# Bending Stresses in a Single Lap Rivet Joint

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## Research Objective

Non-axiality of load path in riveted and bolted joints causes local bending stresses and rivet rotation at the joints. This research investigates the magnitude of elastic and inelastic (elastic-plastic) bending stresses in a single lap riveted joint.

## Approach

A two-rivet, single lap joint of typical fuselage construction was analyzed using a nonlinear contact finite element analysis. The rivet joint was modeled as a smooth fit. Bending and membrane stresses on a perpendicular plane through the rivet axis was examined. The analysis was repeated for both elastic and elastic-plastic deformations. Plate was modeled as a multilinear isotropic hardening material with yield and ultimate strengths of 270 MPa and 440 MPa respectively. Whereas the rivet was modeled as an elastic material.

## Accomplishment Description

Figure a. shows the rivet joint configuration and axial loading. Both plates and rivet were modeled by 8-node solid elements. Contacts between top and bottom plates, rivet shank and hole, rivet head and plates were modeled by contact elements. Friction, clampup and interference effects were not considered. Both elastic and elastic-plastic analysis were conducted. Membrane and bending stresses at the hole boundary are shown in figure b. Bending stresses decreased with increased remote load. It was almost zero for elastic-plastic case for $\sigma_\infty \geq 95$ MPa. Plastic deformation at the hole relieves the bending stresses. The membrane stresses plateaus at about 320 for higher applied loads.

## Significance

Effect of non-axiality of the load path causes bending stresses local to the hole, but at high load levels, bending stress is small and can be neglected. At high load levels, a Simple membrane analysis would provide the complete description of the local stresses.

## Future Plan

Write a detailed report on this work and publish as a NASA TM and selected data as a journal article.

## Reference

1. Vivek Ramanujapuram, K. N. Shivakumar, J. C. Newman, Jr., "Three dimensional nonlinear contact stress analysis of a rivet joint including various joint complexities", 39th AIAA/ASME SDM conference, Long Beach, CA, April 18-24, 1998.
2. Vivek Ramanujapuram, MS Thesis, North Carolina A&T State University, 1998.

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