LASER SPOT WELD ANALYSIS USING ANSYS SOFTWARE

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***Abstract*— In this paper we are going to analyze the BIW (Body In White) using ANSYS software under the static loading. The BIW consist mainly two part i.e. top hat and flat plate which are joint together by using laser spot weld. Spot welds made by resistance spot welding are used extensively in automotive engineering. More recent material, equipment and welding process developments to extend electrode-life, enhance weld quality and reduce power consumption are making this process increasingly attractive to automakers. However, owing to increasing demands in the use of advanced and lightweight materials, laser welding has become a popular alternative for producing spot welds. Because of the complexity and uncertainties of laser welds and thus formed structures, the finite-element (FE) modeling of the welds for dynamic analysis is a research issue. In this project first outlines some of the existing modeling of top hat and analyzed by using ANSYS software for different static load and validate by using free hammer test. SOLID 285 (Tetrahedral 4 node 285) elements is used FE modeling. In this work, we are using LVDT accelerometer to calculate the modal frequency of the different BIW part at given static load. Also, by using ANSYS V 12.0 software we going to generate mesh BIW part and model generated by using PRO-E software.**

***Keywords*— BIW, ANSYS 12.0, SOLID 285.**

I. ABOUT WELDING PROCESS

Welding generally requires a heat source to produce a high temperature zone to melt the material, though it is possible to weld two metal pieces without much increase in temperature. There are different methods and standards adopted and there is still a continuous search for new and improved methods of welding. As the demand for welding new materials and larger thickness components increases, mere gas flame welding which was first known to the welding engineer are no longer satisfactory and improved methods such as Metal Inert Gas welding.

Tungsten Inert Gas welding, electron and laser beam welding have been developed .In most welding procedures metal is melted to bridge the parts to be joined so that on solidification of the weld metal the parts become united. The common processes of this type are grouped as fusion welding. Heat must be supplied to cause the melting of the filler metal and the way in which this is achieved is the major point of distinction between the different processes. The method of protecting the hot metal from the attack by the atmosphere and the cleaning or flux in gas way of contaminating surface films and oxides provide the second important distinguishing feature.

II. ABOUT ANSYS

It is widely accepted method of accessing product performance without the need for physical building and testing. It also shortens prototype development cycle times & facilitates quicker product launch. FEA consists of a computer model of a material or design that is loaded and analyzed for specific results. It is used in new product design, and existing product refinement. ANSYS AUTODYN release 12.0 is the latest release of the ANSYS AUTODYN software within the ANSYS Workbench framework. ANSYS Workbench brings many new possibilities to the ANSYS AUTODYN user in terms of CAD geometry import, complex geometry generation, meshing and ease of use. To complement the significantly enhanced model generation capabilities, a range of new solver, material modeling and post-processing features enable larger simulations to be solved in a faster time. Hat-like shell (or 'top-hat') joined together by spot welds at the flanges.

III. BIW COMPONENT

A hat-plate structure shown in Fig.1 is used in this work. The structure, which consists of a flat plate and a formed hat-like shell (or 'top-hat') joined together by spot welds at the flanges, is designed to represent common structures used in the construction of a car BIW. The spot welds, which are produced by LW, are 5mm in diameter and 60 mm apart in the longitudinal. The hat-plate Hat-plate dimensions direction. The overall dimensions of the hat plates are as 564 mm long and 110 mm wide. The plates, of thickness 1.5 mm, are made of cold rolled mild steel sheet metal. The overall dimension of top hat and flat plate shown in fig 4.2 by using Pro-E software. A set of nine identical pairs of the structures are built in-house, each having the same nominal dimensions .Nominal values for the material properties of mild steel are used for both models, with Young's modulus E = 210GPa, Poisson's ratio ν= 0.3,anddensityρ = 7860kg/m3

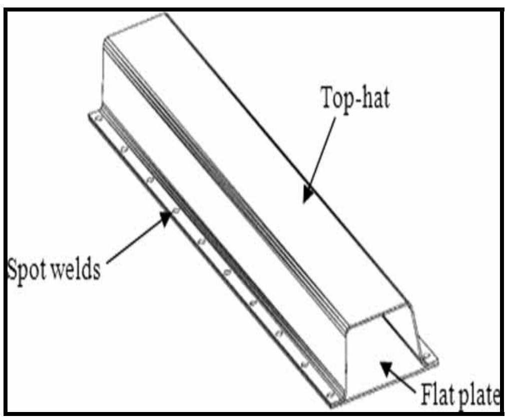

Fig. 1 Top hat and flat plate structure

It is essential to high light that FE model updating can only correct the errors that originated from the uncertainties of modelling parameters in a geometrically well-defined model.Therefore, manual tuning of the initial model, based on trial and error and or engineering judgement,must be carried out first.The manual tuning procedure involves manual alterations of the model geometry to bring the FE model closerto the physical structure. Here,for FE modelling the top hate,flate plate and there assembly is created by using Pro-E software and it is import in ANSYS Autodyne 12.0 for furthe analysis.Fig 2 and 3 is gives overall diemention and structure of top hate respectively.

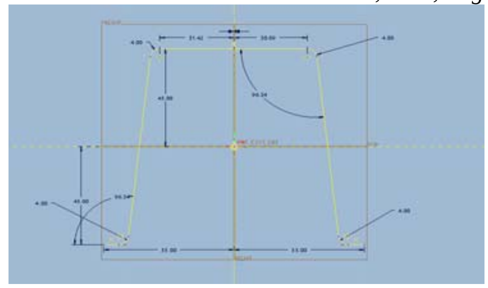

Fig. 2 The overall dimension of top hate.

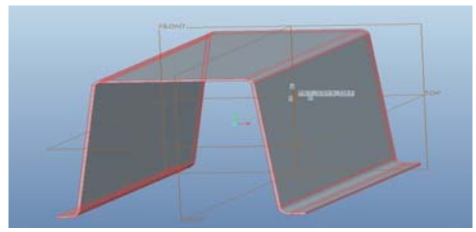

Fig. 3 The top hate structure.

Also, fig 4 and 5 is gives overall diemention and structure of flat plate respectively.

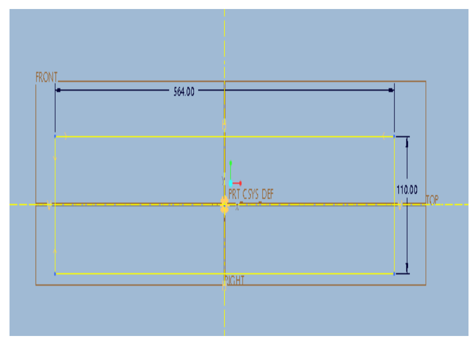

Fig. 4 The overall dimension of flat plate

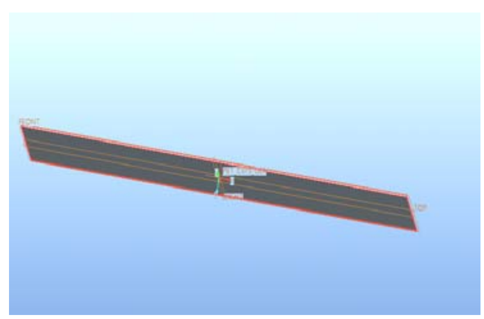

Fig. 5 The flat plate structure.

It usually includes a small number of key parameters from the FE model that can be controlled manually. In this work, the outcome of the numerical model is found to be sensitive to the top-hat's fold radii and the thicknesses of the flat plate and the top-hat. Therefore, the thicknesses of all the plates are measured at different places and a mean value of 1.45mm is incorporated in the FE models of both components. Furthermore, a closer inspection of the top-hats reveals that the fold radii are approximately 4 mm, which is 1mm smaller than the specimen radii.

IV. SOLID 285

For analysis the BIW part i.e. top hat SOLID 285 element (Tetrahedral 4 node) is used for FE modeling. The reason as below-

1. Convergence of solution is better in tetrahedral element compare other element.
2. If we select the tetrahedral with more than 4 node i.e.8 nodes, 10 nodes, etc. So, it will take more time for analysis because number of nodal point is increases.
3. SOLID 285 is the nomenclature for 4 nodes quadrilateral element according to NAFEMS (National Agencies For Finite Element Method And Standards, London).
4. Less number of nodes are taken to reduce computational time (Reduce number of equation and number of boundaries. The element description as shown in fig 6 as

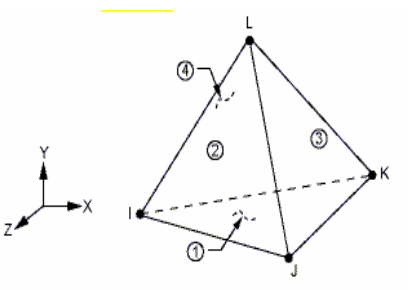

Fig. 6 SOLID 285 Geometry

It is lower order 3-D,4-node mixed u-p element. The element is suitable for modeling irregular meshes such those generated by various CAD/CAM system and general material including incompressible material. . In nonlinear analysis you can control the tolerance of HDSP separately via control command. The element has plasticity, hyper elasticity, creep, stress stiffness, large deflection and large strain capability. It is capable of simulation deformation of nearly incompressible hyper elastic material, nearly incompressible hyper elastic material, and fully incompressible hyper elastic material. In geometry nodal location and co-ordinate system for this element are shown in fig 8.In addition to the node the input data includes the orthotropic or anisotropic material properties, material properties and anisotropic material direction correspond to the element co-ordinate direction.

V FE MODELING USING ANSYS 12.0

Here we used SOLID 285 element i.e. (Tetrahedral 4 node 285).The total number of mesh division is 25 i.e. each division of 22.56 mm distance .Total number of node taken in this type of element is 5965. Now, we are going to model i.e. top hate of BIW parts by using ANSYS software. Meshed element as shown in fig 7

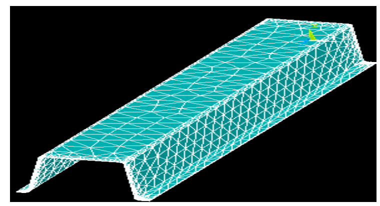

Fig. 7 Meshing of Top hat structure

The impact load is varies from 0.7 kg to 1.1 kg. But, in analysis this load acting like a static load so it varies from 1.5-2 times impact load. So, we assume according to impact theory of a load taken this load as 2 times impact load as 1.4 kg to 2.2 kg i.e. from 13.734 N to 21.582 N. Following are the stress shapes observed for the load 13.73N to 21.582N as

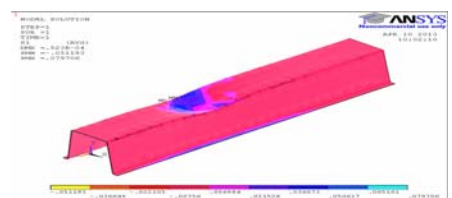

Fig. 8 Stress after applying 13.73 N force at nodal point

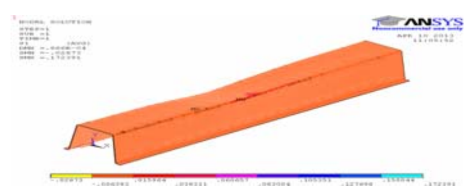

Fig. 9 Stress after applying 15.696 N force at nodal point

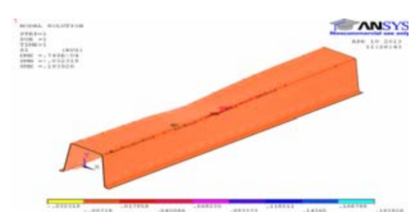

Fig. 10 Stress after applying 17.658 N force at nodal point

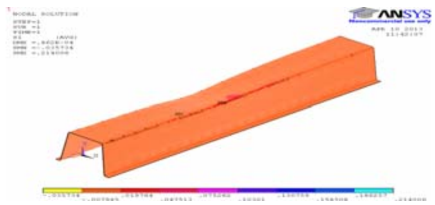

Fig. 11 Stress after applying 19.62 N force at nodal point

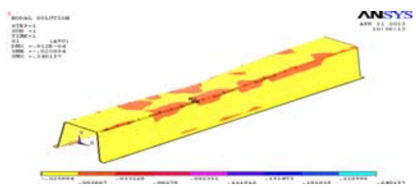

Fig. 12 Stress after applying 19.62 N force at nodal point.

VI CONCLUSION

FE modeling we know that failure of model is by means of the loading i.e. by impact loading. Because the laser spot weld is failure under action of heat treatment only. In case of BIW part the heat generation at the junction is negligible. This work has reviewed some of the FE models developed to represent spot welds normally produced by RSW in the past. Amongst all these models, SOLID 285 is selected to modeling and different static load analysis and mode generation at that respective static load most importantly, it is essential to have an appropriate mesh in the FE model since it will influence the size of the patch used in the FE model. The maximum stress is 0.20184 N/mm^2 at a static load of 21.582 N i.e. at a 1.1 kg weight of accelerometer in free hammer test for complete structure. The minimum stress is 0.12844 N/mm^2 a static load of 13.734 N i.e. at a 0.7 kg weight of accelerometer in free hammer test for structure. Variation of maximum and minimum stress are shown in fig 13 and 14 respectively.

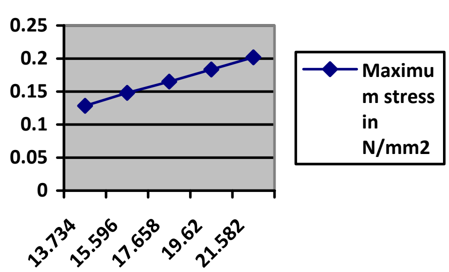

Fig.13 Maximum stress verses static load

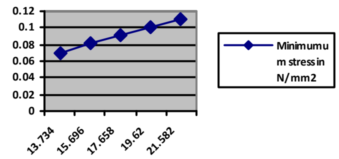

Fig.14 Maximum stress verses static load

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