Inelastic Finite Element Method for Structures

Module-No./Abbreviation	Credits	Workload	Term	Frequency	Duration
CE-WP06	6 CP	180 h	3rd Sem	winter term	1 Semester
Courses			**Contact hours**	**Self-Study**	**Group Size:**
Inelastic Finite Element Method for Structures			4 SWS (60 h)	120 h	No Restrictions

Prerequisites

Basic knowledge of tensor analysis, continuum mechanics and linear Finite Element Methods. Previous participation in the course Advanced Finite Element Methods is recommended and participation Object-Oriented Modeling and Implementation of Structural Analysis Software is advantageous.

Learning goals / Competences

After successfully completing the module the students will

- understand the fundamentals of dissipative processes in the context of modeling inelasticity in quasi-brittle materials, using concrete as the main example.
- learn the computational approaches for modeling elastoplastic, damage and friction behavior.
- be familiar with the concept of strain localization and localized failure, including their mathematical and numerical implications, as well as strategies to address them.
- gain practical experience with implementation and algorithmic treatment of inelasticity in the context of incremental-iterative nonlinear structural analysis.
- develop skills to select appropriate numerical methods and material models, including multi-scale approaches, for practical problems and critically assess their limitations.
- be able to perform incremental analyses of progressive structural failure, critically evaluate the results, and assess the key design parameters such as load and deformation at the onset of inelasticity and structural redundancy (plastic reserve/residual strength).

Content

The course is concerned with inelastic material models including their algorithmic formulation and implementation in the framework of nonlinear finite element method. Strain localization and localized failure will be explored in detail, focusing on their mathematical and numerical implications, as well as the strategies to address them. Further, the course covers the fundamental theory and implementation aspects of frictional contact. Special attention will be given to efficient algorithms for physically nonlinear structural analyses, including elastoplastic and damage models for quasi-brittle materials, as well as friction algorithms. While concrete serves as a primary example, these modeling approaches are equally applicable to other materials such as rocks, fiber composites, sea ice, bone, stiff soils, and wood. The course includes coding exercises and a final assignment, where students implement a selected inelastic model into a finite element program and apply it to nonlinear structural analysis.

Teaching methods / Language

Lecture including Exercises (4h / week) / English

Mode of assessment

Project work (implementation of an inelastic model into FE code) with final student presentation / bonus points for homework assignments

Requirement for the award of credit points

Passed final module examination

Module applicability

MSc. Computational Engineering, MSc. Bauingenieurwesen , MSc. Subsurface Engineering
Weight of the mark for the final score -
Module coordinator and lecturer(s) Prof. Dr. R. A. Sauer, Dr. Ing. Vladislav Gudžulić, Assistants
Further information