



Triple-Master's degree in Civil Engineering "Mechanics of Sustainable Materials and Structures"



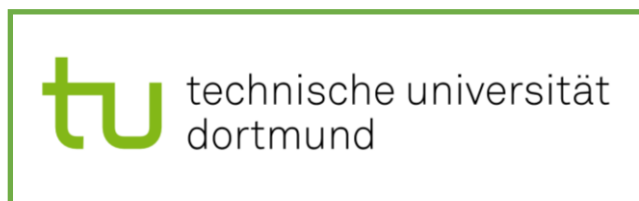
Co-funded by
the European Union

December 11, 2024

Why this program?

Building constructions and operations show a high environmental footprint, with 36% of global energy consumption and 39% of CO₂ emissions, superior to transportation (33%) and industrial activities (29%). The latest report of the United Nations Environment Program shows that a significant part of this intense exploitation of resources (28%) finds its roots in the use of materials and that the demand for buildings and floor area is growing and expected to double by 2060. Within this framework, innovative building technologies employing low-carbon materials and proposing novel low-impact structural solutions are of paramount importance in embodied carbon reduction, with the aim to reduce construction-related CO₂ emissions through:

- *improved design of buildings and structures*
- *lifetime extension and vulnerability reduction*
- *low-impact structural design*
- *building material optimization and waste reduction through reuse and recycling*
- *sustainable management of renewable energy resources*





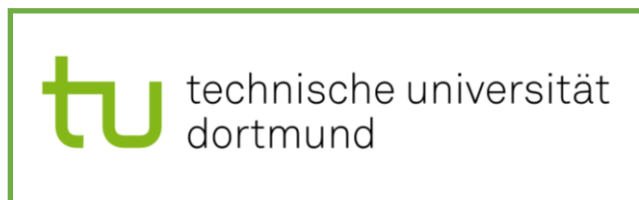
Program's objectives

This program is designed to train a new generation of civil engineers as future leaders in the development of innovative solutions for sustainability and performance in the built environment by fostering creative and independent thinking and promoting low-impact oriented problem-solving. This is done by providing a solid background in fundamental mechanics, coupled with cutting-edge research in innovative materials and structures, and a research and development environment in the private sector.

This cocktail of solid fundamental skills, innovative research and link to the private sector is the perfect environment to train engineers capable to provide innovative solutions to the global today's challenges.

The program qualifies graduates for research-related and technical professional activities in the areas of

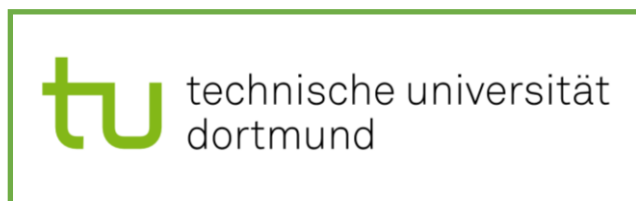
- » *Advanced Mechanics for Innovative Materials and Structures*
- » *Materials and Structures under Extreme Conditions*
- » *Materials and Structures in their Environment*



Prospective students

The main target group are international students from EU and non-EU countries, with a high degree of mobility and a willingness to study in an intercultural dimension.

The main skills of the students trained under this program will be in the **mechanical modeling and simulation of materials and structures**.





Dept. of Mechanics, Materials
and Civil Engineering

tu technische universität
dortmund

Faculty of Architecture
and Civil Engineering

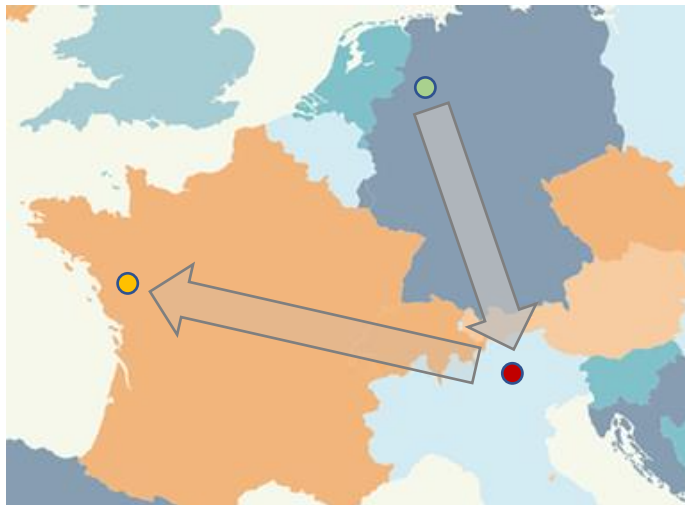


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DI TRENTO**

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and Mechanical Engineering

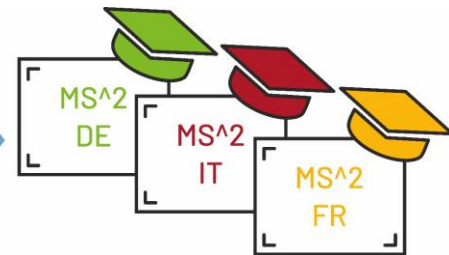
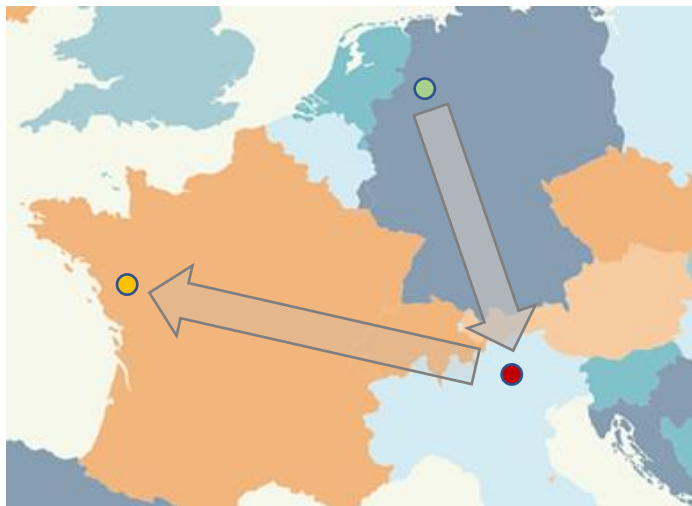
Mechanics of Sustainable Materials and Structures – MS²

Program's structure



Mechanics of Sustainable Materials and Structures – MS²

Program's structure



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Program's structure



Advanced Mechanics for Innovative Materials and Structures

Mandatory Courses (4)	ECTS
Engineering mathematics	5
Advanced continuum mechanics	8
Enriched continua and metamaterials	5
Nonlinear structural analysis	6

Elective Courses (2 among 4)	ECTS
Construction with trees in practice	3
«How sustainable can building materials be?»	3
Structural systems in engineering practice	3
Organic design and structures	3

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Program's structure



Materials and Structures under Extreme Conditions

Mandatory Courses (4)	ECTS
Stability of structures	6
Modeling and simulation of structures	6
Mechanics of solids and structures under extreme conditions	6
Machine learning for wireless structural health monitoring	6

Elective Courses (1 among 2)	ECTS
Metastructures	6
Risk analysis and structural reliability	6

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Program's structure



Materials and Structures in their Environment

Mandatory Courses (6)	ECTS
Mechanics of porous media	5
Homogenization methods for materials and structures	5
Coupled problems in mechanics: from mathematical formulation to numerical methods	6
Design and behavior of modern concrete	5
Modern language	2
Summer school	2

Elective Courses (1 among 2)	ECTS
Durability and Structural Maintenance	5
Earthquake engineering	5

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Program's structure

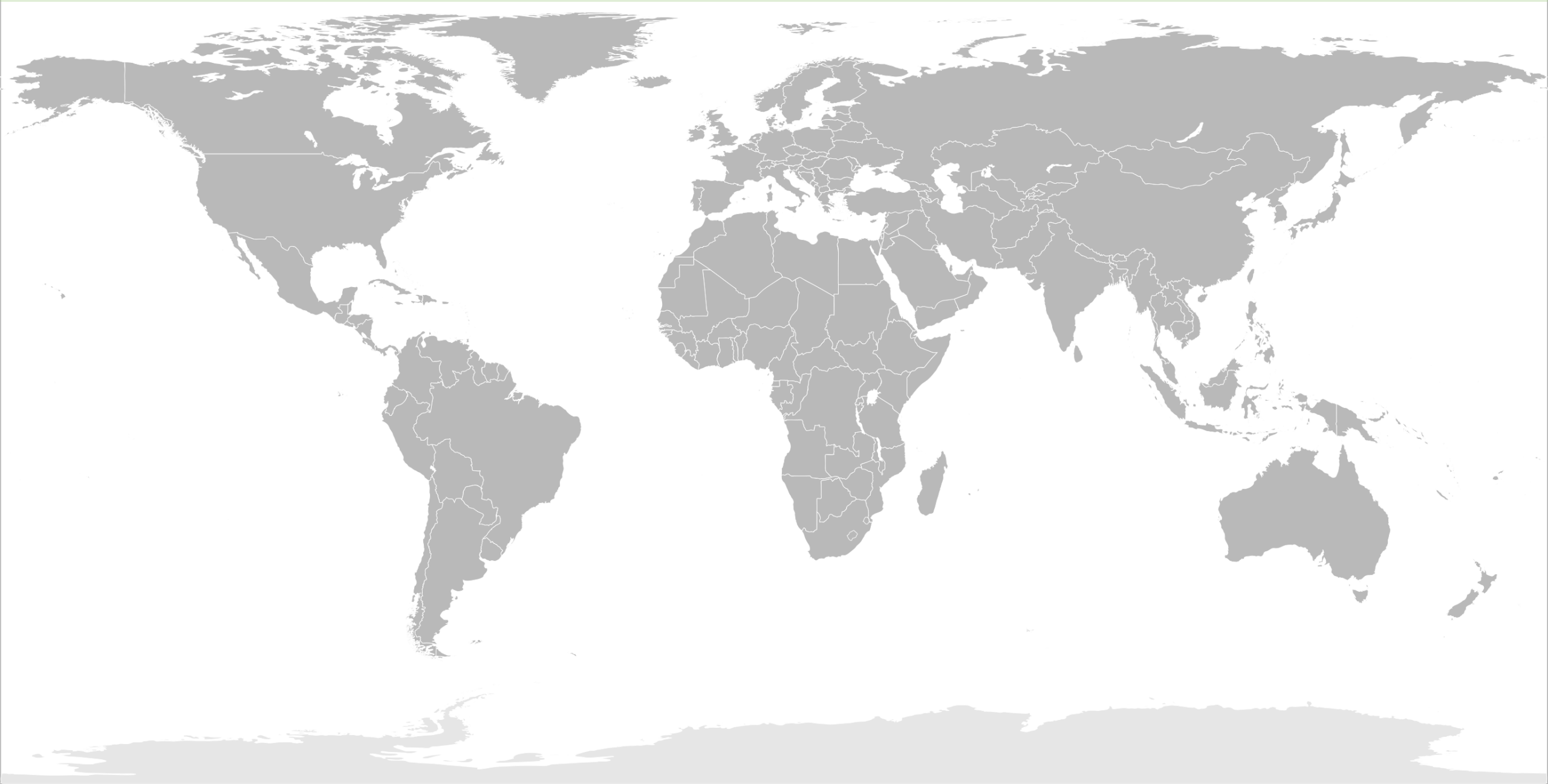


The Master's thesis can be completed at

- TU Dortmund
- UniTrento
- EC Nantes

or at one among the MS² associate academic and industrial partners in the world...

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LUXEMBOURG
INSTITUTE OF SCIENCE
AND TECHNOLOGY



NATIONAL
TECHNICAL
UNIVERSITY
OF ATHENS



SAPIENZA
UNIVERSITÀ DI ROMA

Associate Academic partners in Europe

Mechanics of Sustainable Materials and Structures – MS²



Associate Industrial/Public partners in Europe

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جامعة جيلالي ليابس - سيدي بلعباس
DJILLALI LIABES UNIVERSITY
SIDI BEL ABBES



جامعة أبو بكر بلقايد
UNIVERSITY OF TLEMCEN



Associate Academic partners in North Africa

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UC San Diego

GT Georgia Institute
of Technology.

Associate Academic partners in North America

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Associate Academic partners in Asia



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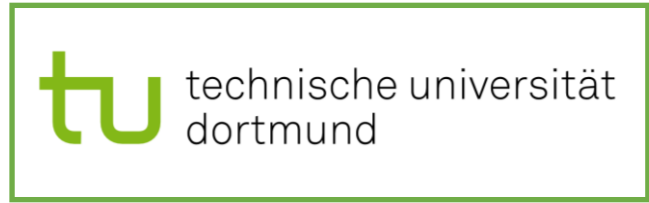
Prof. A. Madeo



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- Dortmund, the largest city in the Ruhr area
- 10 Million inhabitants in the surrounding Rhine-Ruhr Metropolitan Region

Distance	[km]
Essen	31
Düsseldorf	57
Köln	72
Frankfurt	175
Amsterdam	200
Berlin	422



Mechanics of Sustainable Materials and Structures – MS²



TU Dortmund University

- Founded in 1968
- Over 30,000 students with over 5,350 international students
- Member of the UA Ruhr



- 250 different sports courses
- Free public transport through the whole of Germany
- Free access to libraries



Department of Architecture and Civil Engineering

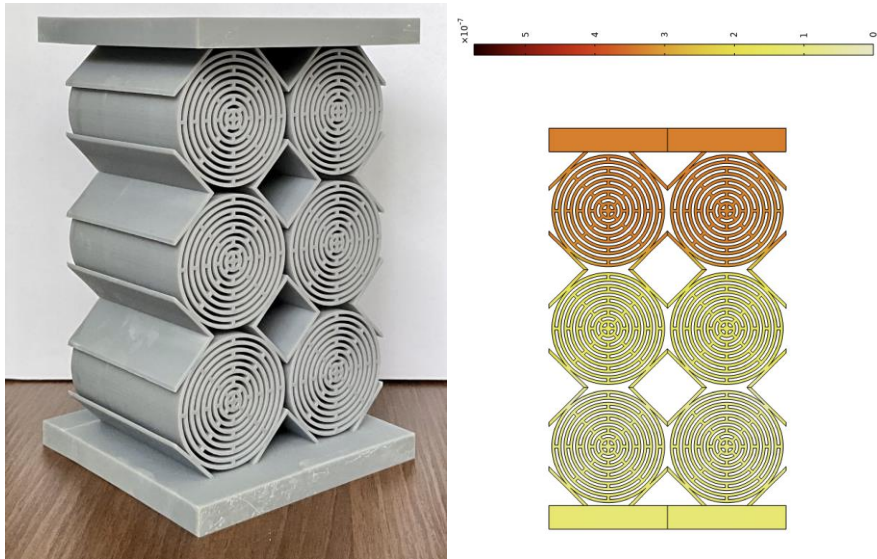
- Founded in 1974
- 1995 students enrolled in the faculty with over 100 teaching staff
- Architects and Civil Engineers are trained together in the Dortmunder Model

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Institute of Structural Mechanics, Statics and Dynamics

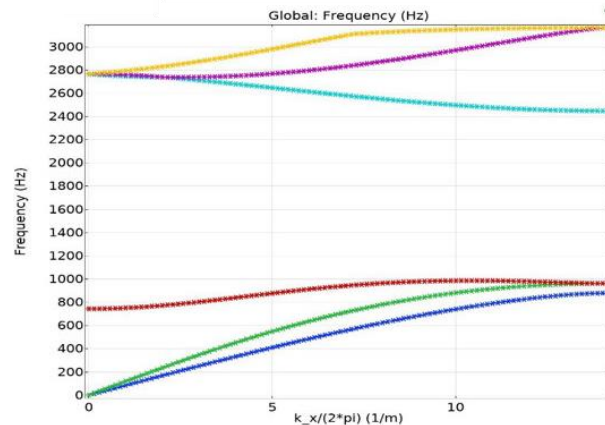
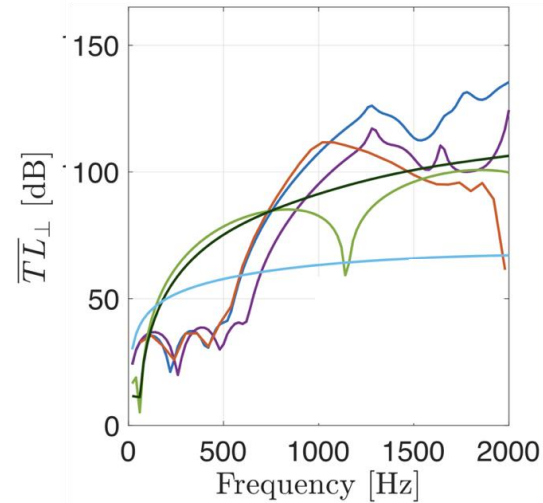


- META-LEGO ERC-Grant
- Finite-size metamaterial modeling

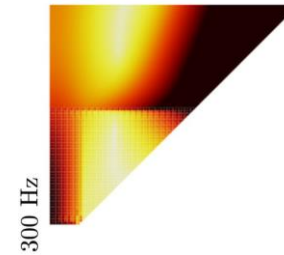


- Dispersion and Band-gap description through enriched continua
- Surface forces and non-coherent interfaces

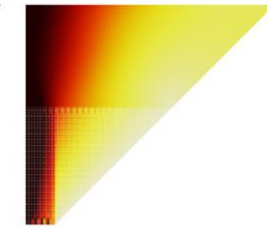
Transmission loss



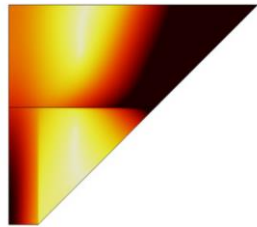
α Cell's Cut



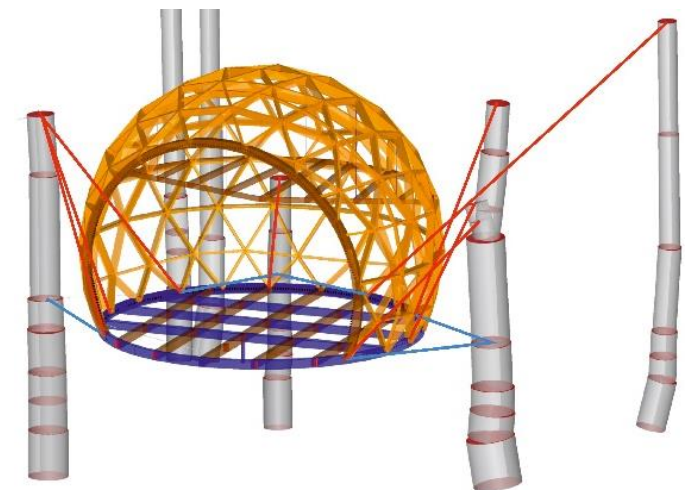
β Cell's Cut



Reduced Relaxed



- Sustainable Building with Trees





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Prof. F. Dal Corso

Mechanics of Sustainable Materials and Structures – MS²

Trento is a small city (121,000 inhabitants) located in Northern Italy and due to its position it is a natural meeting point between Italian and Central European culture.

Distances from Trento to:

- Verona 98 km
- Venice 157km
- Innsbruck (Austria) 173 km
- Milan 226 km
- Florence 319 km
- Rome 592 km



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Trento is a roman town, rich in art and history



Piazza Duomo



Buonconsiglio Castle



Garda Lake



Dolomites



Located in the river Adige valley, on the Brenner axis, it is surrounded by beautiful mountains, such as the Dolomites, and alpine lakes

Mechanics of Sustainable Materials and Structures – MS²



- Always among the top 3 medium-sized Italian universities (1st CENSIS 2023-24)
- High internationalization
- Favoured study environment thanks to its human-scale dimensions and high level of services
- Quality of life (1st according to ItaliaOggi 2022)



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5 Libraries
Monday to Saturday 8-24
Sunday 14-21



Free circulation card
annual subscription to the transport network of the province of Trento (€70)

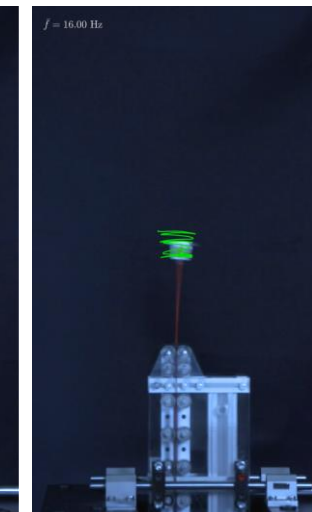
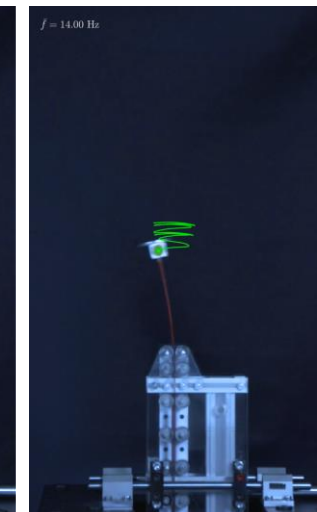
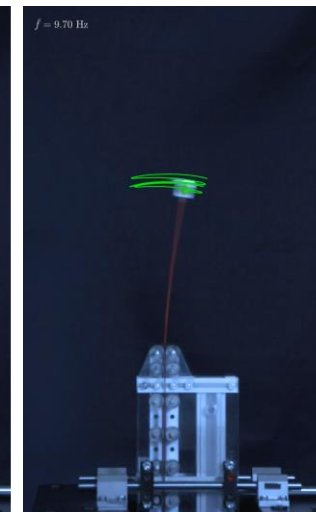
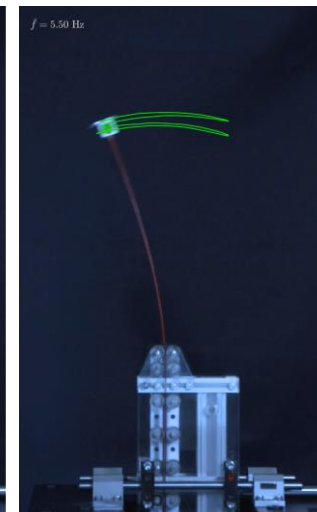
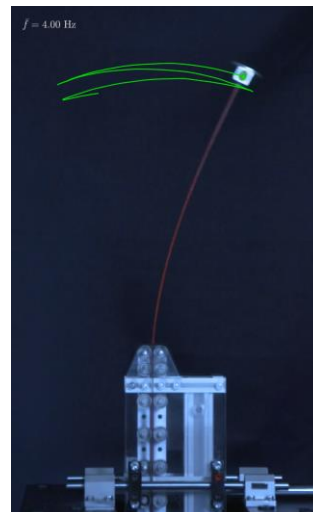


Mechanics of Sustainable Materials and Structures – MS²

- Excellent Italian Department of Civil Engineering



- Coordination of/participation in several of the world's most prestigious European projects (multiple ERC winners, FET, Marie Curie, etc.)
- High faculty to student ratio (200 faculty and staff: 2000 students)
- Europe's largest Materials and Structures Testing Laboratory





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Prof. G. Sciarra

tu technische universität
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and Civil Engineering



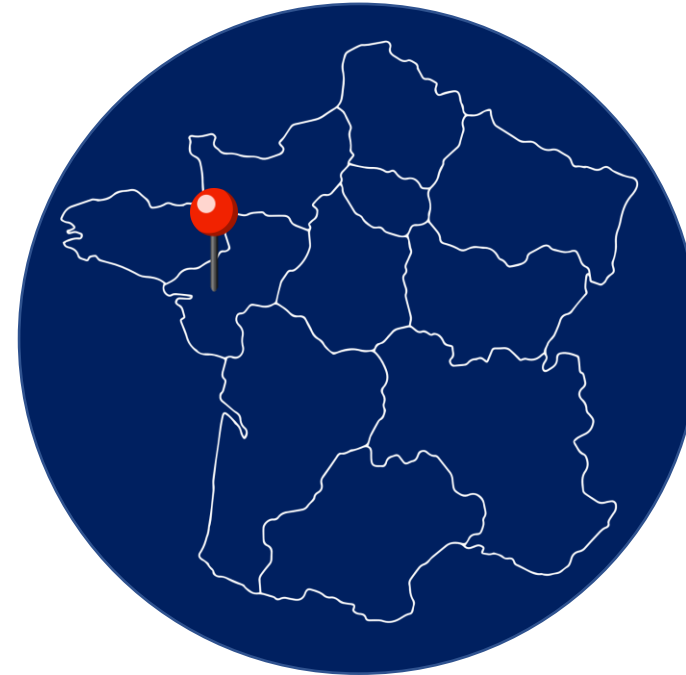
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Mechanics of Sustainable Materials and Structures – MS²

NANTES

- 2 hours away from Paris by train
- Easily **accessible** (airport, train, bus, tramway)
- +100 parks and gardens
- Nantes, historically an **industrial** pool
- City of **Arts, History** and Innovation
- European Capital of **innovation** (2019)



6th largest city in France
Home to 65 000 students



Mechanics of Sustainable Materials and Structures – MS²



- Proximity with large industrial groups (Airbus, Naval Group, or STX Shipyard)
- European Green Capital in 2013
- Elected 3rd best city for students in 2020



CENTRALE NANTES

- World-class engineering training in science and technology
- A major focus on **sustainable development, energy transition, factory of the future and engineering for health**
- Extensive collaboration with industrial partners
- International outreach (academic and research)
- Internationally recognized faculty
- A dynamic economic model that is unique in France (more than 50% of the budget comes from research income)



FACTORY OF
the Future



ENERGY
TRANSITION



ENGINEERING
FOR HEALTH

Mechanics of Sustainable Materials and Structures – MS²

LIFE ON CAMPUS



- Excellent sports facilities: artificial pitch, squash courts, dojo, gym
- Over 80 student clubs and associations on campus: jazz, chess, theatre, cinema, dance, sailing, rugby, football, basketball, martial arts, robotics, cooking,



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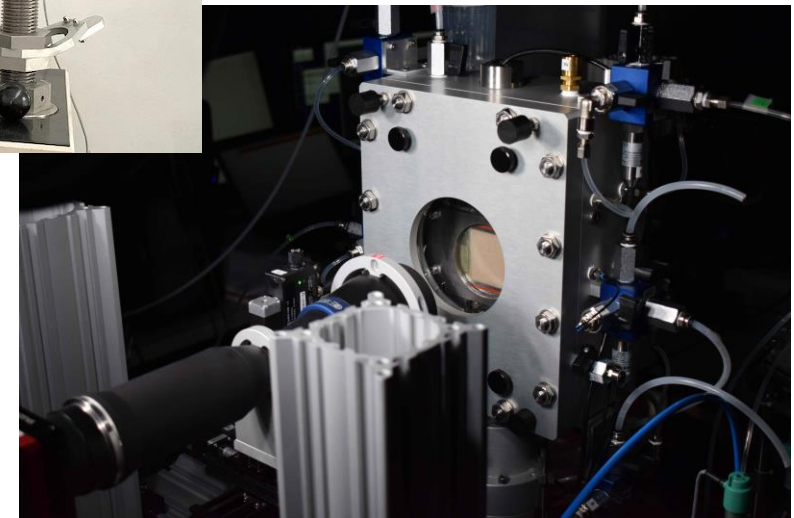
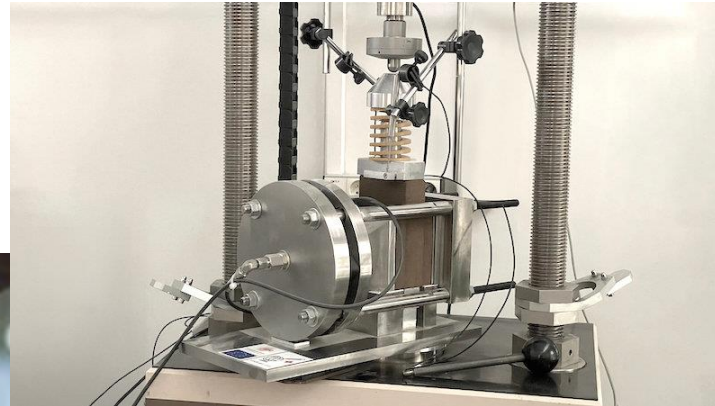
- Accommodation booking
- Airport / Train station Pick Up by our Welcome Team
- Welcome week
- Buddy programme
- Welcome support from the International office
- Help with administrative procedures such as health insurance, [visa renewal](#)...

Mechanics of Sustainable Materials and Structures – MS²

Institut de recherche en Génie Civil et Mécanique GeM



Research at GeM is balanced between advanced and applied research. The research unit is characterised by its significant and differentiating testing resources, with several technological platforms. Projects are conducted in close collaboration with industry and companies specialising in mechanical and civil engineering, in the framework of French and European programmes and networks.

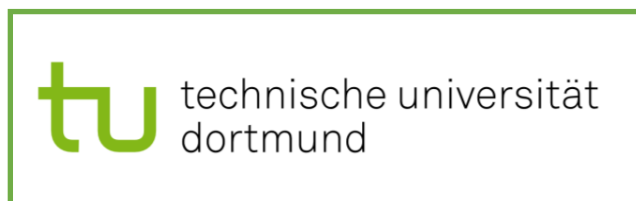


Mechanics of Sustainable Materials and Structures – MS²

- Admission Requirements
- Tuition fees
- Funding opportunities
- Scholarships Selection Procedure
- Timeline



Dr. J. Voss



Admission Requirements

Academic Merit

- Bachelor's degree qualification in the field of Civil Engineering or equivalent
- Final Grade better or equal to
 - B according to ECTS grading (best 35%)
 - 2.8 on the German grading scale (from 1.0 to 4.0)
- English language with at least a B2 certificate



Enrolment

- With a letter of admission, you enroll at TU Dortmund first [link](#)
- Start of study: September 2025

The program's admission application is submitted in parallel to a possible scholarship opportunity via:

[uni-assists](#) (non EU/EEA) or [TUDortmund](#)(EU/EEA)

- Applicants without EU/EEA citizenship with a foreign university degree obtained in a country outside the EU/EAA. [link](#)

01.01.2025 to 15.06.2025

- Applicants with EU/EEA citizenship or a university degree obtained in a country part of the EU/EAA. [link](#)

01.01.2025 to 31.07.2025

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Tuition Fees (possible slight changes before the application process opens)

We will select **15** students per year based on merit who have their tuition fees waived

Applicants without EU/EEA citizenship	$3400\text{€ per semester} \times 4$ = 13600€ for entire program	$1900\text{€ per semester} \times 4$ = 7600€ for entire program
Applicants with EU/EEA citizenship or who have obtained their Bachelor's degree in EU/EEA	$1900\text{€ per semester} \times 4$ = 7600€ for entire program	$1150\text{€ per semester} \times 4$ = 4600€ for entire program

Funding opportunities



Mobility allowance

- Mobility bonus from Italy to France
- 2000 € / student
- About 10 students (per cohort)

Scholarship

- 2 years of funding for selected students
- 1400 € / month / student
- About 15 students (per cohort)
- No tuition fees for scholarship holders

Scholarships Selection Procedure



In parallel with the program's admission application

Step 1:

- Application Form
- The same documents as the program's admission application

Step 2:

- Online test (written)

Step 3:

- Colloquium (online)

} Interview

The Selection is based on the following criteria:

- **Interview** (written test + oral colloquium): more details after submitting the scholarship application form → 50 points
- **Academic grades:** final bachelor's degree grade or, if the applicant still needs to graduate, the average mark → 25 points
- **Two reference letters:** we will ask for a letter of recommendation (in English/pdf) from your proposed referees including letterheads of the author's Institution and a signature → 15 points
- **Motivation letter:** CV and a two-page letter that describes why you are the perfect candidate for the EMJM scholarship → 10 points

Scholarship can only be confirmed upon the completion of the program's admission application

Applications are submitted via our website [link](#)

01.01.2025 to 15.03.2025

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Content of entrance test

$\frac{d}{dx} \left[\frac{f(x)}{g(x)} \right] = \frac{g(x)f'(x) - f(x)g'(x)}{g(x)^2}$
 $F = mg = ma = m \frac{d^2h}{dt^2}$
 $m \frac{d^2x}{dt^2} = -kx$
 $\frac{dA}{dt} = \frac{dB}{dt} = \frac{dC}{dt} = \frac{dD}{dt} = (A)AB - (C)CD$
 $y = mx + b$
 $\frac{dx}{dx} = \frac{dy}{dy} = \frac{dy}{dx}$
 Gottfried Wilhelm Leibniz
 Maria Gaetana Agnesi
 $f(x) = x^2$
 $(\ln x)' = \frac{1}{x}$
 $\int \frac{1}{x} dx = \ln|x| + c$
 $\int \sin x dx = -\cos x + c$
 $\int_a^b f'(x) dx = f(b) - f(a)$
 $m \frac{d^2x}{dt^2} = -kx$
 $\frac{df(x)}{dz}$

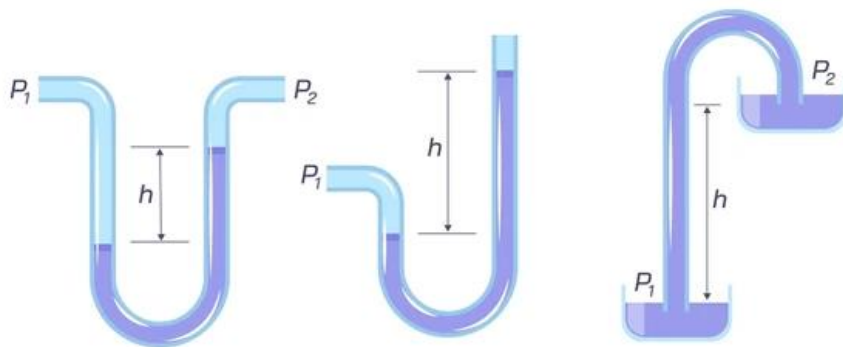
Calculus

PHYSICS

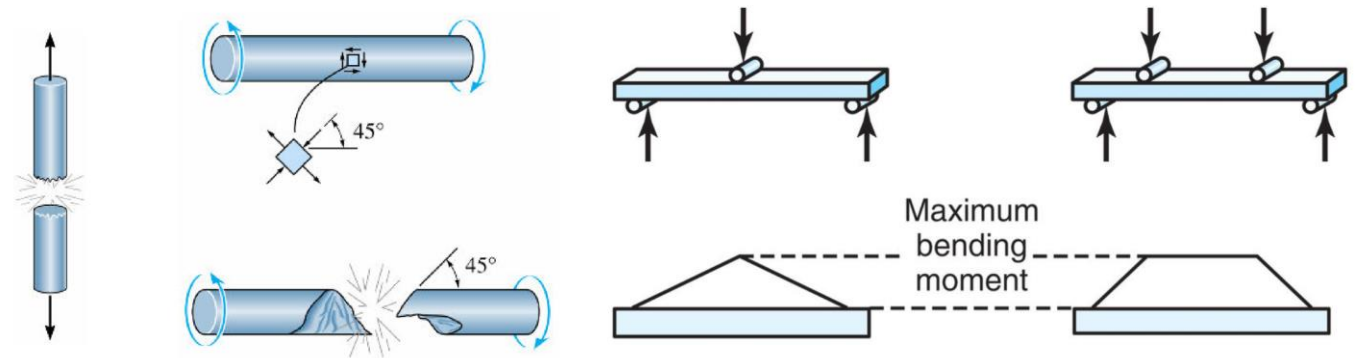
Linear Algebra

$$\begin{bmatrix} a_0 & b_0 & c_0 & 0 & 0 & 0 & \dots \\ d_0 & e_0 & f_0 & 0 & 0 & 0 & \dots \\ g_0 & h_0 & i_0 & 0 & 0 & 0 & \dots \\ 0 & 0 & 0 & a_1 & b_1 & c_1 & \dots \\ 0 & 0 & 0 & d_1 & e_1 & f_1 & \dots \\ 0 & 0 & 0 & g_1 & h_1 & i_1 & \dots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{bmatrix}_{3n \times 3n} \times \begin{bmatrix} x_0 & 0 & \dots & 0 \\ y_0 & 0 & \dots & 0 \\ z_0 & 0 & \dots & 0 \\ 0 & x_1 & \dots & 0 \\ 0 & y_1 & \dots & 0 \\ 0 & z_1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \end{bmatrix}_{3n \times n} = \begin{bmatrix} x'_0 & 0 & \dots & 0 \\ y'_0 & 0 & \dots & 0 \\ z'_0 & 0 & \dots & 0 \\ 0 & x'_1 & \dots & 0 \\ 0 & y'_1 & \dots & 0 \\ 0 & z'_1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \end{bmatrix}_{3n \times n}$$

(a bit of) Fluid mechanics

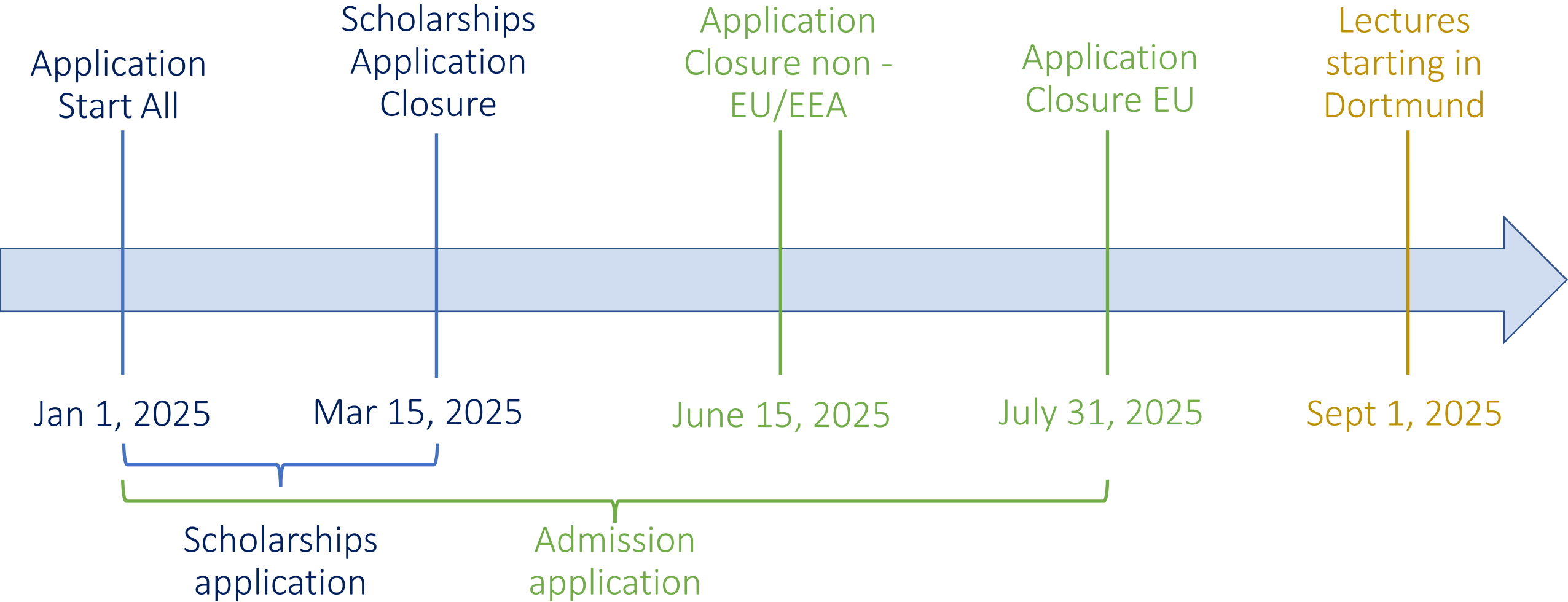


Mechanics of Solids and Structures



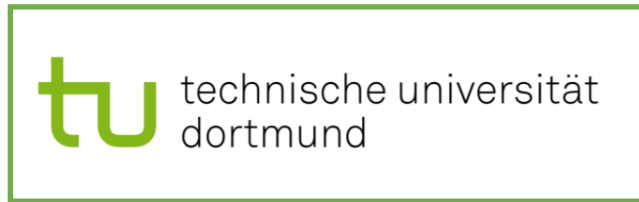
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Timeline





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Thank you for your attention!!