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Study of welded Stiffeners Under Compression Loading

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Abstract: *Plates with spot welded stiffeners are widely used in automotive and many other industries to reduce vibration. The objective of this investigation is to study the effect of design of spot weld and design of stiffeners on characteristics of plates under compression loading conditions.*
In this study, a methodology proposed to study design of spot welded structures, considering design of spot weld and design of stiffeners at loading conditions. The study of spot weld of welded structures under compression loading includes the study of spot weld dimensions, arrangement and study of stiffeners includes the study of stiffener profiles, dimensions and arrangement. The overall study of structure includes the study of stiffeners and spot weld, which gives characteristics of stiffened structures.
The analysis of structural models is performed by using LS-DYNA and HyperMesh like softwares. Material for structural model is mild steel is widely useful for such types of applications.
Keywords: *Stiffener, Structures*

I. Introduction

Stainless steel has been widely used for rail vehicle body-shell design for many years owing to its corrosion resistance, low life-cycle cost, high strength-to-weight ratio and fire resistance. However, with ever more demanding requirements for improved passenger safety, the impact performance of the body-shell structure has become increasingly important.Resistance spot-welding (RSW) is a process in which two sheets of material are joined together using the heat generated by the resistance to the flow of electric current through the work piece, melting a `nugget' which, when cooled, fuses the sheets together.Resistance spot welding is the most preferred and widely used method for joining metal sheets in automotive and many other industrial assembly operations due to its easiness, cost-effectiveness, high speed and suitability for automation.

Spot-welded joints are usually the weakest regions of structures. Spot weld joints provide localized connection, and thus lead to high stress concentration in the joined plates, any improper design may result in excessively high stresses and premature failure. The number of spot-weld and their spatial distribution has a significant impact on the structural performance criteria that must be taken into account, including the static and dynamic behaviors. Increasing the strength of the joints through geometrical changes will also increase the overall integrity of the whole structure.

II. Design Of Experiment For Analysis Of Structures

Nomenclature

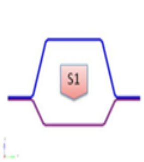
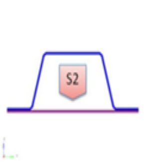
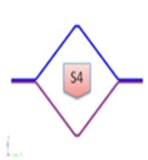
Design of Experiments Matrix	Section 1	Section 2	Section 3	Section 4
				
Pattern 1	S1P1	S1P2	S1P3	S1P4
Pattern 2	S2P1	S2P2	S2P3	S2P4
Pattern 3	S3P1	S3P2	S3P3	S3P4

Figure 1 show the design of experiment which is used for the analysis of structures under compression loading. As per the designed DOE twelve types of structures are analysed considering compression loading

III. Finite Element Analysis

This is most representative technique to prepare the model of structural object. FE models are generated to obtained detailed response of structures and to determine structural characteristics. F.E Models are more practical because they predict realistic structural response. This section describes the geometrical and finite element modeling process in detail. Also brief information regarding analysis of structural models are included.

A analysis of structures uner compression loading:

1. Results of Iteration S1P1

Graphs of Forces induced vs. time of structure S1P1:

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to timeof structure S1P1 is shown in figure.

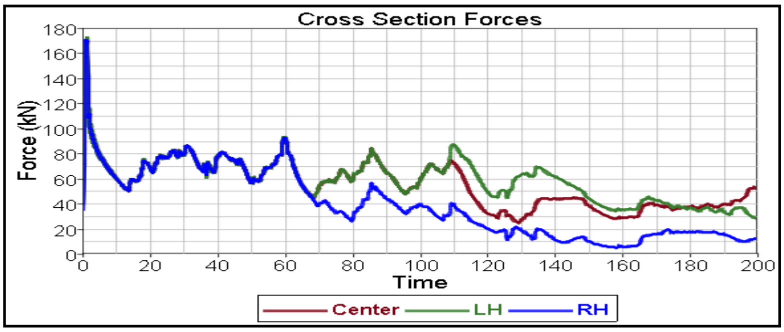


Fig.2 Graph of Cross Section Forces of structure S1P1

2..Results of Iteration S1P2

Graphs of Forces induced vs. time of structure S1P2:

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S1P2 is shown in figure.

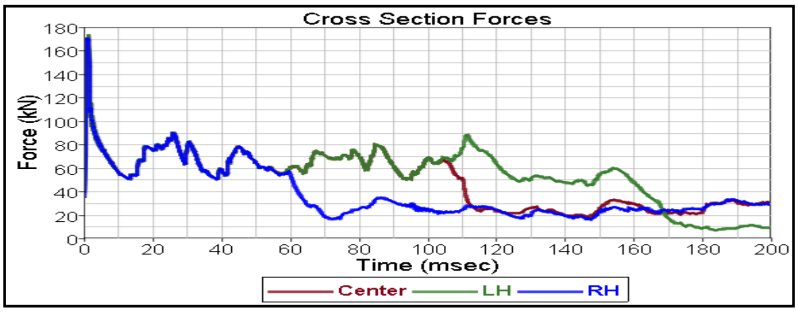


Fig. 3 Graph of Cross Section Forces of Structure S1P2

3.Results of Iteration S1P3

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S1P3 is shown in figure.

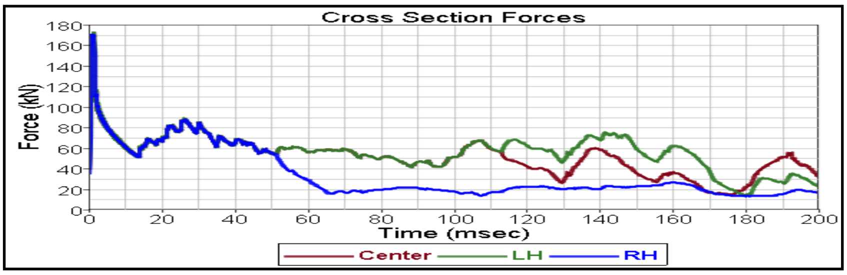


Fig. 4 Graph of Cross Section Forces of Structure S1P3

4.Results of Iteration S2P1

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S2P1 is shown in figure.

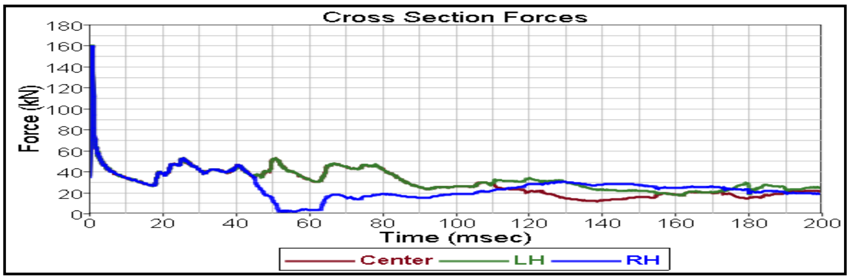


Fig.5 Graph of Cross Section Forces of Structure S2P1

5.Results of Iteration S2P2

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S2P2 is shown in figure.

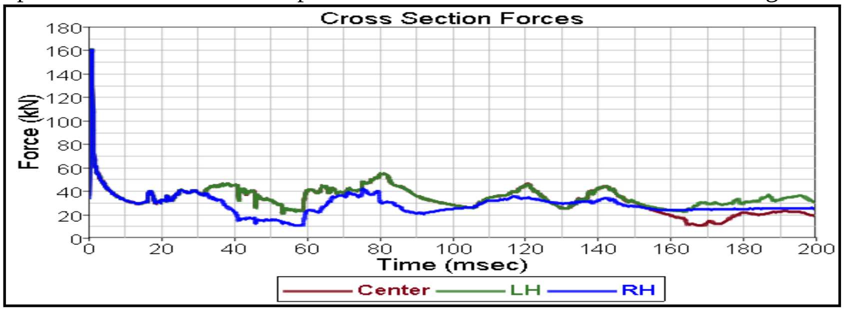


Fig.6 Graph of Cross Section Forces of Structure S2P2

6.Results of Iteration S2P3

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S2P3 is shown in figure.

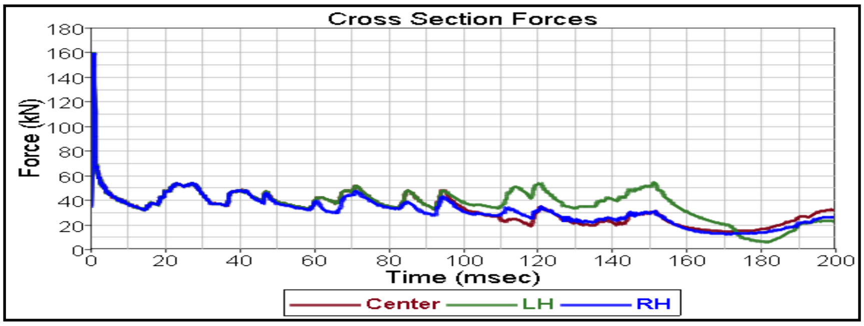


Fig.7 Graph of Cross Section Forces of Structure S2P3

7.Results of Iteration S3P1

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S3P1 is shown in figure.

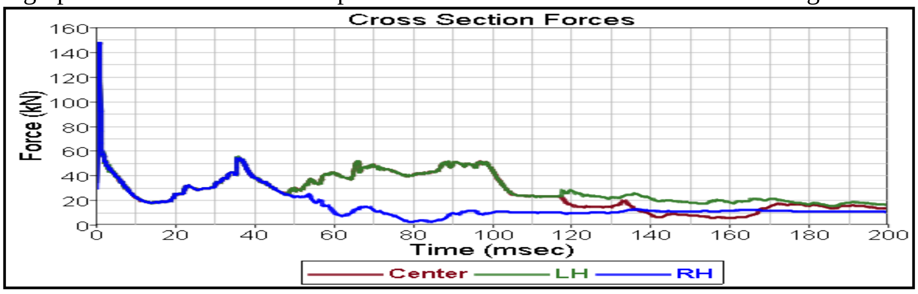


Fig.8 Graph of Cross Section Forces of Structure S3P1

8.Results of Iteration S3P2

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S3P2 is shown in figure.

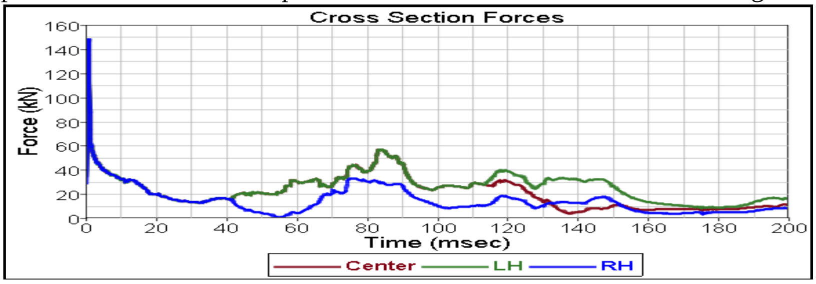


Fig.9 Graph of Cross Section Forces of Structure S3P2

9.Results of Iteration S3P3

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S3P3 is shown in figure.

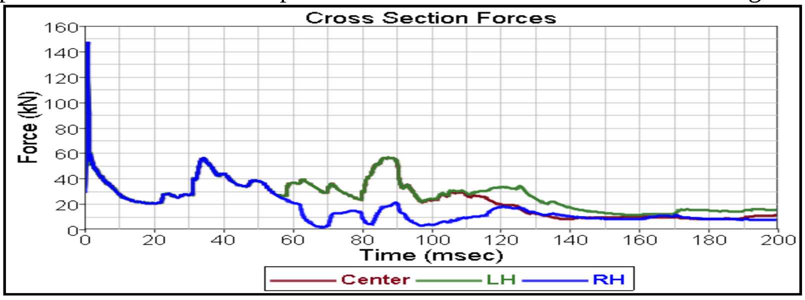


Fig.10 Graph of Cross Section Forces of Structure S3P3

10.Results of Iteration S4P1

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S4P1 is shown in figure.

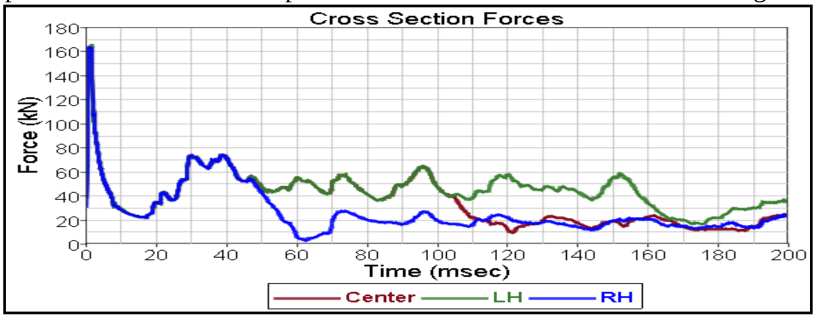


Fig.11 Graph of Cross Section Forces of Structure S4P1

11.Results of Iteration S4P2

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S4P2 is shown in figure.

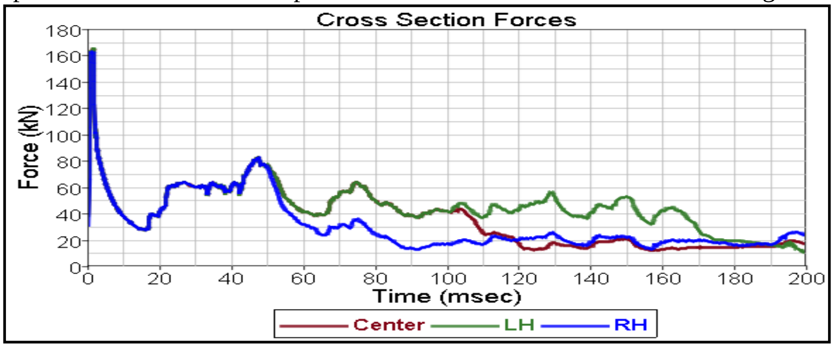


Fig.12 Graph of Cross Section Forces of Structure S4P2

12.Results of Iteration S4P3

After application of displacement to structures forces are induced in upper and lower part of the structures. The graph of these forces with respect to time of structure S4P3 is shown in figure.

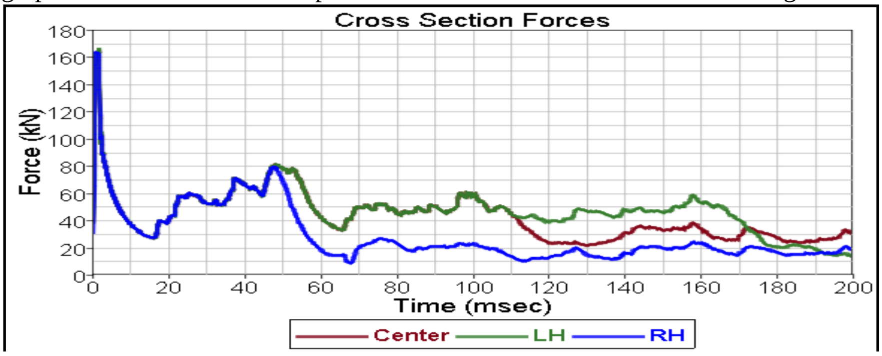


Fig.13 Graph of Cross Section Forces of Structure S4P3

IV. Result summary

- From the above study for various cross section and weld patterns it is observed that S1 > S2 > S4 > S3
- It is observed that pattern P2 is the best spot weld pattern as compared to P1 & P3. Performance of pattern P1 & P3 is nearly same.
- Pattern P2 shows better crashworthiness performance which is required for effective Crash Energy management system.
- The DOE study yields that the best combination of Section and Pattern comes to be S1P2.

V. Conclusion

From the FEA and experimental study, following conclusions are made;

- Spot-welded and laser-welded structures, prepared using standard size nugget and stitch welds were shown to perform satisfactorily under both quasi-static and impact loading.
- Although minor weld failure occurred, this did not appear to affect the overall collapse behavior which, provided the parent material possessed sufficient ductility, was dominated by progressive folding, absorbing significant amounts of energy.
- Weld spacing was shown to be an important parameter: increasing the distance between welds was found to alter the collapse mode such that the backing-plate ceased to remain an integral part of the structure.
- It was also shown that the post-buckling behavior of spot-welded structural sections could be modeled with reasonable accuracy using Dyna3D. Predicted energy absorption values, were found to be within 10 % of those observed experimentally

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