Non Linear Contact Analysis of Lug joint

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ABSTRACT
Lugs are connector type elements widely used for structural support for pin connections. The pin and lug contact has been analyzed using plane stress with thickness. The stress concentration effect as well as contact pressure development in the structure has been studied by considering axial load on lug joint. Generally stress concentration effect and nonlinear contact are the sources of failure of structures.

Keywords: Contact Analysis, Non Linear analysis, Lug Joint, Ansys

1. INTRODUCTION
In the past the lug strength is overdesigned weight and size requirements were given less importance, However refinement of these requirements have necessitated conservative methods of design. Therefore due to the optimization of structure it is necessary to check the contact strength of pin and lug plate. The pin and lug plate contact has been analyzed using plane stress with thickness. The stress concentration effect as well as contact pressure development in the structure.

2. LUG STRENGTH CALCULATIONS:
Lug plate and Pin Strength under Uniform Axial Loading Lugs must be analyzed for bearing and net-section strength while pins are analyzed for shear and bending load. See Figure.1 for an overview of basic lug geometry.

2.1 Lug plate Design

![Fig.2 Lug Plate Model](image)

Total load on single lug plate = 375000N
Material allowable stress =140 N/mm²
Stress Concentration hole region $K_\sigma = 3$

![Fig 2.1 Stress variation along the pin hole interafce](image)
Nominal Stress at hole region = 140/3 N/mm²
Area required at whole resistance
A = 375000 x 3/140
A= 8035.7 mm²
Considering structural thickness t = 32mm
Width of lug plate = 8037.5/32 = 251.11
Considering Standard width W = 252 mm
Therefore main lug plate dimension
Thickness= 32mm
Width = 252 mm

2) Pin load calculations
Shear load on pin = 375000N
Considering FOS: 5-6 for varying load: EN8
Considering yield stress of material as σ_y = 385 N/mm²
Critical Shear stress τ_d =175 N/mm²
FOS = 5 for Pin material (Considering varying loads)
τ_d = (175/5) = 35 N/mm²
π / 4 x d² = 375000/35
d = 117 mm
Standard size of pin diameter minimum = 120mm.

3. MODEL OF PIN AND LUG PLATE

Fig.3 Geometry of the lug plate and pin problem
4. CONTACT STRESS ANALYSIS

The figure 4 shows Vonmisses stress development in the lug plate material. The extra projects are not considered for the plate material. So stress value is increasing and maximum stress value is around 120.856 Mpa. Contact between both the members is moving to the left.

4.1 CONTACT STRESS CALCULATIONS

Ratio \( \frac{a}{d} = \frac{120}{252} = 0.4761 \)

Where \( a \) = diameter of plate hole
\( d \) = width of lug plate

\( K_t \) = Theoretical stress concentration factor for Tension or Bending.
\( K_t = 2.4 \) from graph.

Selecting \( K_t = 3 \)

Average stress \( \sigma_{av} = \frac{F}{(d - a)h} \)

\( \sigma_{av} = \frac{375000}{(252 - 120) \cdot 72} = 39.457 \text{ N/mm}^2 \)

Stress Concentration hole region \( K_\sigma = 3 \)

Contact stress between pin and plate hole region
\( \sigma = \sigma_{av} \times K_\sigma \)
\( \sigma = 39.45 \times 3 = 118.35 \text{ N/mm}^2 \)

As ansys results are permitted to 15% erroneous the, analytical and software comparison produces the 2% error and the analytical results are within the permitted error range.
The figure shows stress variation along the plate geometry. Maximum stress is observed at the contact region and stress slowly dropping to nominal stress value. Maximum stress is observed as 120.856 Mpa at the pin and plate interface.

CONCLUSION
Contact analysis has been carried out to check the contact stress generation at the lug plate and pin hole interference. The results shows a stress development of around 120 Mpa near the left side of the pin hole interface, this is due to contracting contact surface due to axial loading.

REFERENCES
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