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**Pedersen, N. L.**

*Published in:*
Proceedings of the 32nd Nordic Seminar on Computational Mechanics

*Publication date:*
2019

*Document Version*
Publisher's PDF, also known as Version of record

Proceedings of the 32nd Nordic Seminar on Computational Mechanics
A.H. Niemi and H. Koivurova (Eds.)


# On optimal design of lug joints

N. L. Pedersen

Dept. of Mechanical Engineering, Solid Mechanics
Technical University of Denmark
Nils Koppels Allé, Building 404, DK-2800 Kgs. Lyngby, Denmark
e-mail: nlp@mek.dtu.dk

## Introduction

A lug or pinned connection is a simple assembly type that allows for quick assembly and disassembly. The connection have many practical applications both in mechanical and civil engineering cases. In the present work the loading on the assembly is assumed to be cyclic so that the design criteria for strength is fatigue, i.e. the maximum stress in the assembly. The usual design of lug joints is controlled by standards, e.g. ISO2338.

The stress state is 3 dimensional but still the normal design is constant through the thickness so focus is on the cross sectional design. The typical sectional design is circular and stress concentration factor charts can be found in the literature. The typical assumption used is that it is sufficient to use a 2D model, where a further assumption of either plane stress or plane strain is needed. In practical designs where the thickness is of the same order as the pin diameter we find that there is a significant variation in the stress in the axial direction. The same type of variation is also found in e.g. interference fits, see e.g. [1]. For simplification we will however here neglect the 3D effect on the stress concentration.

In the present work the aim is to minimize the stress concentration resulting in an increased strength of the connection. The finite element method (FEM) is used as the analysis tool, and for the successful application a number of aspects must be taken into account, and will be discussed in relation to the design. The different aspects includes,

- The definition of the stress concentration factor.
- Mesh refinement (in non-linear contact analysis).
- Head distance.
- Poisson's ratio.
- Plane stress or plane strain.
- Friction.
- Clearance.

The design optimization is performed using shape optimization. For the present optimization we have the special case that the shape to be designed is the contact zone. The selected shape parameterization used is the super elliptical one. Further information can be found in [2].

## References

[1] N. L. Pedersen. On optimization of interference fit assembly. *Structural and multidisciplinary optimization*, 54(2): 349-359, 2016.

[2] N. L. Pedersen. Stress concentration and optimal design of pinned connections. *Journal of strain analysis for engineering design*, 54(2): 95–104, 2019.