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# How to predict the plastic collapse of structures efficiently?

given by

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The prediction of the collapse load (limit load) of a structure made of a material exhibiting elastic-plastic behavior is often of practical interest. The standard approach to obtain such collapse loads is based on iterative calculation schemes using classical nonlinear finite element methods, as, e.g., can be found [1].
However, as an alternative approach the so-called finite-element-based limit analysis (FELA) can be applied. This approach is based on plastic limit theorems, first formulated by A.A.Gvozdev in 1936, and later independently by D.C.Drucker in 1952. Thereby, the collapse load is obtained as the minimum of a certain optimization problem, either considering kinematically compatible velocity fields (upper bound approach) or statically admissible stress fields (lower bound approach) within the structure, at the time instant of collapse. Thus, the whole load history does not need to be taken into account, resulting in a stable and numerically efficient approach compared to the standard scheme based on classical finite element formulations. The two significant disadvantages of the FELA method (the assumption of geometrical linearity and ideal plasticity) can be overcome by the so-called sequential finite-element-based limit analysis (SFELA), as, e.g., shown in [2]. Thereby, the FELA method is called repeatedly, where the geometry and the plastic strain is updated after each iteration.
In this talk capability of the FELA and SFELA methods is demonstrated on several numerical examples. An incorporation of isotropic hardening and softening is possible in the framework of the SFELA method and is demonstrated in a plastic collapse of a steel frame. An ability to analyse wooden structures, considering the Tsai-Wu orthotropic strength criterion, is demonstrated by two examples: first, by the collapse of a wooden block with two asymmetric holes, and second, by the collapse of a pressure loaded cross laminated timber (CLT) plate. The latter example includes comparison with experimental results.

[1] A.Robertson, H.Li, D.Mackenzie, Plastic collapse of pipe bends under combined internal pressure and in-plane bending. *Int. J. of Pressure Vessels and Piping* (2005) **82**:407-416.
[2] D.Kong, C.M.Martin, B.W.Byrne, Modelling large plastic deformations of cohesive soils using sequential limit analysis. *Int. J. Numer. Anal. Meth. Geomech*. (2017) **41**:1781--1806

**The lecture will be held on Wednesday, September 22, 2021 at 10 AM in the building of the Institute of Theoretical and Applied Mechanics, Prosecká 76, 190 00, Prague 9.**

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