International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 09 | Sep 2019 www.irjet.net p-ISSN: 2395-0072

Analysis and Optimization of Weld Distortion in Automobile Chassis

Harshavardhan mane[1], Santosh wankhade[2]

[1] *M.E. Machine Design, Department of Mechanical Engineering, YTIET*

[2] *HOD, Department of Mechanical Engineering, YTIET*

***Abstract**-The chassis is considered to be one of the significant structures of an automobile welding process plays an important role in chassis building. If the welding process is not controlled properly, it creates several deficiencies in process one of those deficiencies is distortion occur during welding. Distorted structure of chassis results in severe effects in vehicle operation such as, disturbed vehicle behaviour, develops residual stresses in chassis, chassis can't bear torque and twisting loads, chassis can't bear to the vibrational forces developed in the vehicle and long term life of the chassis is affected. The aim of the work presented in this project is to analyze the chassis assembly for the existing weld sequence, and check deficiencies in the process in ANSYS software. Then based on results an optimized welding sequence is recommended*

Key Words: Welding distortion, Analysis, ANSYS

1. INTRODUCTION

The chassis provides the strength needed for supporting the different vehicular components also to support the payload and helps to keep the automobile rigid and stiff. The chassis is an important component of the overall safety system of any vehicle. Chassis structure also ensures low levels of noise, vibrations and harshness throughout the automobile. Chassis should be rigid enough to withstand the shock, twist, vibration and other stresses. To perform above stated operations efficiently chassis building should be strong enough; Welding Process plays an important role in chassis building Welding distortion, a result of the non-uniform expansion and contraction of weld metal and adjacent base metal during the heating and cooling cycle of the welding process, is a major concern during the fabrication of a welded structure. Welding distortion causes complex consequences. In this project the chassis assembly is to be analyzed for the various different weld sequences, using the transient thermal and transient structural analysis in ANSYS software. Then based on results an optimized welding sequence is recommended..

2. OBJECTIVE

1. To create analysis Standard Operating Procedure in WORKBENCH.
2. To optimize the welding distortion along the following line.
   - Weld Sequence.
3. Based on result a new improvised weld sequence is recommended.

3. METHODOLOGY

The proposed work involves the following steps:

1. Study of current structure of chassis is done by collection of information such as dimensions of current structure, loading condition, welding speed, maximum temperature reached during welding etc. from various journals, manuals and data provided by Vaftsy CAE. This will include type of welding process, maximum temperature reached during welding, speed of welding etc.
2. Keeping all other input parameters constant a transient thermal analysis is carried out on the small section of chassis frame.
3. Keeping welding speed constant and considering full model of chassis perform Transient Thermal analysis with given input condition.
4. Perform Transient Structural Analysis with result obtained in thermal analysis as an input named imported body temperature along with the fixed supports to calculate deformation.
5. Perform above steps with different weld paths to calculate minimum deformation and hence decide the optimum weld path.

Validation of results will be done by comparing distortion at optimum welding speed with same path at designated working conditions.

4. MODEL

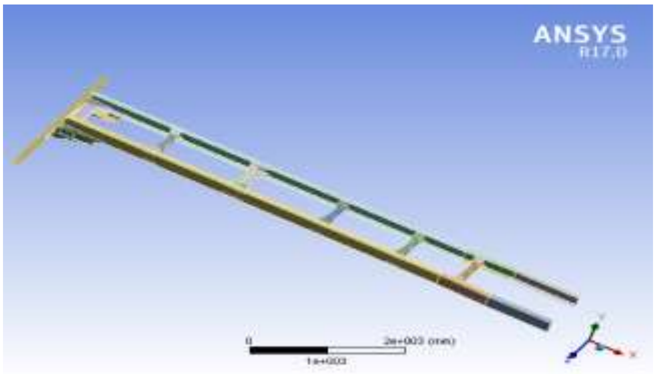


Fig-1: Model of chassis imported in ANSYS 17

5. MESHING

Steps Involved in Meshing of valve Assembly in ANSYS

- Selection of element type for meshing.
- Creating simplified parts.
- Meshing the part.
- Obtaining desirable mesh pattern for different size and quality.

Fig-2: Model of chassis after mesh

6. ANALYSIS

A transient analysis, by definition, involves loads that are a function of time. In the Mechanical application, we can perform a transient analysis on either a flexible structure or a rigid assembly. The basic equation of motion solved by transient dynamic analysis where,

[M] - mass matrix [C] - damping matrix

[k] - stiffness matrix {ü} - nodal acceleration vector

{ú} nodal velocity vector {u} - nodal displacement vector
{F(t)} - load vector

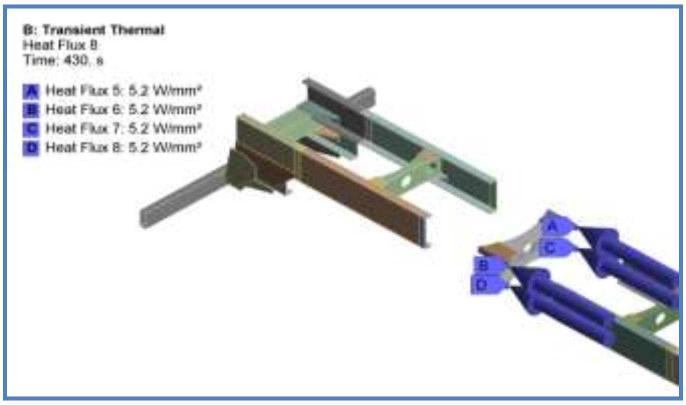


Fig-3: Heat flux is given at welding zone

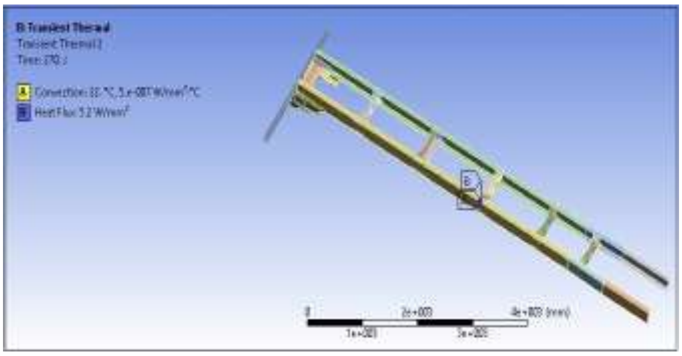


Fig-4: Boundary conditions given like convection.

6.1. INPUT PARAMETERS

- Type of welding = MIG welding.
- MIG welding temperatures vary from 3000°c to 20000° c
- Maximum HAZ temperature reached during welding = approximately 3,000 °C.
- Convection film coefficient = 0.5 w/m².
- Weld time is the time during which welding current is applied to the metal sheet. The weld time is measured and adjusted in cycles of line voltage as are all timing functions one cycle is 1/50 of a second in a 50 Hz power system.
- Here the welding length is kept constant and different welding speeds are applied to get optimum weld duration which gives minimum deformation.

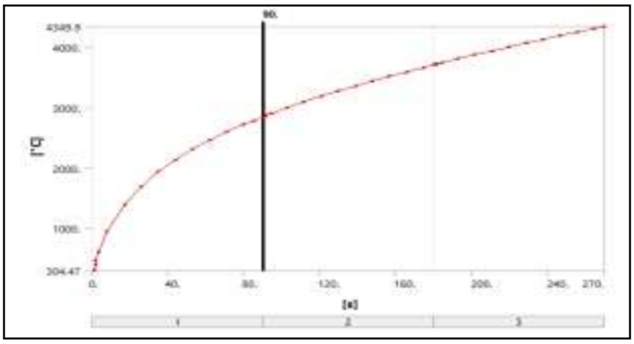


Fig-5: Graphical representation of result obtained in ANSYS.

7. RESULTS

From the data obtained from analysis carried out in the transient thermal that is temperature output, the pattern of uneven heat distribution in the base metal is seen. The results then imported to transient structural and based on imported temperature the structural analysis was been carried out which showed the values for maximum and minimum deformation also the values for deformation at each node. In weld path I because welds 1, 2, and 3 are welded first, welds 4, 5, and 6 are free to expand and contract. When the next three welds are welded, welds 1, 2, and 3 are cool and cannot freely expand and contract, leading to a greater amount of welding deformation In weld path IV this sequence both sides of the symmetrical weld are welded at the same time. Thus, the weld's expansion and contraction is isotropic and simultaneous causing reduced deformation because of the constraints on both sides of the weld while welding the first weld and after weld. However, this increases the degree of freedom of the welds, which causes post-weld free expansion along the welding direction. Therefore, the welding sequence causes a minimum welding deformation.

7.1. WELD PATH I

Linear application of heat flux at all plates serially throughout the length.

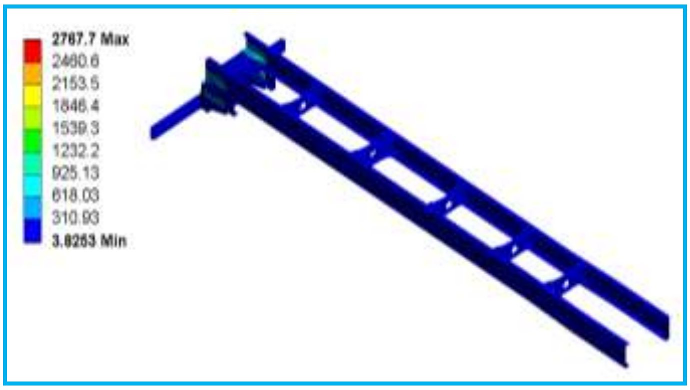


Fig-6: Temperature obtained from transient thermal analysis for weld path I is 2731.8 0C

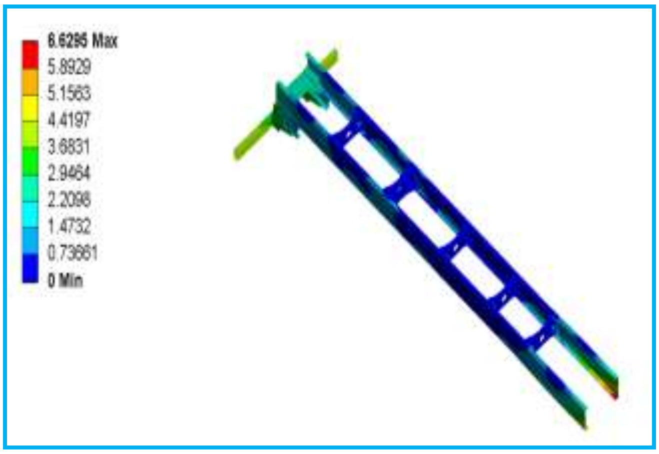


Fig-7: Deformation due to transient structural analysis for weld path I is 6.6295 mm.

7.2. WELD PATH II

Alternate application of heat flux to the rows of plates throughout the length.

Fig-8: Temperature obtained from transient thermal analysis for weld path II is 2747.8 ^{0}C.

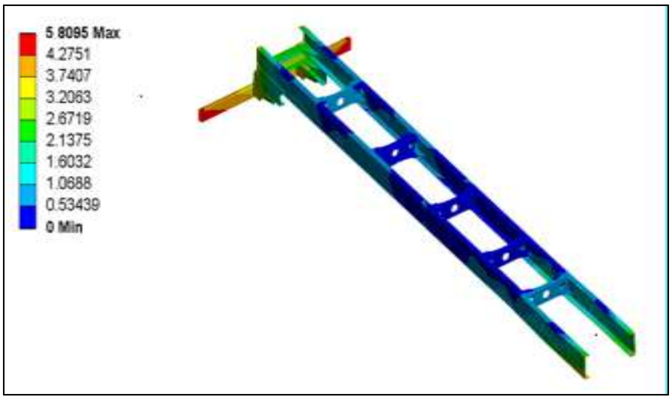


Fig-9: Deformation due to transient structural analysis for weld path II is 5.8095 mm

7.3. WELD PATH III

Application of heat flux to the top plates of alternate rows and then bottom plates respectively throughout the end. In this case 4 plates getting weld at a time.

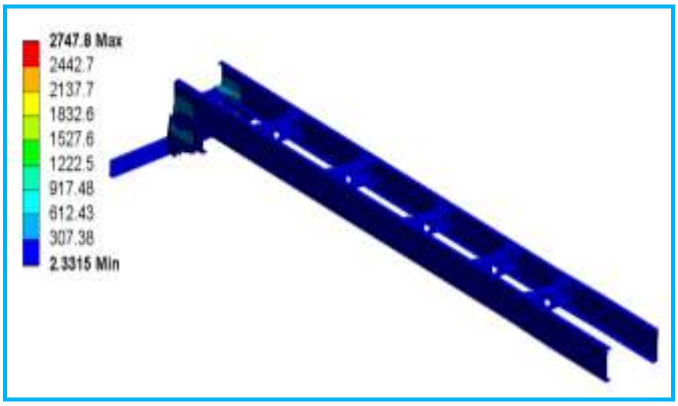


Fig-10: Temperature obtained from transient thermal analysis for weld path III is 2767.7 0C

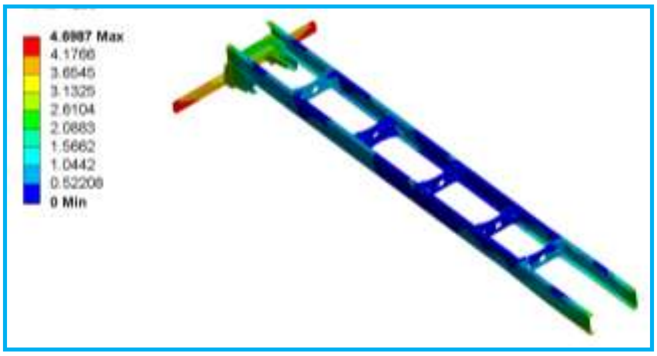


Fig-11: Deformation due to transient structural analysis for weld path III is 4.6987 mm

7.4. WELD PATH IV

Simultaneous application of heat flux to the top and bottom plates of alternate rows throughout the length

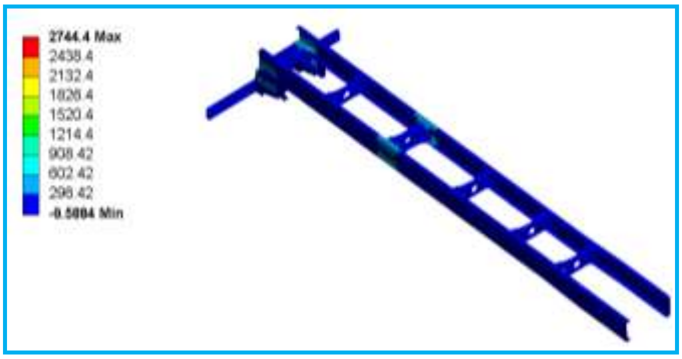


Fig-12: Temperature obtained from transient thermal analysis for weld path IV is 2744.4 0C

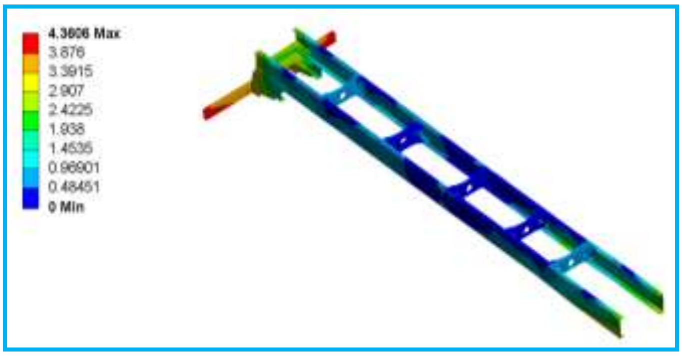
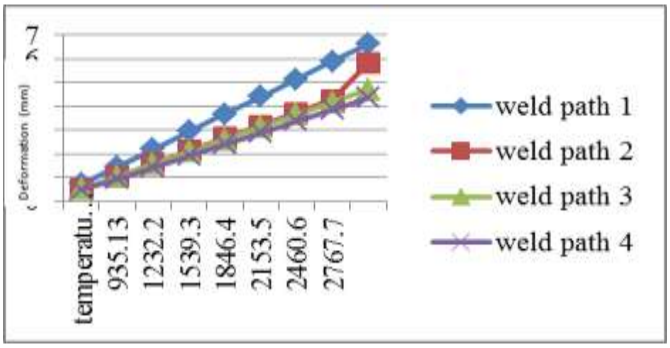


Fig-13: Deformation due to transient structural analysis for Weld path IV is 4.3606 mm.

Table-1 : Result table for transient structural analysis of various weld sequences

SR No	WELD PATH	MAX. TEMP. OUTPUT	MAX. STRESS	MAX. DEFORMAT ION
1	Weld path I	2731.8 ^{0}C	1512.7 MPa	6.6295 mm
2	Weld path II	2747.8 ^{0}C	1490.6 MPa	5.8095 mm
3	Weld path III	2767.7 ^{0}C	1472.4 MPa	4.6987 mm
4	Weld path IV	2744.4 ^{0}C	1447.8 MPa	4.3606 mm



Graph-1 : Graph showing deformation values in different weld sequences vs. temperature

9. CONCLUSIONS

1. It is seen that when temperature increases during welding in weld pool the deformation also increases but from above result it is clear that althouth the highest temperatures reached at any place on chassis are constant for different sequences the total deformation changes.
2. So it is clear that we can reduce deformation by improving weld sequence.
3. it is seen that the weld distortion is reduced by 34% in Weld path IV compaired to Weld path I, that is simultanious application of heat flux should be applied for more even heat distribution of heat resulting in less recidual sress and minimum deformation in chassis.
4. The present optimized weld sequence (weld path IV) help to keep deformation minimum
5. Further analysis in terms of weld clamps and weld duration will add value to this work.

10. References

1. S. R. Patil, C. A. Waghmare,"Optimizationof MIG welding parameters for improving strength of welded joints" E-ISSN2249–8974 Int. J. Adv. Engg. Res. Studies / II/ IV/July-Sept., 2013/14-16
2. A .Chattopadhyay, G. Glinka, M. El-Zein, J. Qian, R Forams,"STRESS ANALYSISand FATIGUEof welded structures, 1106_0037_WELDING_7_8_2011.indd 20
3. Chang Doo Jang, Yong Tae Kim, Young Chun Jo, Hyun Su Ryu, "Welding Distortion Analysis of Hull Blocks Using Equivalent Load Method Based on Inherent Strain",10th International Symposium on Practical Design of Ships and Other Floating Structures Houston, Texas, United States of America © 2007 American Bureau of Shipping.

4. C.M.Cheng, C.P.Chouy, I.K.Lee and H.Y.Lin, "Distortion Analysis of Single V-groove Butt Welding on Heat Treatable Aluminium Alloys", J. Mater. Sci. Technol., Vol.21 No.5, 2005
5. Y. P. Yang, R. Dull, H. Castner, T. D. Huang, and D. Fanguy,"Material Strength Effect on Weld Shrinkage and Distortion", NOVEMBER 2014 / WELDING JOURNAL 421-s
6. N. R. Mandal and C. V. N. Sundar,"Analysis of Welding Shrinkage",WELDING RESEARCH SUPPLEMENT I 237-sJUNE 1997
7. Z. M. Liu, C. S. Wu, Y. K. Liu, and Z. Luo,"Keyhole Behaviors Influence Weld Defects in Plasma Arc Welding Process",SEPTEMBER 2015 / WELDING JOURNAL 281-s
8. Dean Deng, Ninshu Ma, and Hidekazu Murakawa, "Finite Element Analysis of Welding Distortion in a Large Thin-plate Panel Structure",Transactions of JWRI, Vol.40 (2011), No. 1
9. Nuraini, A.A, Zainal A.S.M. and Azmah Hanim, M.A,"The Effect of Welding Process Parameter on Temperature and Residual Stress in Butt-Joint Weld of Robotic Gas Metal Arc Welding",Australian Journal of Basic and Applied Sciences, 7(7): 814-820, 2013 ISSN 1991-8178
10. Z. Barsoum, "Determination of Weld Loads and ThroatRequirements Using Finite Element Analysis with Shell Element Models--A Comparison with Classical Analysis",Weldingresearch supplement April 1999
11. Dragi Stamenkovic, Ivana Vasovic, "Finite Element Analysis of Residual Stress in Butt Welding Two Similar Plates", Scientific Technical Review,Vol.LIX,No.1,2009
12. K.T. B. Padal, K. Ajay Kumar, "Optimization and Control of Welding Distortion in Hatch Cover Girders", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 11, Issue 2 Ver. VII (Mar- Apr. 2014), PP 22-29