During the first step of the analyses, the overlapping surfaces of pin and box are brought into contact. This results in the von Mises stress distribution as shown in figure 2 a). The stress at the tip of the pin is a hoop stress of about 450 MPa.

An additional external axial load is applied on the connection giving the stress distribution of figure 2 b). As can be expected from [1], the highest stress concentration is located at the root of the last engaged thread of the pin. This stress concentration is mainly caused by axial stress, while the stress state at the tip of the pin is caused by hoop stresses from make-up and opening between the threads of the pin and box.

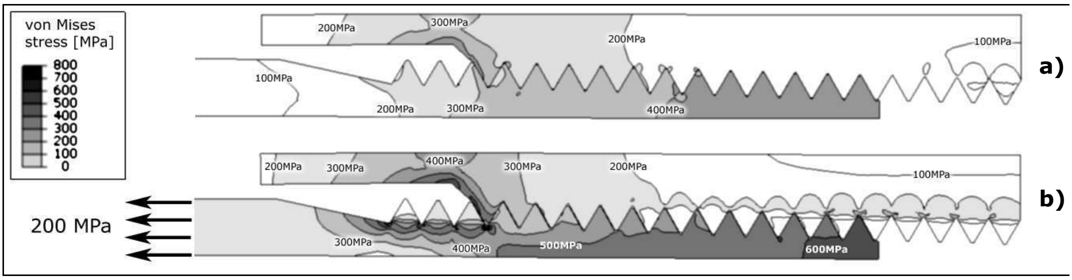

Figure 2. Stress distribution resulting from a) make-up, b) make-up + 200 MPa axial load.

When the wall thickness of the box is increased, the box becomes more rigid. This increases the hoop stresses in the pin. If on the other hand, the wall thickness of the pin is increased, the acting hoop stress on the pin will decrease while the hoop stress in the box will increase.

It can be seen in figure 2 b) that the box has an unthreaded extension at the left side. Due to a combination of hoop stress and bending of the extension, an additional stress concentration is introduced where it is connected to the threaded section of the box. When this extension is left out however, the opening between the threads under load increases together with the hoop stress in the pin, reducing the connection's strength.

It was observed that the opening between pin and box threads is significantly influenced by the coefficient of friction between the threads. Since a larger opening will decrease the static pull-out strength of the connection, it is important to have accurate data of the coefficient of friction. However, this data is generally not present and can only be determined experimentally.

4. Conclusions

A finite element analysis of a preloaded conical threaded connection is presented. Results are consistent with data known from literature. The strength of the connection depends on both geometrical and material properties. The coefficient of friction between the threads should be determined experimentally to predict the connection's behavior accurately.

6. References

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FAST MULTIPOLE EVALUATION OF DOMAIN TERMS IN INTEGRAL EQUATIONS OF TWO-DIMENSIONAL ELASTICITY

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1. Introduction

Application of the fast multipole method (FMM [1]) reduces the complexity of the boundary element method (BEM) analysis. Reference [2] gives a review on applications of the fast multipole boundary element method (FMBEM) and directions of further research, which should be carried out. Among others, a fast evaluation of domain integrals is mentioned. Reference [3] gives a comparison of efficiency and accuracy of different methods applied to evaluation of such integrals, for both Poisson and Helmholtz equations. Four methods were considered, namely: particular solution, dual reciprocity, direct integration and multipole method [4]. It is shown, that the domain integration methods are more efficient and provide better accuracy than the other ones, in spite of necessity of discretization of the domain. In Reference [5] analysis of gradient materials by the BEM, using the classical fundamental solutions of two-dimensional elasticity, is presented. The method requires evaluation of domain integrals. Results of the analysis are compared to the ones obtained using isoparametric finite element method (FEM). It is shown, that the BEM is more accurate than the FEM in the cases of stress concentration and distorted internal cells (finite elements). In Reference [6] a FMBEM application to analysis of elasto-plastic plates is presented. Linear or quadratic boundary elements and constant triangle internal cells are used. In the present work, a FMBEM analysis of elastic plates loaded by volume forces is presented. Here, quadratic boundary elements and quadratic triangle internal cells are used.

2. Fast multipole boundary element method

The linear elasticity problem can be described using an integral equation. In this equation, boundary and volume integrals occur, which are dependent on the fundamental solutions of Navier-Lamé operator [7]. Boundary integrals depend also on boundary displacements and traction forces, and the volume integral depends on a known field of body forces. The boundary of analysed structure is discretized, and for each boundary node as the collocation point the integrals are evaluated. In order to calculate the volume integrals, the domain of analysed body is discretized, using internal cells. Thus, a linear system of algebraic equations is obtained. The conventional algorithm has complexity $O(N \times (M + N))$, where N is the number of boundary elements and M is the number of internal cells. The complexity is reduced to $O(N + M)$ by hierarchical grouping of influences coming from integration points. A tree structure of clusters, containing groups of boundary elements and internal cells is formed. The integrals evaluated for clusters located far enough from collocation points are expanded into multipole series, near to integration points. The coefficients (multipole moments) of the expansion are transformed by shifting the expansion points to larger clusters. The integrals are also expanded near to collocation points (local expansion). The local moments are formed from the multipole ones, and then the influences are distributed to smaller clusters, by shifting the expansion points. Finally, the far-field terms of potentials are evaluated for each collocation points, using the local moments. The near-field terms of potentials are calculated directly. The operations lead to obtaining the matrix-vector products. The matrices are not built explicitly, so the system of equations is solved iteratively. More details can be found in References [1, 2, 3, 6, 8].