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Research Article

Shear Stress Analysis of Single Chain Riveted Lap Joint

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Abstract

Rivets are permanent, non-threaded, one-piece fasteners that join parts together by fitting through a pre-drilled hole and deformed the head by mechanically upsetting from one end. In this paper the results of experimental analysis based on lap-shear test on riveted connection are presented. For experimentation specimens were prepared and different thickness and configurations were considered. The results of experimental test allowed the influence of various parameters such as plate width and pitch. These results are compared with the Ansys result. The experimental test using Universal Testing Machine and shear stress results are calculated. These results were compared with model simulation in FEA software.

Keywords: *Shear Test, Pitch, Universal Testing Machine, FEA software.*

1. Introduction

Manufacturing large and complex structures is usually possible only when they are composed of assemblies of smaller parts joined together by variety of joining techniques since most products are impossible to be produced as a single piece. Manufacturing components and then joining them into a single product is easier and less expensive then manufacturing the whole product at once. In order to ensure the manufacturability, and reduce the overall manufacturing cost, certain fastening and joining method should be utilized.

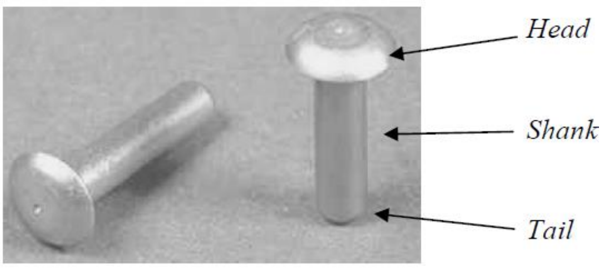

Fig.1 Solid rivet having Universal head

A rivet is short cylindrical bar with a head integral to it. A cylindrical portion of the rivet is called shank and lower portion of shank is known as tail (Fig.1). The rivets are used to make permanent fastening between the plates. A rivet is a permanent mechanical fastener. Effective transmission is possible if the pairs don't have any short of disorder in manufacturing and assembling. The function of rivet in a joint is to make the connection that has strength and tightness. The tightness is necessary in order to contribute to strength.

The most common riveted joint failures are tearing between the rivet holes, shearing of a rivet or crushing of either the rivet or the material joined by it. Tearing between rivet holes happens at the material joined, not at the rivet.

2. Literature Review

M. D'Aniello *et al*, studied load capacity of riveted lap joint was analyzed by tensile shear test. For this analysis sheet thickness, rivets and different materials of sheets are used. It was observed that during tensile shear test, differences in the shearing force were obtained for different arrangements of the sheet material. During the test it was also observed that several parameters are influenced in stress concentration of joint such as clearance between the rivet and hole, rivet diameter, hole diameter and squeeze force.

Babak Anasori *et al,* obtained the residual stress from riveting process by using thermal expansion method. By selecting different coefficients of thermal expansion of the rivet shank, height of the rivet shank was reduced and diameter of the rivet shank was increased. Reducing height of rivet shank corresponds to the clamping force in riveting process. Different coefficients of thermal expansion in the rivet shank were specified to simulate different clamping forces. Four different (0.0, 0.1, 0.2 and 0.5) clamping force

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ratios were selected. Expanding the rivet shank in the radial direction corresponds to rivet filling in the hole. Similarly different coefficients of thermal expansion were chosen so that different interference fit ratios were obtained. Interference fit ratio was defined as the interfacial pressure divided by the yield stress. For different interference fit ratios (0.00, 0.03, 0.06 and 0.15) were used to examine the effect of different interference level in the rivet hole.

3. Design and Preparation of Specimen

3.1 Factors affecting strength of riveted joint

After doing literature survey some parameters are observed which affects strength of riveted joint. The henceforth chapter discuss the effect of parameters on strength of riveted joint.

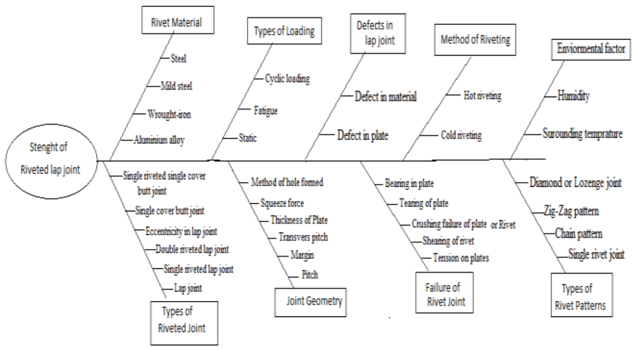

Fig.2 Cause effect diagram for riveted joint

Table. I Parameters and its selection

Sr. No.	Parameter	Selection	Reason for Selection
1	Type of loading	Shear loading	Maximum components are observed under Shear loading.
2	Type of material	Aluminium Alloy	Wide range of application.
3	Geometry of joint	Linear Pitch and Thickness of Plate	Varying this parameters affect the strength of the joint.
4	Type of joint	Lap Joint	The parameters under study are Linear Pitch and Thickness of Plate.

According to study, it is found that the rivet life is improved by varying pitch size. Pitch size effects on strength of the joint. Experimentally it is found that pitch plays major role in strength of the riveted joint. Stress variation of lap joint changed by the linear pitch and thickness of plate.

For experimentation parameters to consider linear pitch and Thickness of plate for specimen to be varied in single chain riveting.

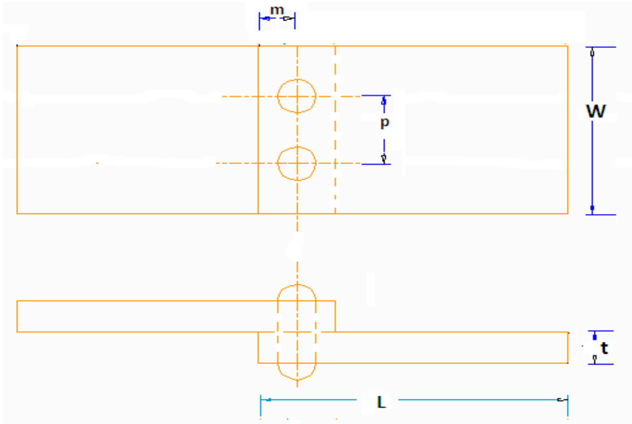

Fig.3 2D Drawing of specimen

Table. II Specimen details (for 15 mm Linear Pitch)

Sp. No.	Thickness of Plate	Margin (m =1.5d)	Pitch (p =3d)	Pitch (p =3d)	Pitch (p =3d)
1	3mm	7.5	15	18 (increasing pitch by 3mm)	21 (increasing pitch by 3mm)
2	5mm				
3	6mm				

For preparation of specimen dimensions to be considered as per fixture design as follows:- L = 100 mm, W= 50mm

4. Experimentation

The shear test on the specimen has carried out using UTM as shown in figure.

Fig.4 Photo of UTM

Fig.5 Prepared Specimen photo

Case I:-Following are the graphs when Specimen prepared for pitch 15 mm

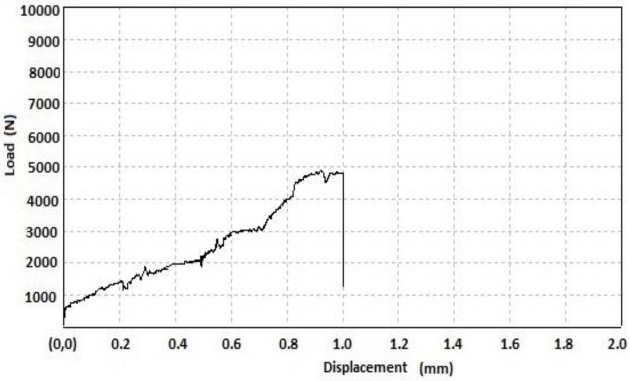

Fig. 6 Graph of Specimen No.1

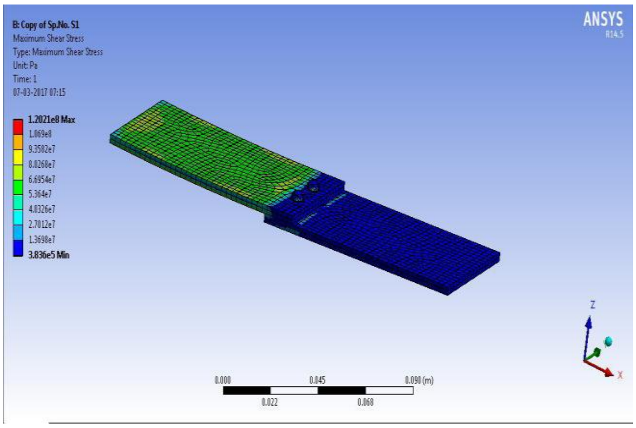

Fig.7 Simulation in Ansys

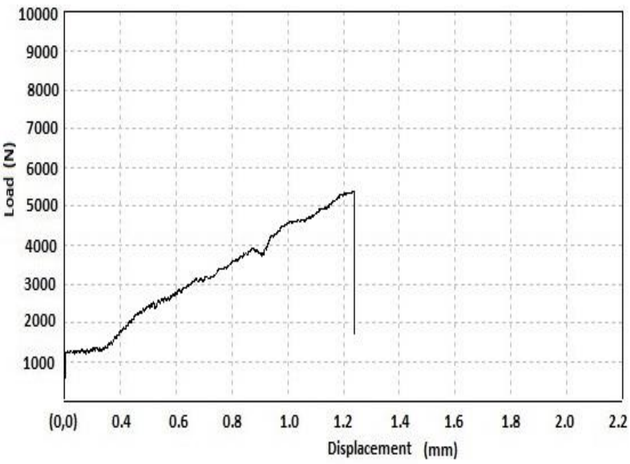

Fig. 8 Graph of Specimen No.2

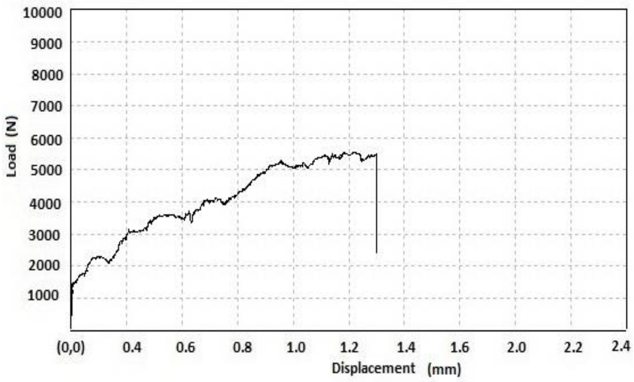

Fig. 9 Graph of Specimen No.3

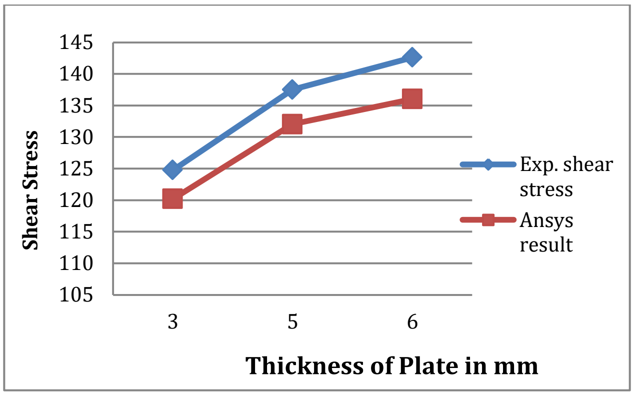

Fig. 10 Experimental and Ansys results graph

Case II:-Following are the graphs when Specimen prepared for pitch 18 mm

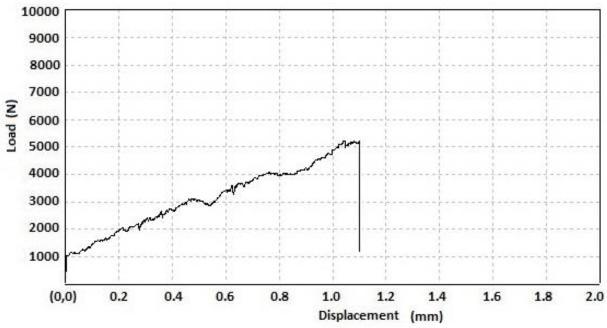

Fig. 11 Graph of Specimen No.4

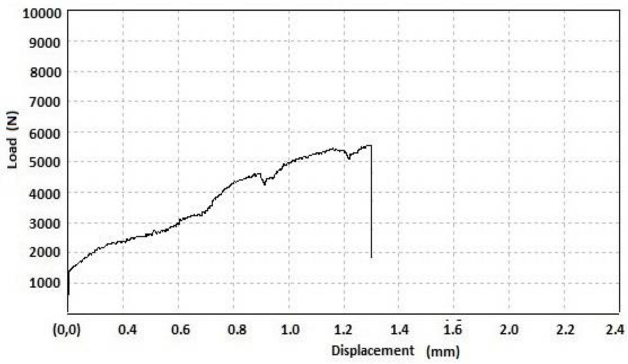

Fig. 12 Graph of Specimen No.5

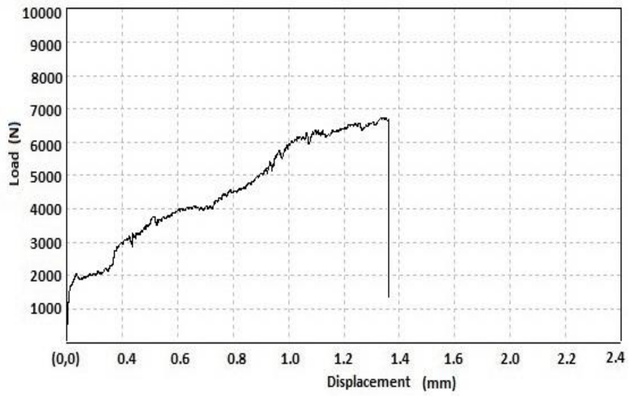

Fig. 13 Graph of Specimen No.6

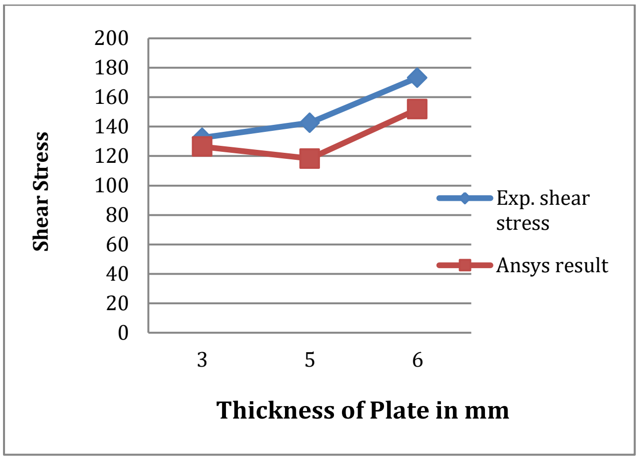

Fig. 14 Experimental and Ansys results graph

Case III:-Following are the graphs when Specimen prepared for pitch 21 mm

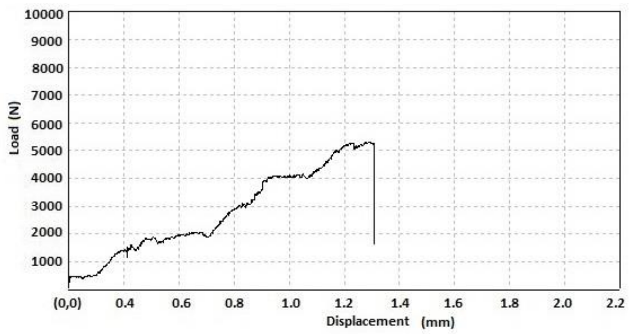

Fig. 15 Graph of Specimen No.7

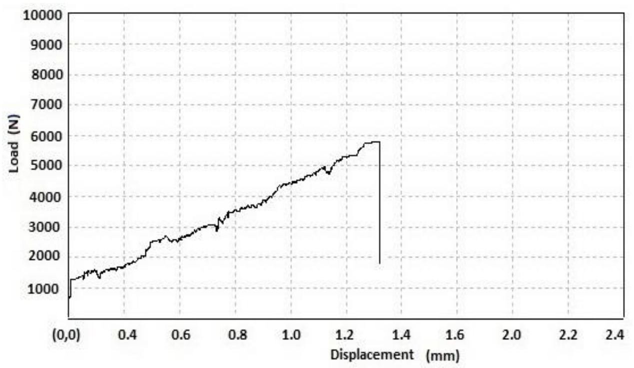

Fig. 16 Graph of Specimen No.8

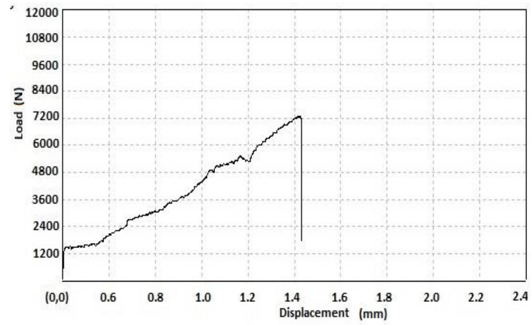

Fig. 17 Graph of Specimen No.9

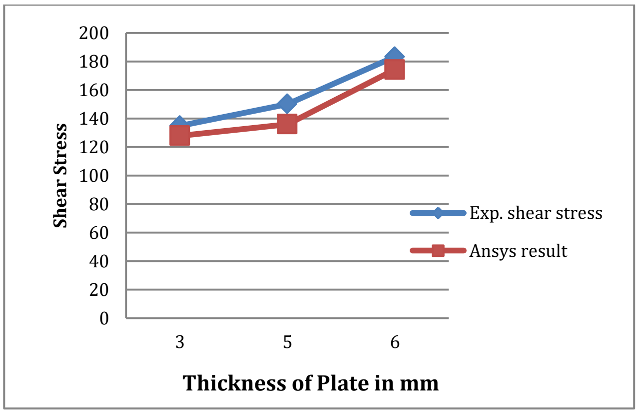

Fig. 18 Experimental and Ansys results graph

5. Interpretation of Experimental result

On the basis of the result obtained, the effect of selected parameter on the response of connections are analyzed below

5.1 Effect of plate length

Test accentuate that shear behavior is depend on the geometry and load conditions. if length of specimen is increased bending of plate occurs. The influence of bending was most pronounced in specimens with only a single rivet in the direction of the applied shear.

5.2 Effect of Pitch

Test shows that pitch is the one of important parameter which influence on strength of riveted joint. The results shows that were pitch increases strength of joint is also increased.

5.2 Effect of Plate Width

Plate width is another parameter which effects on the efficiency of joint. As increasing the plate width as ultimately increases the strength of joint.

Table. III Considering pitch 15mm

Thickness of plate in mm	Exp. shear stress result (N/mm2)	Ansys result (N/mm2)
3	124.77	120.21
5	137.51	132.05
6	142.60	136.02

Table. IV Considering pitch 15mm

Thickness of plate in mm	Exp. shear stress result (N/mm2)	Ansys result (N/mm2)
3	132.42	126.42
5	142.60	118.27
6	173.24	151.8

Table. V Considering pitch 15mm

Thickness of plate in mm	Exp. shear stress result (N/mm2)	Ansys result (N/mm2)
3	134.96	127.96
5	150.24	135.99
6	183.35	174.36

Conclusions

Various design parameters are considered and effect of this parameter on shear strength of riveted lap joint is discussed.

1) For same diameter of rivets if thickness of plates to be joined increased tensile strength of joint.

2) Experimental results highlighted that as pitch is increases at different thickness of joint which increases shear strength of joint.

3) As comparing with Ansys result that also shows increasing of joint strength by increasing the pitch and thickness of plate.

References

M. D'Aniello, F. Portioli, L. Fiorino, R. Landolfo, (2011) Experimental investigation on shear behaviour of riveted connections in steel structures. Engineering Structures 33 516–531.

Babak Anasori, Franklin Saillot, David Stanley, Jonathan Awerbuch, and Tein-Min Tan, (2014) Fatigue Crack Growth in Aluminum Lithium Riveted Lap Joints. Procedia Engineering 74 413 – 416.

Małgorzata Skorupa, Tomasz Machniewicz, Andrzej Skorupa, Adam Korbel, (2015) Investigation of load transmission throughout a riveted lap joint. Procedia Engineering 114 361 – 368.

Nanjiang Chena,, Hongyu Luo , Min Wan , Jean-loup Chenot, (2014) Experimental and numerical studies on failure modes of riveted joints under tensile load. Journal of Materials Processing Technology 214 2049–2058.

Dazhao YU, (2013). A Numerical Analysis of Riveted Lap Joint Containing Multiple-site Damage. Appl. Math. Inf. Sci. 7, No. 2L, 699-704

M.Skorupa, A.Korbel, A.Skorupa, T.Machniewicz, (2015) Observations and analyses of secondary bending for riveted lap joints. International Journal of Fatigue 72 1–10.

Jacek Mucha, Waldemar Witkowski, (2015). The structure of the strength of riveted joints determined in the lap joint tensile shear test. acta mechanica et automatica, vol.9 no.1

M. D'Aniello, F. Portioli, R. Landolfo, (2014) Lap shear tests on hot-driven steel riveted connections strengthened by means of C-FRPs. Composites: Part B 59 140–152.