Institute of Structural Mechanics, Statics and Dynamics

TEACHING AND RESEARCH FOCUS

The chairs “Structural Mechanics” as well as “Statics and Dynamics” teach the mathematically oriented fundamentals for the mechanical design and evaluation of buildings and structures in the bachelor's degree program in Civil Engineering. In addition, in-depth, practice-oriented as well as research-oriented courses are offered, which individualize the profile of the graduates and prepare them for the wide range of tasks in civil engineering.

In this context, topics relating to sustainable construction are increasingly addressed, which is reflected in the establishment of the international Master's degree programme ‘Mechanics of Sustainable Materials and Structures’ (MS2 for short).

12 students from 10 different countries have enrolled for the first intake in winter semester 2024/25, who will now be trained in cooperation with the Università di Trento (Italy) and the Ecole Centrale de Nantes (France). The resulting internationalization and focus on the socially important topic of sustainability in the construction industry are in line with the overarching goals of TU Dortmund University and the faculty. The importance of the topics dealt with in MS2 was recognized by the acquisition of Erasmus Mundus Joint Master's funding from the European Community amounting to around 4 million euros. A large proportion of these funds will be used to award scholarships to particularly qualified students. Those responsible at TU Dortmund University (Prof Madeo, Prof Münch) would like to thank everyone involved for their support during the planning and accreditation phase.

EMPLOYEES

Chairs
Prof. Dr.-Ing. habil. F.-J. Barthold
Prof. Dr.-Ing. A. Madeo
Prof. Dr.-Ing. I. Münch

Secretary
Mirjana Vukovic

Scientific Staff
B. Sc. Kira Peper
M. Sc. Simon Loske
M. Sc. Jan Wulf
M. Sc. Fabian Guhr
Dr.-Ing. Jan Liedmann
M. Sc. Seyed Ali Ghasemi
Dr. Svenja Hermann
Dr. Felix Erel-Demore
Dr. Gianluca Rizzi
Dr. Max Jendrik Voss
M. Sc. Leonardo Andres Perez Ramirez
M. Sc. Plastiras Demetriou

Lecturer
Dr.-Ing. Daniel Algernon

Student Asssistants
Justus Förster
Derya Cengiz
Ariana-Lucia Hargesheimer
Hussein Abbas
Niclas Knoop
Christian Müller
Niklas Eisenblätter
Lucas Ossa-Funken

COURSES

WINTERSEMESTER 2023/24
Stereostatik
Höhere Mathematik 3 Bauwesen
Grundlagen der Statik und Dynamik
Lineare Elastizitätstheorie
Lineare Finite Elemente Methode
Computerorientierte höhere Mechanik
Nichtlineare Finite Elemente Methode
Engineering with ANSYS
Sondergebiete der Strukturoptimierung

SUMMERSEMESTER 2024
Elastostatik
Computerorientierte Statik und Dynamik
Software in der Strukturmechanik (WPF)
Nichtlineare Materialmechanik
Strukturoptimierung (WPF)
Zerstörungsfreie Bauwerksdiagnostik (WPF)
Bauen mit Textilbeton (WPF zusammen mit WdB)
Mathematical foundations of mechanics (WPF)
Enriched Continua and Metamaterials (WPF)
The principle of virtual work in mechanics (WPF)

RESEARCH PROJECTS

ERC Consolidator Grant - Meta-Lego (101001759): Learning to play LEGO with metamaterials!

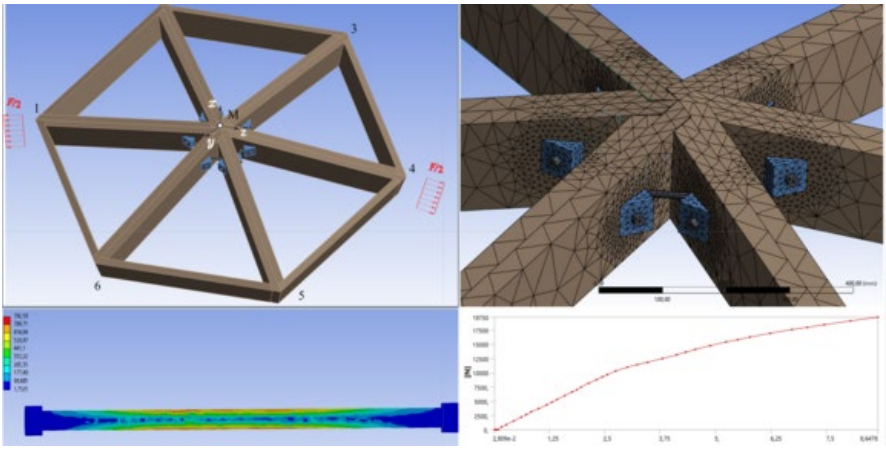
Kombinierte Form- und Querschnittsoptimierung von Faserverbundstrukturen basierend auf der Singulärwertzerlegung der Empfindlichkeiten (DFG)

SFB/Transregio 188 „Schädigungskontrollierte Umformprozesse“, TP C05: „Sensitivität und Optimierung“ (DFG)

Adaptive Lernumgebung im Fach Dynamik als OER - Alfdyn (Förderlinie „OER-Content.nrw“ zur Produktion von digitalen Lehr- und Lernangeboten für das Landesportal DH-NRW)

Elective module: Engineering with ANSYS

The elective subject expands the possibilities for designing and optimizing structures using the finite element method, e.g. taking contact elements, non-linear material models and equilibrium on the deformed system, even with large displacements and rotations, into account. The images show an example of the segment of a grid shell, which in turn is made up of triangles in multilayer construction. At the junction point, the contact surfaces of the individual timber beams are prestressed by threaded rods in such a way that the grid shell can transfer both high compressive forces and tensile forces. This results in yielding in the threaded rods in the limit state of the load-bearing capacity. In fact, this failure mechanism is preferred to failure in the timber matrix, which is optimized by the pre-tensioning force in the threaded rods.

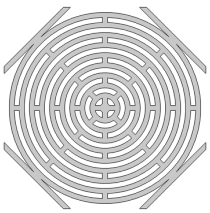


Elective Module: Enriched Continua and Metamaterials

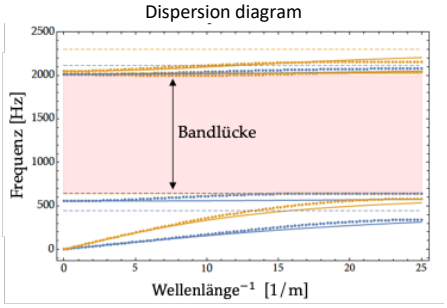
Mechanical metamaterials - as shown below as an example - offer promising application potential in the construction industry, for example in noise protection and earthquake insulation. The use of metamaterials opens up new perspectives for the design of sustainable structures. An important aspect of research is the control of elastic waves by the periodically arranged unit cells. In this module, students learn to design mechanical metamaterials with unconventional mechanical properties in terms of wave propagation. The WPF is research-oriented and divided into two parts.

The first part deals with fundamentals of metamaterials, including waves and their propagation. In addition, the course includes the analysis and design of unit cells giving rise to band gaps in dispersion diagrams (see figure). The second part of the course focuses on the continuum mechanical description of metamaterials through enriched continua. First, basic knowledge of this modeling is imparted. Subsequently, wave propagation in enriched continua is discussed.

Unit cell



Dispersion diagram



3-D print

Deformation for frequency load outside (a) and within (b) the band-gap