# Reduced Finite Element Modelling of Rivetted Joints Using Semi-Empirical Formulations

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Critical structural components in the various industries are connected via flanges using riveted joints, which offer superior shear strength compared to bolts, making them well-suited for load-bearing applications. Despite their geometrically simple shape, the stress behavior of rivets is complex due to assembly-specific features such as preload, interference fit, and the use of sealing elements or adhesives [1]. This complexity makes it impractical to model rivets with solid finite elements. To address this, rivets are commonly represented as mesh-independent point fastener elements in finite element models. Existing approaches in the literature — including formulations by Huth, Boeing, Douglas, Tate & Rosenfeld, and Grumman — estimate fastener shear compliance using semi-empirical expressions derived from test data [2]. However, these formulations may vary and can be difficult to choose for specific systems.

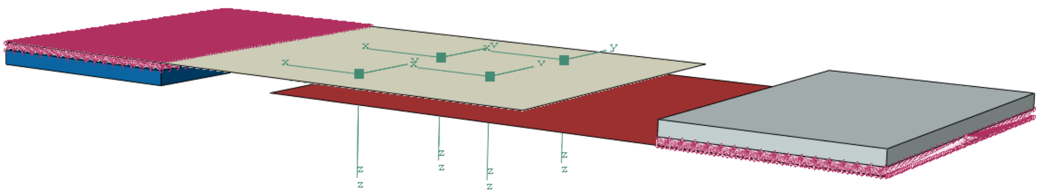

Figure 1. Reduced riveted joint FEA model in ABAQUS.

In this study, a new semi-empirical shear compliance formulation was developed using tensile test data obtained from riveted plate specimens covering a range of plate thicknesses and rivet diameters. The base term structure of the formulation was adopted from existing literature formulations such as Huth, Boeing, and Douglas, utilizing fundamental terms of the form (t/d)^0.8/Et, 1/tE, 1/(tE_f ), 1/(dE_f ) and similar expressions. The iterative finite element models employed shell elements for plates with contact definitions. Shear compliance values were extracted iteratively from global stiffness measurements, and multiple regression techniques — including least squares, weighted least squares, regularized least squares, and PCA-based order reduction — were applied to determine the formulation coefficients. A three-term model was selected by balancing prediction error and condition number stability.

Finite element analyses using the new formulation were compared against rigid fastener modeling and existing literature formulations. The results demonstrate that the new formulation correctly predicts failure modes and produces structural responses consistent with the actual assembly behavior — an outcome not reliably achieved with rigid modeling approaches.

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