ANALYSIS OF RIVETS BY USING FINITE ELEMENT ANALYSIS

P.RAJU [1], R.JYOTHU NAIK [2].

1 M.Tech Student, Narasaraopeta Engineering College, Guntur dt, Andhra Pradesh, INDIA

Email: raju.sunny305@gmail.com

2 Asst Professor of MECH, Narasaraopeta Engineering College, Guntur dt, Andhra Pradesh, INDIA

Abstract A rivet is a cylindrical body called a shank with a head. A hot rivet is inserted into a whole passing through two clamped plates to be attached and the heads supported whilst a head is formed on the other end of the shank using a hammer or a special shaped tool. The plates are thus permanently attached. Cold rivets can be used for smaller sizes the - forming processes being dependent on the ductility of the rivet material. When a hot rivet cools it contracts imposing a compressive (clamping) stress on the plates. The rivet itself is then in tension the tensile stress is approximately equal to the yield stress of the rivet material. Design of joints is as important as that of machine components because a weak joint may spoil the utility of a carefully designed machine part. Here in this project we are modeling the rivet using proe and analysing the rivet forces by Ansys which will give results by using finite element analysis.

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I. Introduction

Rivets are considered to be permanent fasteners. Riveted joints are therefore similar to welded and adhesive joints. When considering the strength of riveted joints similar calculations are used as for bolted joints.

Rivets have been used in many large scale applications including shipbuilding, boilers, pressure vessels, bridges and buildings etc. In recent years there has been a progressive move from riveted joints to welded, bonded and even bolted joints A riveted joint, in larger quantities is sometimes cheaper than the other options but it requires higher skill levels and more access to both sides of the joint There are strict standards and codes for riveted joints used for structural/pressure vessels engineering but the standards are less rigorous for using riveted joints in general mechanical engineering Mechanical joints are broadly classified into two categories viz., non-permanent joints and permanent joints. Permanent joints cannot be dissembled without damaging the components. These joints can be of two kinds depending upon the nature of force that holds the two parts. The force can be of mechanical origin, for example, riveted joints, joints formed by press or interference fit etc, where two components are joined by applying mechanical force. The components can

also be joined by molecular force, for example, welded joints, brazed joints, joints with adhesives etc.

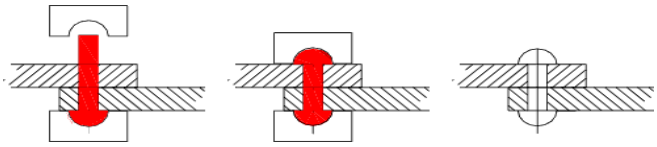

FIG:1

II. LITERATURE SURVEY

Ali M. Ai-Samhan presented the paper on "Analysis of adhesively bonded riveted joints" he considered a model for sample Analysis. He created a model and analysed in GID pre-processing program for the chosen working conditions and differentiated through the graphs at constant load on different conditions of lap joints with and without adhesives [1].

Hoffer determined the load bearing capacity of a riveted joint by statistically testing the joints and evaluating joint failure types [2].

Schvechkov studied experimentally the effect of adhesive mechanical properties along with the geometry of butted sheets on the point of failure cycle longevity on riveted bonded joints[3].

Fung built a finite element model for snap and counter sink riveted single joints, and were able to examine the interaction between rivets and jointed members for these two types of joints. The stress concentration factor s around the joints were also determined [4].

III. RIVET

A Rivet is a short cylindrical rod having a head and a tapered tail. The main body of the rivet is called shank

(see figure 1.1). According to Indian standard specifications rivet heads are of various types. Rivets heads for general purposes are specified by Indian standards IS: 2155-1982 (below 12 mm diameter) and IS: 1929-1982 (from 12 mm to 48 mm diameter). Riveting is an operation whereby two plates are joined with the help of a rivet. Adequate mechanical force is applied to make the joint strong and leak proof

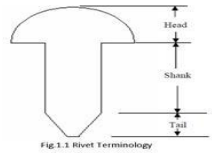

Fig.1.1 Rivet Terminology

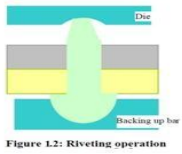

Figure 1.2: Riveting operation

Fig:2

IV.RIVET MATERIAL: Rivets are manufactured for the materials conforming to IS: 1148-1982 and IS: 1149-1982 for structural work and to IS: 1990-1973 for pressure vessels. Rivets are usually made from the tough and ductile material namely low carbon steel (C15), nickel alloy steel, and wrought iron. Rivets are also made from non-ferrous material such as copper, aluminum alloys and brass for anti corrosive properties where strength is not major requirement. According to BIS, the rivet material should have tensile strength more than 350 N/mm^{2}and elongations not more than 20%.

Manufacturing of rivet

Solid rivets which is of commonly used in mechanical system are generally manufactured in large numbers starting with a wire, rod or bar of material of substantially the same diameter as the desired shank of the finished rivet. In fabrication, the rod is cut off; the end of the rod is inserted into the die defining the rivet, and then typically given an initial upset followed by a final blow to form the head and tapered region between the head and shank of the rivet.

- Selecting of rod of same dia as of rivet
- Cutting of rod
- Cold heading of rivet into dies

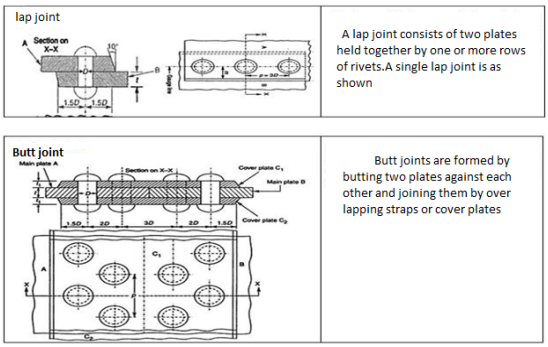

Fig:3 Types of joints.

V.RIVETING TECHNIQUES: There are several common methods or techniques for performing riveting operations. There is the standard hand riveting with a bucking bar or a blind rivet. Three basic alternative methods of riveting are cold riveting, hot riveting, and automated riveting. Each method is used to achieve different characteristics. In the standard riveting process and in cold or hot riveting a bucking bar is used at the bottom end of the rivet to cause it to form a head when the rivet is driven through the hole. Bucking bars are of different weights depending on the size of the rivet being used. In the cold riveting process the rivets are kept in a refrigerator until they are ready to be used

VI.DESIGN STRESSES: For rivets used for structures and vessels etc the relevant design stresses are provided in the applicable codes. For rivets used in mechanical engineering, values are available in mechanical equipment standards which can be used with judgment.BS 2573 Pt 1 Rules for the design of cranes includes design stress values based on the Yield stress (0,2%proofstress) $Y_{R0.2}$ as follows Hand driven rivets tensile stress(40%$Y_{R0.2}$,.Shear (36,6%$Y_{R0.2}$),Bearing(80%$Y_{R0.2}$) Machinery's handbook includes some values for steel rivets . I have interpreted these values and include them below as rough approximate values for first estimate. These are typical values for ductile steel. Tensile (76MPa), Shear (61MPa), Bearing (131MPa).

VI.ANALYSIS OF RIVET

The material properties which are used for analysis of rivet

Table: 1

Table Material properties of adherents and adhesive used			
Material	Young's modulus (N/mm^2)	Poisson's ratio	Shear modulus (Gpa)
Adhesive	2.5×10^3	0.38	0.905
Steel	2.0×10^5	0.30	78.1

VII OVERVIEW OF ANSYS

The ANSYS computer program is a large scale multipurpose finite element program, which may be used for solving several classes of engineering analyses. The program contains many special features which allow non linearity or secondary effects to be included in the solution, such as plasticity, large strain, hyper elasticity, creep, swelling, large deflections, contact, stress stiffening, temperature dependency, material anisotropy, and radiation.

VIII .DESCRIPTION OF THE PRESENT WORK

The present work deals with the Analysis of adhesively bonded single lap riveted joint. We have taken the journal paper as a model for the better understanding

IX. RESULT AND DISCUSSION

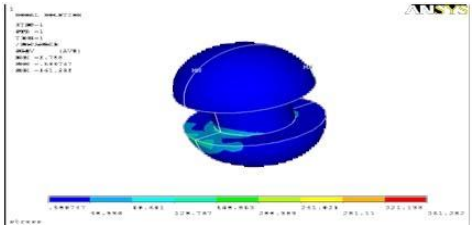

Fig:4 The stress distribution of a rivet without adhesive

This is quite commonly used technique for finding the strength of different applications like pressure vessels, aerospace, marine applications and mostly for leak proof joints like oil tanks, boilers etc..

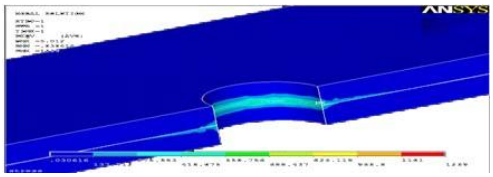

Fig: 5 The stress distribution of a single lap riveted joint without adhesive and shows at the contact of plates and rivet.

In this a lap joint of steel plate material having 100mm*1.5mm*20mm and a friction factor of 0.1 is over lapped with the other plate having same dimensions and material and are joined by means of a rivet having diameter 4mm, apply a load of 500N on one side and the other end is fixed in the ANSYS

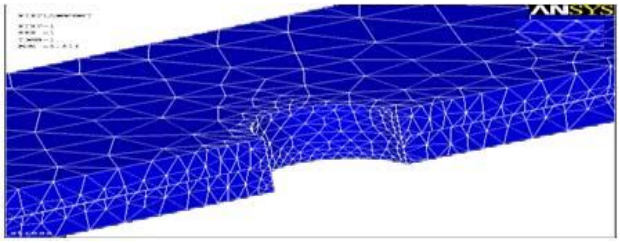

Fig:6 The stress distribution of a single lap riveted joint without adhesive and shows at the contact of plates and rivet with meshing elements

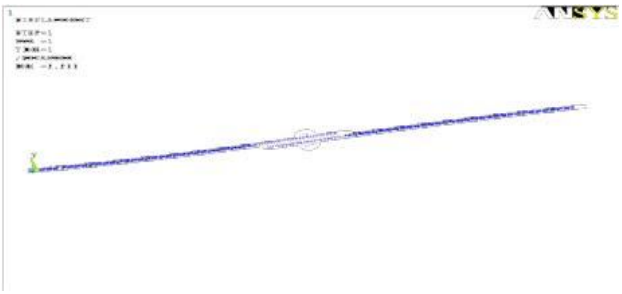

Fig: 7The deformation of a single lap riveted joint with adhesive b/w the plates only.

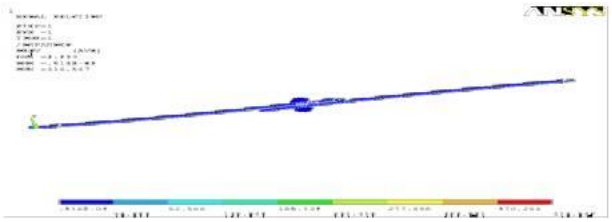

Fig: 8 The stress distribution of a single lap riveted joint with adhesive b/w the plates only

X Finite Element Modelling and Boundary Conditions

Four different bonded layer orientation in bonded-riveted joints were considered in the present work and the considered orientation are listed as follows:

1. A single lap riveted model,
2. A single lap riveted-bonded model (bonded at overlap area only),
3. A single lap riveted-bonded model (bonded at overlap area and rivet-body),
4. A single lap riveted-bonded model (bonded at overlap area, rivet-body and rivet-cap-head).

XI. SUMMARY AND CONCLUSION

- Finite Element Method is found to be most effective tool for designing mechanical components like single lap riveted joints.
- ANSYS can be used for analysis of complex and simple models of different type without any effect on practical and economical issues.
- The results obtained from ANSYS software for the Adhesively Bonded Single lap riveted joints are compared with each other at different conditions of using adhesives at described locations leads to decreasing the stresses, uniform distribution of load gives more efficient and life to the joints.

XII. REFERENCES

1. **Ali M. Ai-Samhan** presented the paper on "Analysis of adhesively bonded riveted joints" he considered a model for sample Analysis
2. **Hoffer** Methods of Analysis and Failure Predictions for Adhesively Bonded Joints of Uniform and Variable Bond line Thickness
3. **Schvechkov** Presented A Methods of Analysisa nd Failure Predictions for Adhesively Bonded Joints of Uniform and Variable Bond line Thickness
4. **Fung** A finite element model for snap and counter sink riveted single joints.