



Politecnico
di Torino



Continuum Damage Mechanics and Advanced Modelling of Hybrid and Composite Structures

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This course encompasses several theoretical aspects for damage mechanics applied to engineering materials. The course starts by introducing the phenomenological description of damage, from the micro to the macro stage using the effective stress formulation for isotropic and anisotropic materials. The thermodynamic model admissibility is presented, and its contribution to the mechanical representation of damage. For the case of brittle damage regularization techniques are introduced to prevent mesh dependency, using fracture energy regularization, non-local state/field variables, and even gradient enhanced damage. Several isotropic and orthotropic damage models are presented as examples, and its formulation is discussed and studied. It is also briefly presented viscoelasticity models, discrete damage mechanics and delamination.

Some numerical examples are presented to provide information about the accuracy of new and old damage models using finite element method. These examples are also compared with previous experimental campaign.

It is envisioned for engineer science students who wish to develop comprehensive skills in this field, from essential concepts to more practical computer-aided design.

The lecture course consists of the following chapters:

Lesson 1 – Introduction to the Field of Damage Mechanics

Lesson 2 – Physical Nature of Damage Mechanics

Lesson 3 – Thermodynamic Admissibility

Lesson 4 – Local Formulations and Kinematic Laws

Lesson 5 – Regularization Techniques

Lesson 6 – Isotropic Damage Models

Lesson 7 – Orthotropic Damage Models

About the speaker

Mário Rui Arruda is a Research Associate from the research center CERIS, from IST in the University of Lisbon.

He obtained his PhD at IST from University of Lisbon (with collaboration of Polytechnic of Milan) in Computational Mechanics applied to Civil Engineering, using damage mechanics to simulate the behaviour of concrete structures.

During the first years of Post-Doc in ICIST research center he performed investigations in: composite structures, more precisely orthotropic damage mechanics; thermal-mechanical

numerical analysis, for the simulation of fire behaviour; applying higher-order beam theories (Carrera Unified Formulation), to study the behaviour of GFRP sandwich panels.

At the moment he started to develop investigations in fireproofing dwellings for wildfires, thermal-mechanical numerical fire behaviour, fire protection for buildings, computational mechanics and orthotropic damage modelling.

Since he started his research as a PostDoc in 2011, he has published more than 100 scientific manuscripts, in which more than 50 are in international journals with impact factor. He has collaborated in 10 research projects in the field of civil engineering, in which he provides consultancy in the topic of thermal-mechanical numerical modelling, and fireproof solution protection in structures. He has been advisor and co-advisor of 11 Phd Students in the field of civil engineering in IST Portugal, USP Brazil, KTU Lithuania and POLITO Italy.

Mário has been an invited assistant professor from 2009 to 2018 in Universidade Nova de Lisboa, Instituto Superior Técnico, Faculdade de Engenharia da Faculdade Católica Portuguesa, and Instituto Autónomo de Estudos Politécnicos.

Course schedule

Monday Sept 5th – From 10:00 to 13:00 (break of 15 to 30 minutes)

Tuesday September 6th – From 10:00 to 13:00 (break of 15 to 30 minutes)

Wednesday September 7th – From 10:00 to 13:00 (break of 15 to 30 minutes)

Thursday September 8th – From 10:00 to 13:00 and 15:00 to 18:00 (break of 15 to 30 minutes)

Friday September 9th – From 8:00 to 9:00 (Final Question Session)

Where

Politecnico di Torino, Sala Ferrari, DiMEAS