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P. Raju
M. Tech Student, Department of Mechanical Engineering, Narasarao pet Engineering College, Narasaraopet, India.

J.R. Jyothu Nayak
Assistant Professor, Department of Mechanical Engineering, Narasarao pet Engineering College, Narasaraopet, India.

Correspondence:
P. Raju
M. Tech Student, Department of Mechanical Engineering, Narasarao pet Engineering College, Narasaraopet, India.

Investigation of rivets using Finite Element Analysis (FEA)

P. Raju, J.R. Jyothu Nayak

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.

Keywords: Investigation, Rivets, Finite Element Analysis (FEA).

1. 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.

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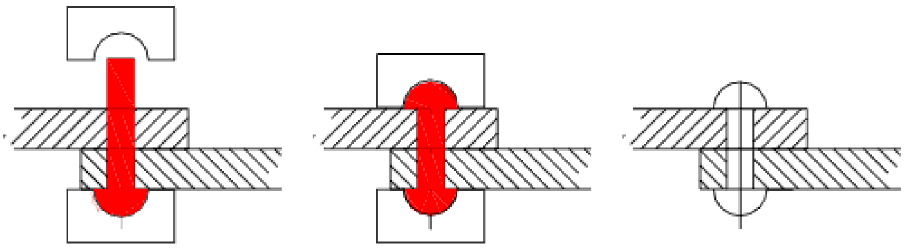
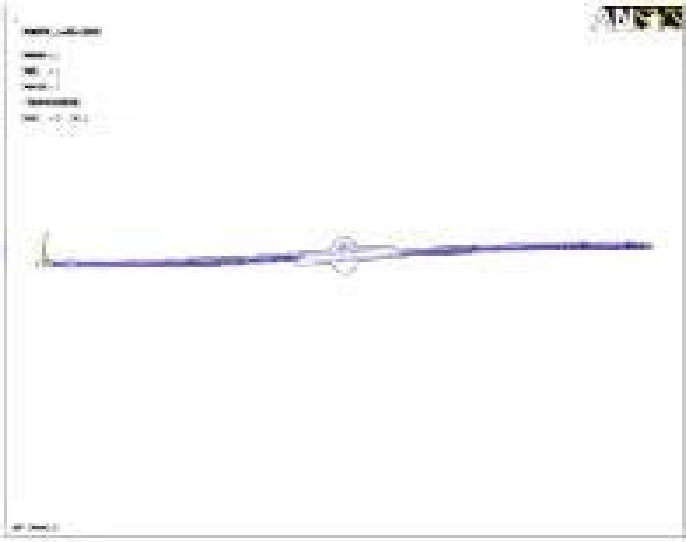


When a hot rivet cools it contracts imposing a compressive (clamping) stress on the plates. The rivet itself is then in tension the tensile stress is approximately equal to the yield stress of the rivet material.

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.

Mechanical joints are broadly classified into two categories viz., non-permanent joints and permanent joints. Non-permanent joints can be assembled and dissembled without damaging the components. Examples of such joints are threaded fasteners (like screw-joints), keys and couplings etc. 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.

2. Results and Discussions



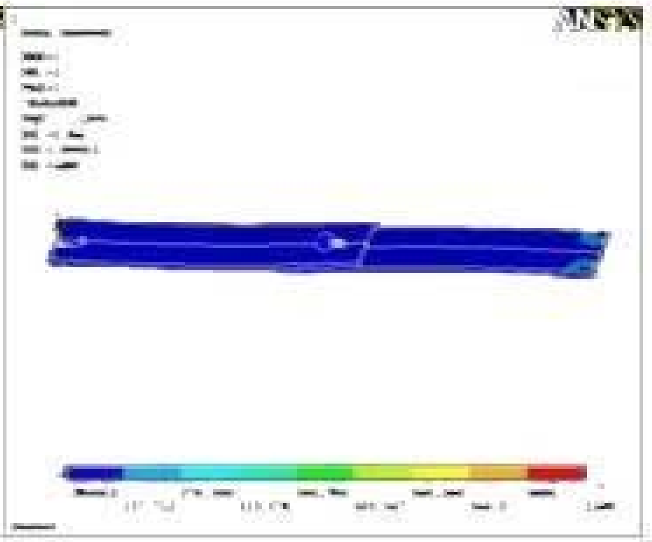
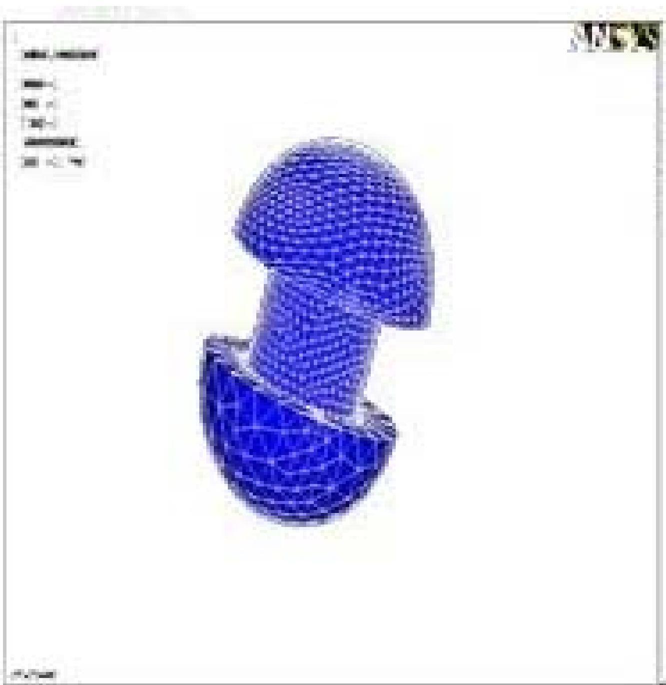


Fig 1(a): The deformation of a single lap riveted joint without adhesive.

Fig 1(b): The stress distribution of a single lap riveted joint without adhesive.



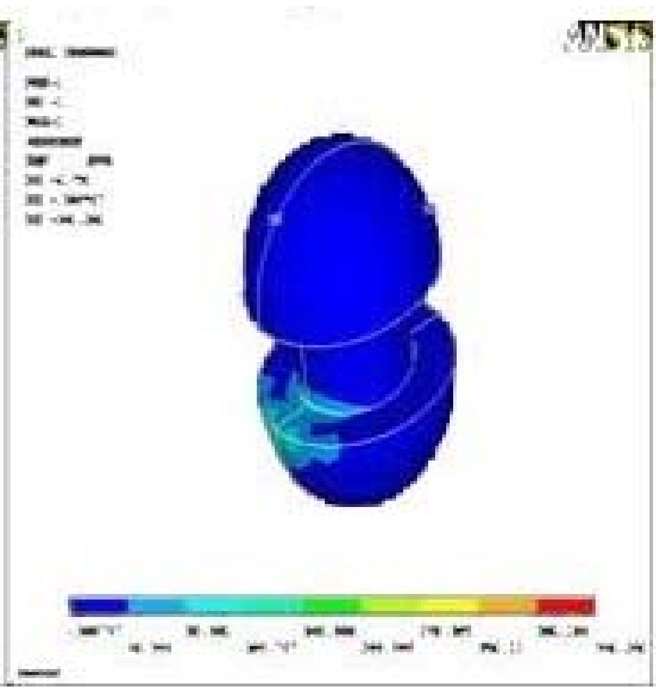


Fig 1(c): The Deformation of a rivet without adhesive

Fig 1(d): The stress distribution of a rivet without adhesive

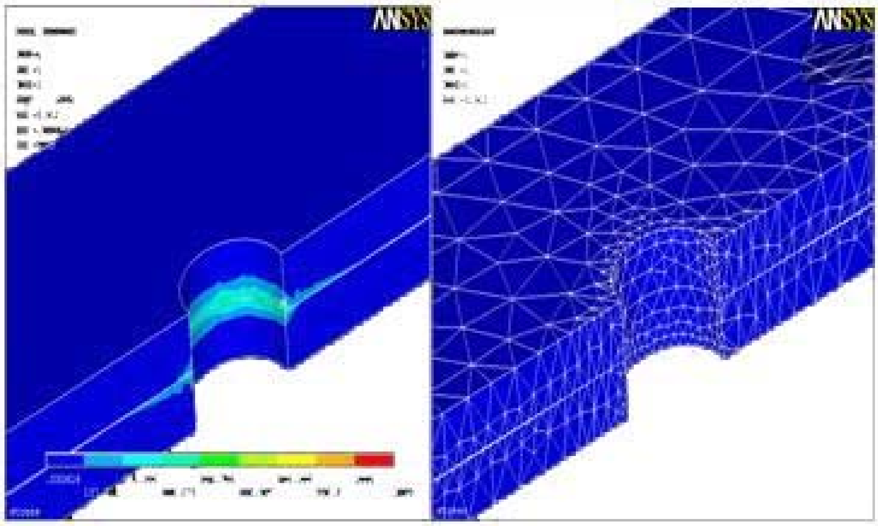


Fig 1(e): The stress distribution of a single lap riveted joint without adhesive and sl at the contact of plates and rivet.

Fig 1(f): The stress distribution of a single lap riveted joint without adhesive and sl at the contact of plates and rivet with meshing elements.

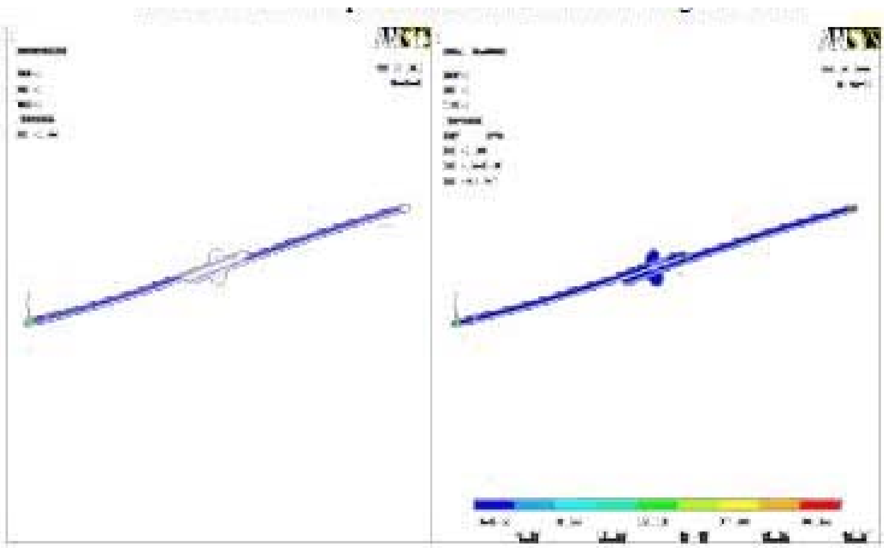


Fig 2(a): The deformation of a single lap riveted joint with adhesive b/w the plates only.

Fig 2(b): The stress distribution of a single lap riveted joint with adhesive b/w the plates only.

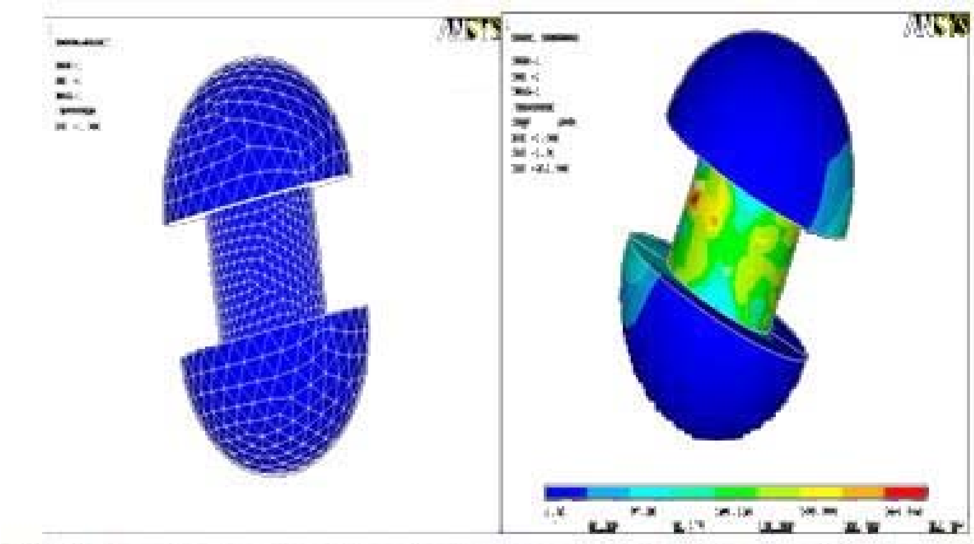


Fig 2(c): The deformation at rivet of a single lap riveted joint with adhesive b/w the plates only.

Fig 2(d): The stress distribution at of a single lap riveted joint with adhesive b/w the plates only.

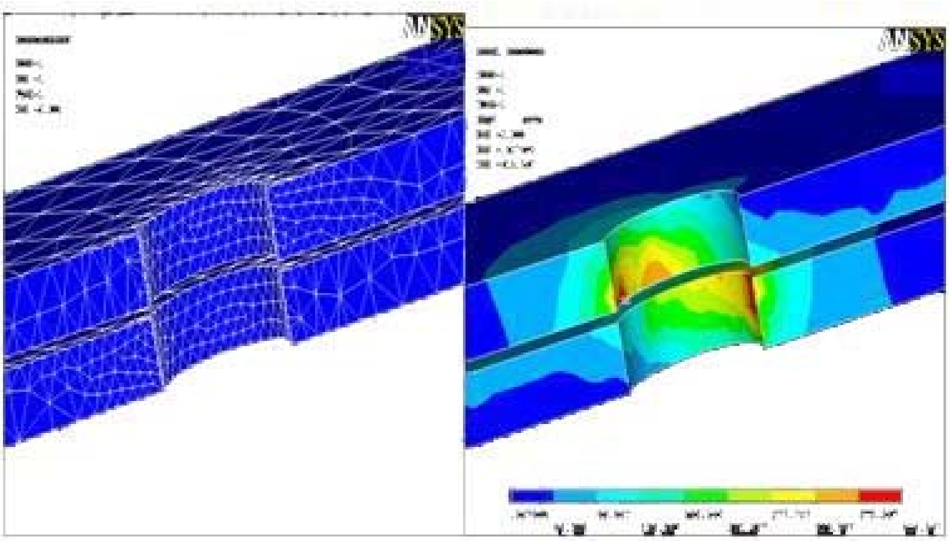


Fig 2(e): The deformation at cross section of a single lap riveted joint with adhesive b/w the plates.

Fig 2(f): The stress distribution at cross section of a single lap riveted joint with adhesive b/w the plates only.

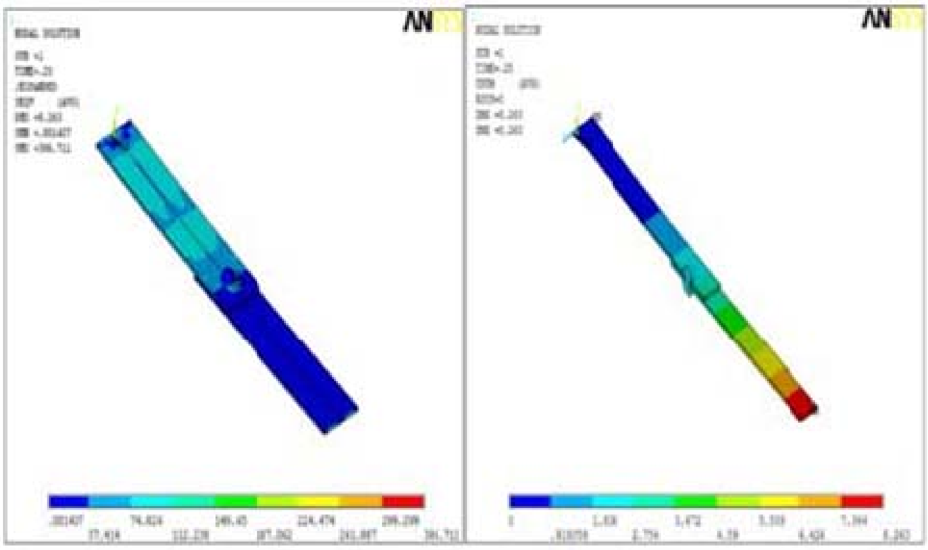


Fig 3(a): The stress distribution of a single lap riveted joint with adhesive b/w the plates and rivet also.

Fig 3(b): The deformation of a single lap riveted joint with adhesive b/w the plates and rivet also.

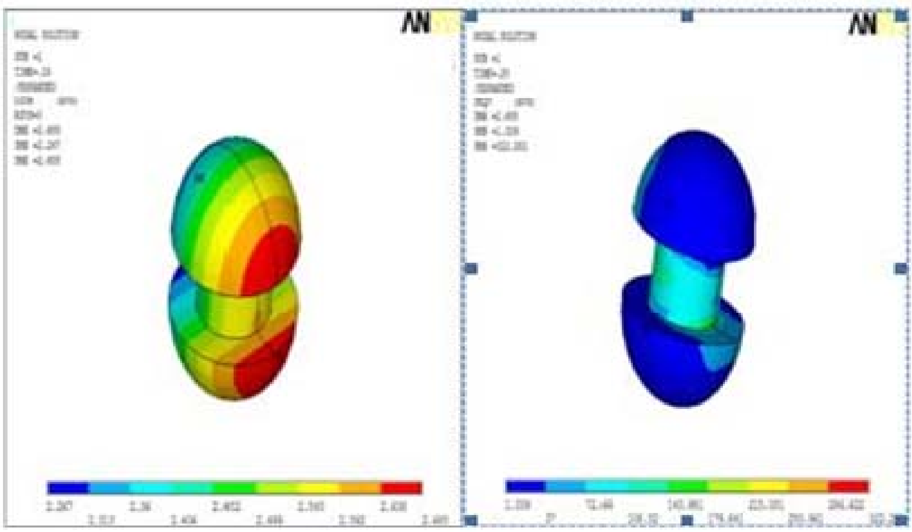


Fig 3(c): The deformation at rivet of a single lap riveted joint with adhesive b/w the plates and rivet also.

Fig 3(d): The stress distribution at rivet of a single lap riveted joint with adhesive b/w the plates and rivet also.

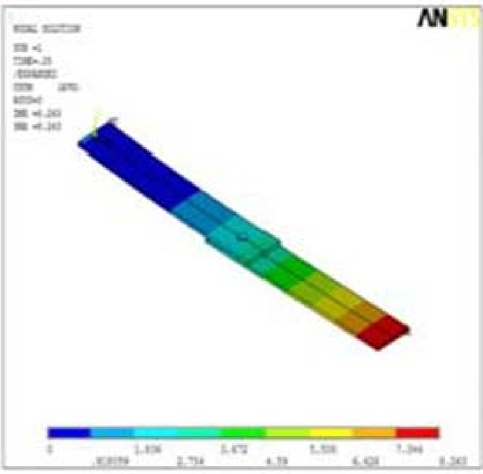
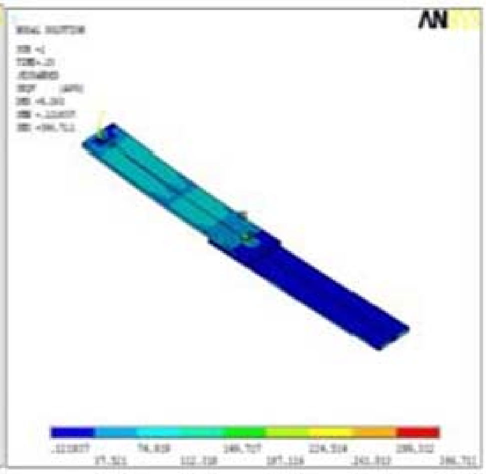



Fig 3(e): The deformation of a single lap riveted joint with adhesive b/w the plates and rivet also.

Fig 3(f): The stress distribution of a single lap riveted joint with adhesive b/w the plates and rivet also.

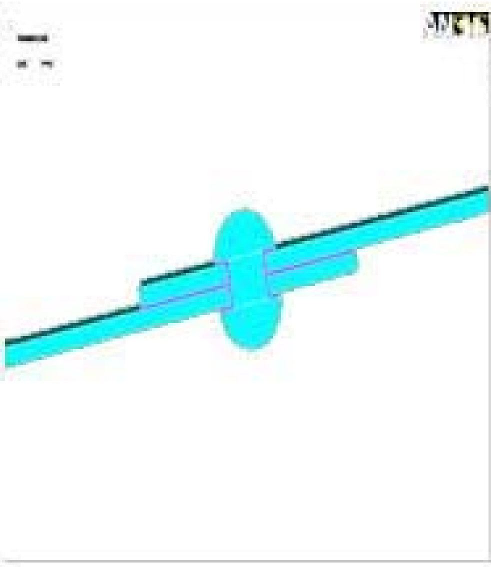
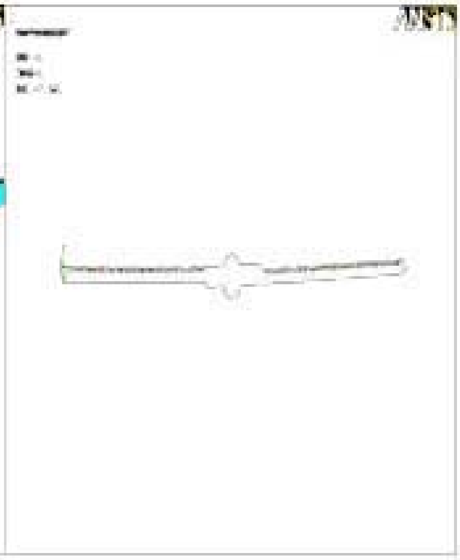



Fig 4(a): The model of a single lap riveted joint with adhesive b/w the plates, rivet and head also.

Fig 4(b): The deformation of a single lap riveted joint with adhesive b/w the plates, rivet and head also.

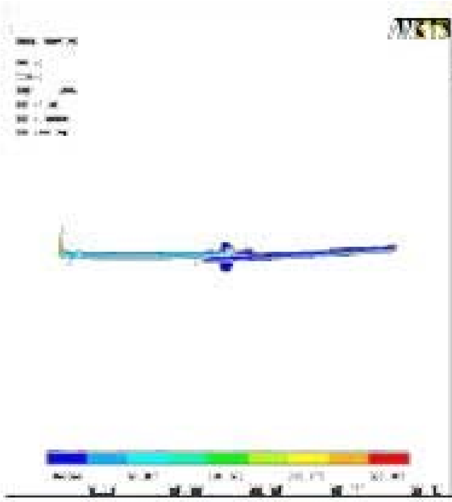
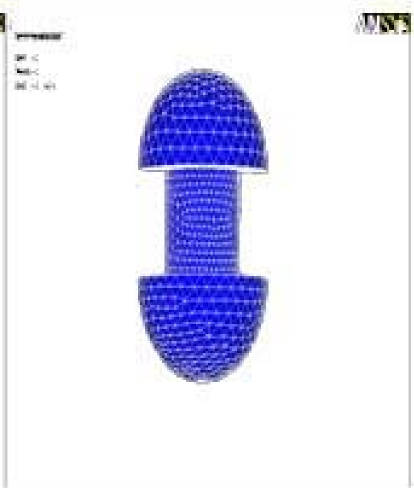
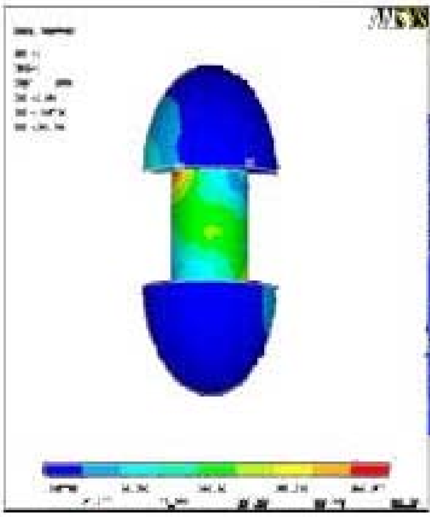



Fig 4(c): The stress distribution of a single lap riveted joint with adhesive b/w the plates, rivet and head also.

Fig 4(d): The deformation at rivet of a single lap riveted joint with adhesive b/w the plates rivet and head also.



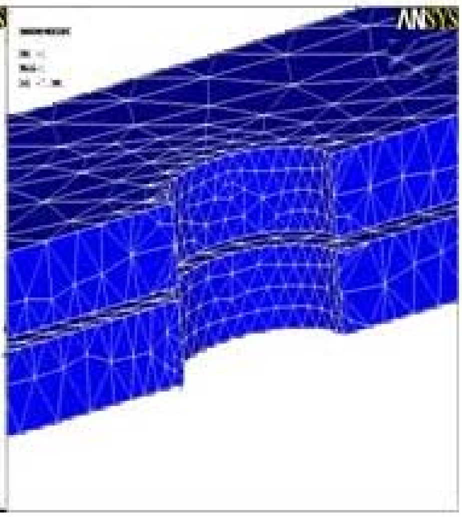
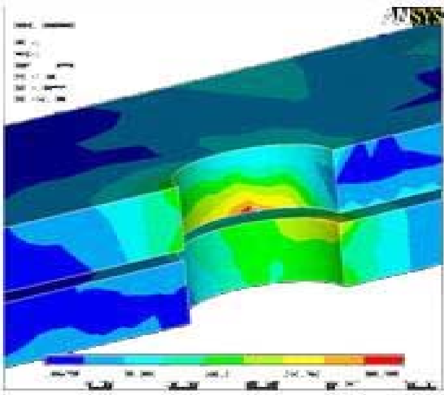


Fig 4(e): The stress distribution at rivet of a single lap riveted joint with adhesive b/w the plates, rivet and head also.

Fig 4(f): The deformation of a single lap riveted joint with adhesive b/w the plates, rivet and head also.



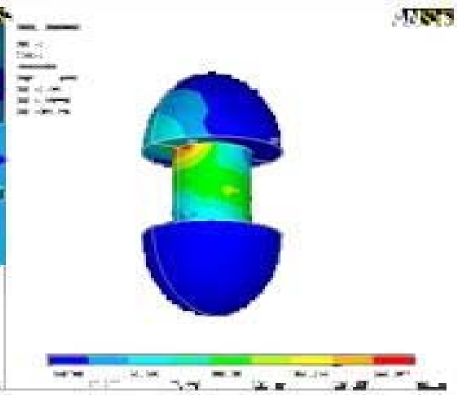


Fig 4(g): The stress distribution at cross section of a single lap riveted joint with adhesive b/w the plates, rivet and head also.

Fig4 (h): The stress distribution at rivet of a single lap riveted joint with adhesive b/w the plates, rivet and head also.

3. 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 economic 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.

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