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PROPOSAL OF FATIGUE TESTS OF WELDED JOINTS IN RELATION TO FEM CALCULATIONS

Návrh únavových zkoušek svařovaných konstrukčních uzlů ve vztahu k FEM výpočtům

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Abstract: The article deals with the proposal of fatigue tests. The goal of the test is the collection of fatigue data of the chosen type of the welded joints in the different modes of loading. The FEM calculations of the tests will be prepared. The results of the calculation will be assessed from the point of view the fatigue life by chosen methods of the assessment. The next step is the implementation of the results on the real test specimen and its verification by experiments.

Keywords: weld, joint, fatigue, test specimen

Introduction

It is necessary to perform fatigue life assessment (FLA) in all stages of the development of the dynamically loaded structures and their parts. Investigation of the stress level is based on the experimental stress analysis (ESA). The finite elements methods (FEM) are used generally both for the determination of the properties of the structure and for identification of the critical places or optimization of the structure. Typical technology of the vehicles production is that of the skeleton by welding rectangular tubes and metal sheet. Many research institutes all over the world develop the process of the fatigue life assessment of the welded joints. New targets are questions regarding multiaxial loading of the welded joins.

Fatigue life assessment in relation to FEM calculations

Most used process of the fatigue life assessment is nominal stress analysis (NSA). This process is based on the knowledge of the Wöehler curves which are valid for the given notch factor of the critical place and nominal oscillating stresses. These Wöehler curves are known for some important or typical welded joints. There are lots of welded joints in the given structure. These joints are often redesigned or modified during the development. It is very expensive to investigate experimentally necessary notch factors β for each joint. When experimental data are missing it is necessary to estimate Wöehler curve from a similar one.

The next way of the fatigue life assessment is given by the Czech standard [2]. The types of the welded joints are classified by categories. Each category has its own Wöehler curve separately for normal and shear stress. There are simple rules how to consider their combinations. The standard is designed to give always conservative results . That means the coefficients of the safety factor are often higher than it is necessary.

Nowadays it is common to use the calculation by FEM in solving the appropriate design of the structure. Result of the calculations is stress field given by stress tensors in nodes of the FEM mesh. Different types of welded joints have different parameters of the Wöehler curve [1], [2] which differ from basic material. The interpretation of the result is difficult. The place with higher stress on the basic material can show lower fatigue damage than the place near the weld. Dividing of the notch effect into contribution of the technology and geometry is a valuable result. It is important e.g. in modifications whose goal is to lower notch effect in critical place. The known methods

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of the fatigue life assessment on the basis of the FEM calculations are summarised in [3]. The goal of the project is to find and verify appropriate methodology and help to solve the described problems.

Proposing of the experimental program

The goal of the experiments and tests in the following years will be to co-ordinate process of the evaluation of the FEM calculations and performed tests on the test specimens and real structure. The whole set of the welded joints cannot be tested in the project. The work will be focussed on the chosen one regarding the determining influence of the technology, geometry and loading mode. The tests will be performed on the tests specimen made of the rectangular tubes loaded by tension or torsion, see Fig. 1.

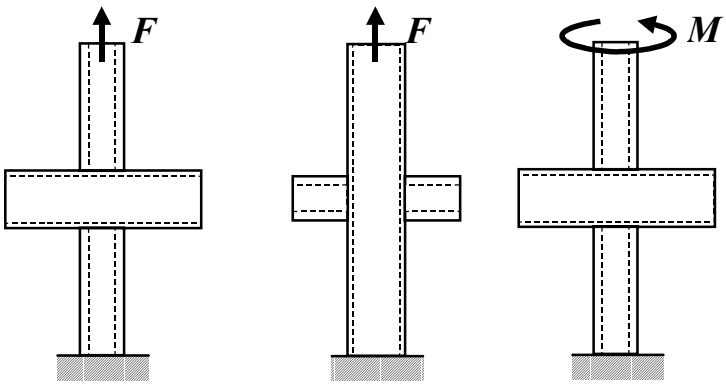

Fig. 1 Proposed test specimens

Next step will be test on the test specimen representing real component including loading by both bending and torsion, see Fig. 2. Simulations of the tests by static FEM calculations will be performed. The known processes of the fatigue life assessment will be applied on the results of calculations. First used method will be Dijkstry's and Gurneye's approach considering the structural stresses. In next years we suppose performing experiments considering non proportional loading of the specimen by combined bending and torsion.

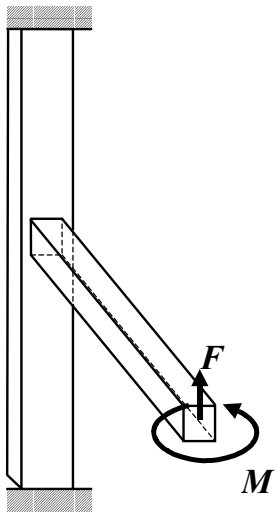

Fig. 2 Test specimen loaded by combined bending and torsion

Conclusion

We supposed that proposed methodology will be utilised for the prediction of complicated structural parts fatigue life on the basis FEM calculations. This article describes experimental parts of the grant GAČR101/02/0141. Authors thank to GA for support in solving these goals.

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