Similar Metal Welded Joints Using ANSYS

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Abstract- *It is important to study the modal analysis (natural frequency and mode shape) of the single lap adhesive joint to understand the dynamic nature of the systems, and also in design and control. In this work modal analysis of bonded beams with a butt joint of plates are investigated. The two specimens are used which consist of Al-Al plates, Cu-Cu plates. ANSYS 19.0 finite element software is use for modal analysis of. butt joint of plates is investigated.*

Keywords- Weld joint, butt joint, frequency, mode shapes.

I. INTRODUCTION

In modern industry it is extremely important to use a number of different elements for the different components or parts which lead to reduce cost, enhance material properties, reduces weight and to optimize the performance of machine elements etc. A schematic representation of the same is shown in figure.

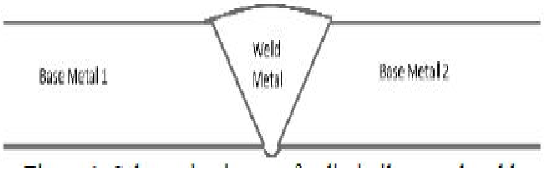


Fig 1: schematic representation of weld

The current trends are to use viscoelastic material in the joints for passive vibration control in the structures subjected to dynamic loading. These components are often subjected to dynamic loading, which may cause initiation and propagation of failure in the joint. In order to ensure the reliability of these structures, their dynamic response and its variation in the bonded area must be understood. The subject of adhesives became even more interesting to scientists when the application of synthetic resins as adhesives for wood, rubber, glass and metals were discovered. Adhesive bonding as an alternative method of joining materials together has many advantages over the more conventional joining methods such as fusion and spot welding, bolting and riveting. Adhesive bonding is gaining more and more interest due to the increasing demand for joining similar or dissimilar structural components, mostly within the framework of designing light weight structures.

WELDING is widely used in automotive industries to assemble various products. It is well known that the welding process relies on an intensely localized heat input, which tends to generate undesired residual stresses and deformations in welded structures, especially in the case of thin plates. Therefore, estimating the magnitude of welding deformations and characterizing the effects of the welding conditions are deemed necessary. With modern computing facilities, the finite element (FE) technique has become an effective method for prediction and assessment of welding residual stress and distortions(1). However, the welding deformations are various with production variations such as dimension, welding materials and welding process parameters. Therefore, rapidly and accurately predicting welding induced distortion for real engineering applications is more challenging. In many high temperature applications, it is necessary to join together components of same or different chemical, physical and mechanical characteristics.

II. LITERATURE REVIEW

Dissimilar butt-welded plates were studied by authors, Lee and Chang.IMurugan et al. modeled a multi pass weld and showed that the patterns of the residual stresses change in each welding pass. This has been confirmed by using the experimental measurements for welded plates with different thickness.

Sattari-Far and Farahani used a finite element technique to analyze the thermo-mechanical behavior and residual stresses in butt-welded pipes.

III. PROBLEM DEFINITION

Vibration testing is useful in a variety of stages in the development and utilization of a product. In the design and development stage, vibration testing can be use to design, develop, and verify the performance of individual components of a complex system before the overall system is assembled and evaluated.

An engineering system, when given an initial disturbance and allowed to execute free vibrations without a subsequent forcing excitation, will tend to do so at a particular “preferred” frequency and maintaining a particular “preferred: geometric shape. This frequency is termed a “natural frequency” of the system, and the corresponding shape of the moving parts of the system is termed a “mode shape”.

Natural, free vibration is a manifestation of the oscillatory behavior in mechanical systems, as a result of repetitive interchange of kinetic and potential energies among components in the system. Proper design and control are crucial in maintaining high performance level and production efficiency, and prolonging the useful life of machinery, structures, and industrial processes.

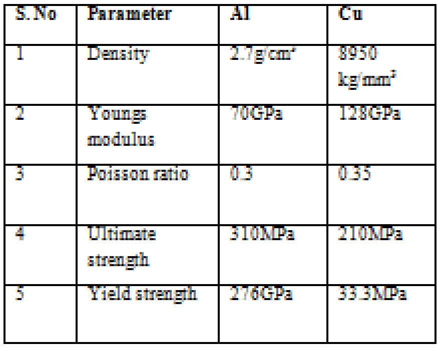
IV. METHODOLOGY

In this work modal analysis of bonded beams with butt joint of plates are investigated. The two specimens are used which consist of Al-Al plates, Cu-Cu plates. The two sets of adherends use are aluminum plates of dimension 50 mm long, 50 mm wide, 5mm thickness; copper plates of dimension 50 mm long, 50 mm wide, 5mm thickness. Welding is a science of joining the metals by the application of heatArc welding process has been used for the present work.

V. MODAL ANALYSIS

If the structural vibration is of concern in the absence of time-dependent external loads, a modal analysis is performed. Modal analysis determines the vibration characteristics of structure or machine components while it is being designed. The vibration characteristics (natural frequencies and mode shapes) are important in the design of the structure for dynamic loading conditions.

5.1 Material Properties



S.No	Parameter	Al	Cu
1	Density	2.7g/cm^3	8950 kg/mm^3
2	Youngs modulus	70GPa	128GPa
3	Poisson ratio	0.3	0.35
4	Ultimate strength	310MPa	210MPa
5	Yield strength	276GPa	33.3MPa

VI. RESULT AND DISCUSSION:

In this work modal analysis of bonded beams with a butt joint of plates are investigated. The two specimens are used which consist of Al-Al plates, Cu-Cu plates. For present study the length of 50mm is use for butt joint. The Modal analysis had been done by using ANSYS 19.0 FEA software.

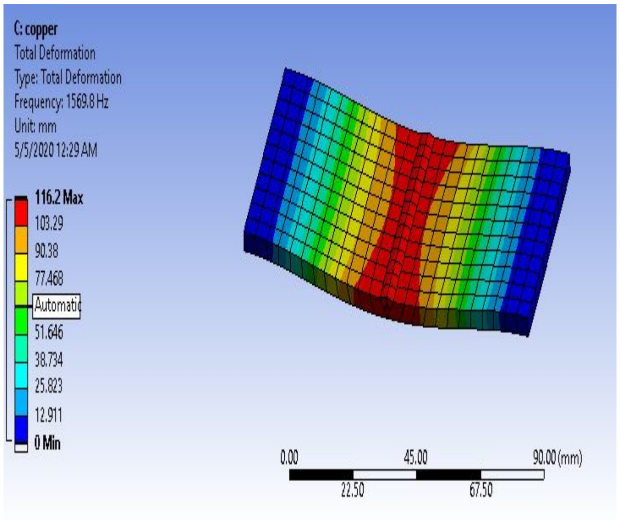


Fig 2: Mode 1 for Cu

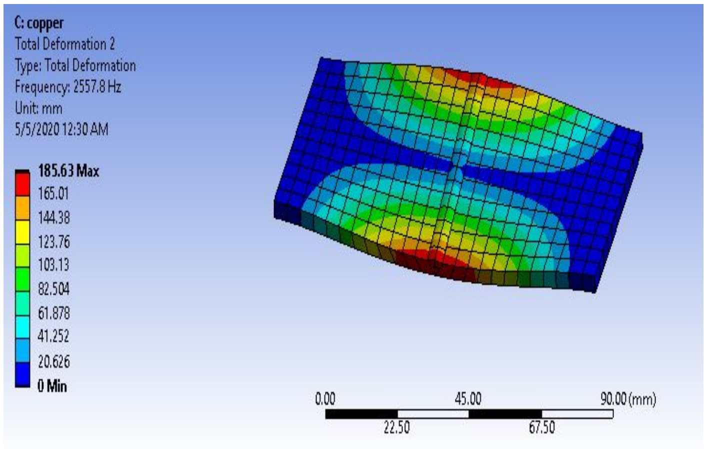


Fig 3: Mode 2 for Cu

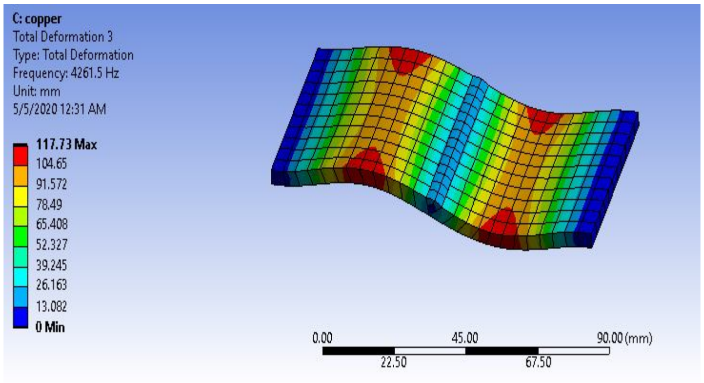


Fig 4: Mode 3 for Cu

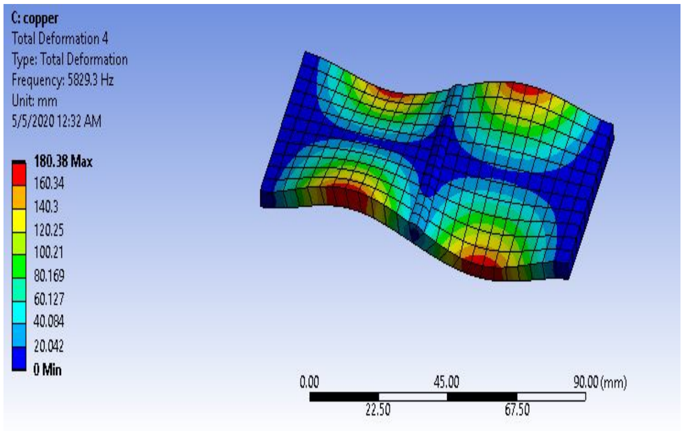


Fig 5: Mode 4 for Cu

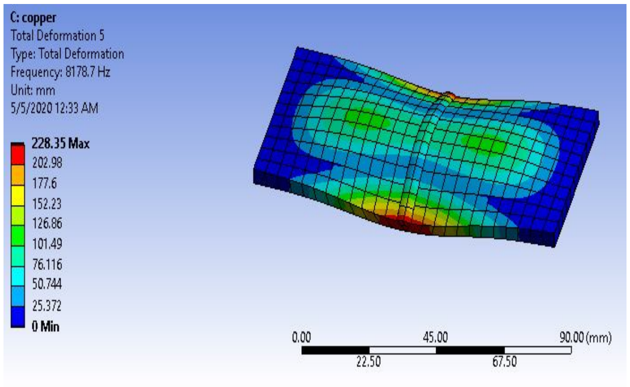


Fig 6: Mode 5 for Cu

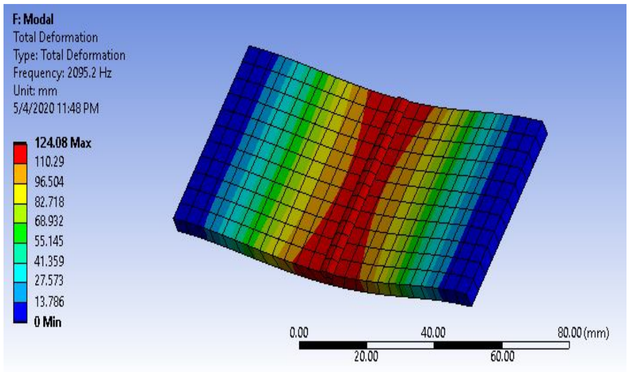


Fig 7: Mode 1 for Al

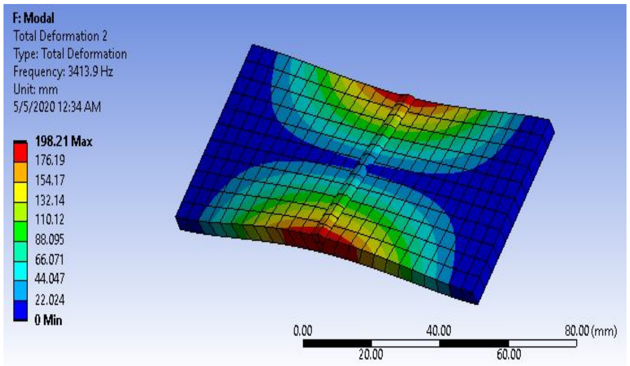


Fig 8: Mode 2 for Al

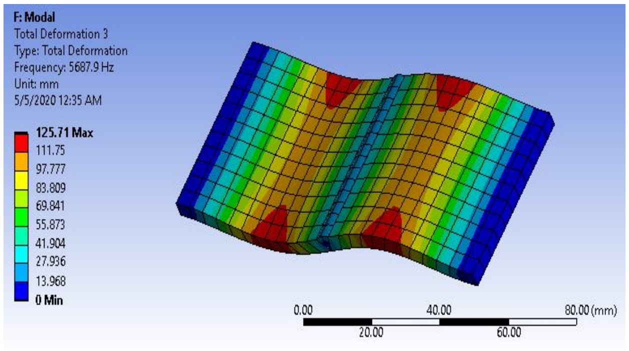


Fig 9: Mode 3 for Al

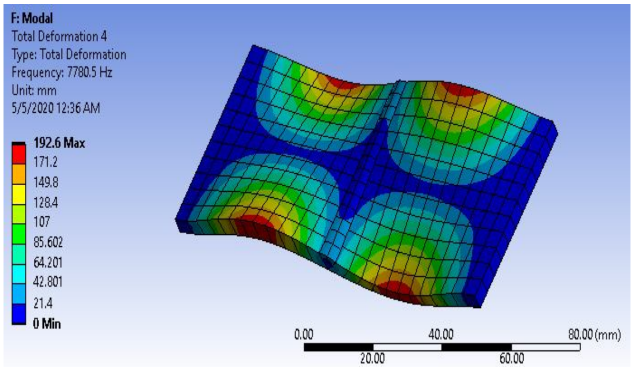


Fig 10: Mode 4 for Al

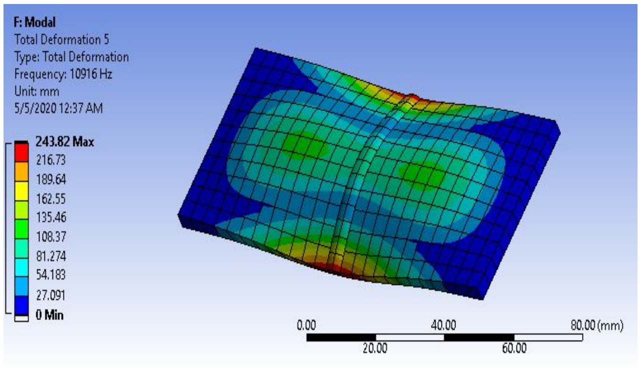
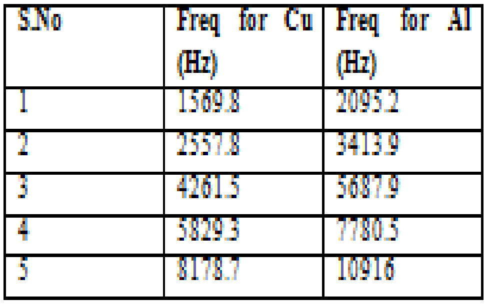


Fig 11: Mode 5 for Al

Tab1: Frequency comparison for Cu and Al



S.No	Freq for Cu (Hz)	Freq for Al (Hz)
1	1569.8	2095.2
2	2557.8	3413.9
3	4261.5	5687.9
4	5829.3	7780.5
5	8178.7	10916

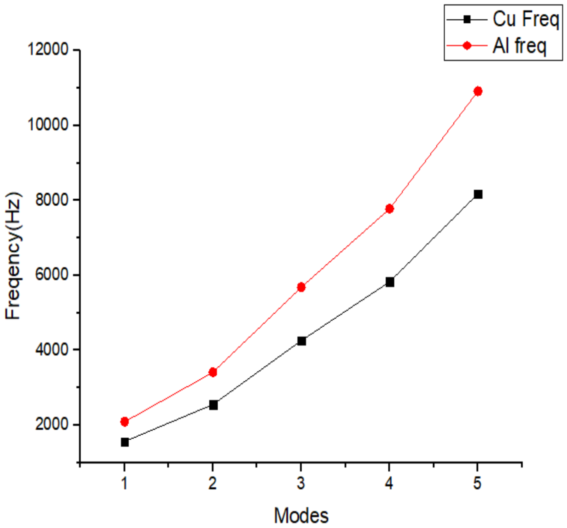


Fig 12: Comparison graph

VII. CONCLUSIONS

The natural frequencies and mode a shape gives designer/engineers an idea of how the design will respond to different types of dynamic loads. This allows to designer/engineer to change the design to avoid resonant vibrations or to vibrate at a specified frequency. Also helps in calculating solution controls (time steps, etc.) for other dynamic analyses. It is concluded that the FEA of dynamic response of the bonded beams with butt joint will help future applications bonding by allowing different parameters to be selected to give as large as a process window as possible for bonded beams vibration analysis.

REFERENCES

[1] M. SeyyedianChoobi, M. Haghpanahi and M. Sedighi, “Investigation of the effect of clamping on residual stress and distortion inbutt-welded plate,” Journal of ScientiaIranica Transaction B: Mechanical Engineering, vol. 17, no. 5, pp. 387-394, 2010.

[2] X.K. Zhu, and Y.J. Chao, “Effect of temperature-dependent material properties on welding simulation,” Journal of Computers and Structures, vol. 80, pp. 967-976, 2002.

[3] K. Deng and H. Murakawa, “Prediction of welding distortion and residual stress in a thin plate butt-welded joint,” Journal of Computational Material Science,vol. 43, pp. 353-365, 2008.

[4] D. Deng, “FEM prediction of welding residual stress and distortion in carbon steel considering phase transformation effect,” Journal of Materials & Design, vol. 30, pp. 359-366, 2009.

[5] E.M. Quresh, A.M. Malik and N.U. Dar, “Residual stress field due to varying tack welds orientation in circumferentially welded thin-walled cylinder,” Journal of Advance in Mechanical Engineering,vol. 2009, pp. 1-9, 2009.

[6] Nguyen, N. T., Ohta, A., Matsuoka, K., Suzuki, N. and Maeda, Y. “Analytical solutions for transient temperature of semi-infinite body subjected to 3-D moving heat sources,” Welding Journal Research Supplement, pp. 265-274, 1999.