Civil Engineering and Architecture

2025

1 PhD COURSE

Civil Engineering and Architecture (Ingegneria Civile e Architettura, ICA)

2 TEACHING BOARD

53 members, 13 coming from international institutions (41th cycle)

3 PhD FELLOWS

28 students (7 from 39th cycle, 14 from 40th cycle, 7 from 41st cycle)

4 THEMATIC AREAS

Architecture, Infrastructures and Structures

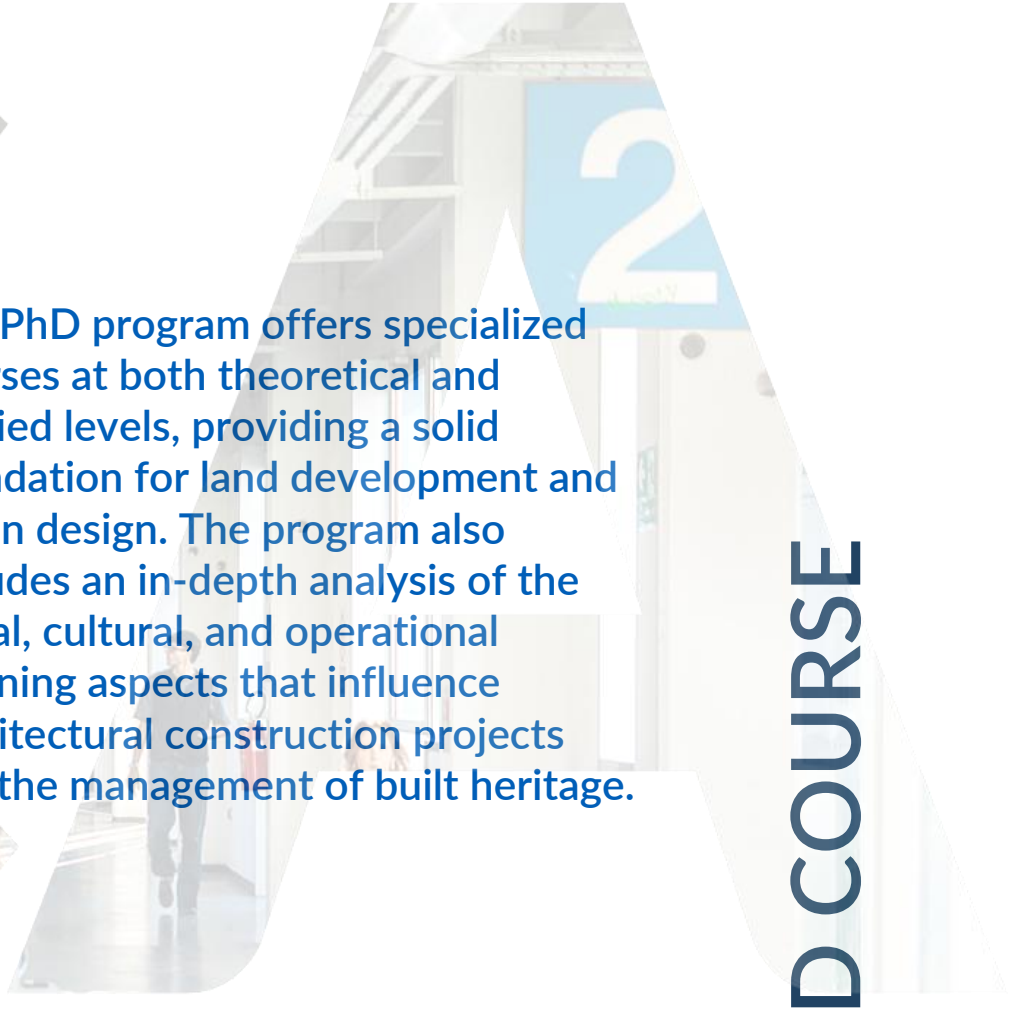
5 DOCTORAL THESES

13 theses (from 37th cycle) discussed in the year 2025



The PhD program in Civil Engineering and Architecture aims to provide students with a solid understanding of the main challenges in civil engineering and architecture, developing their ability to synthesize theoretical and practical solutions across various disciplines (construction, environment, geotechnics, structures, transportation engineering, and architecture), through a strong foundational education and the acquisition of up-to-date research methodologies.

The PhD program offers specialized courses at both theoretical and applied levels, providing a solid foundation for land development and urban design. The program also includes an in-depth analysis of the social, cultural, and operational planning aspects that influence architectural construction projects and the management of built heritage.



1 PhD COURSE

2 TEACHING BOARD



A. Spagnoli
Coordinator



L. Chiapponi
Vice Coordinator



B. Gherri
RAQ

Full list of the Teaching Board members

PhD FELLOWS
3 – 39th cycle



R. BORSATO BELO



S. CARTA



L. LEONI



R. MONTICELLI



G. PEDILARCO



M. VESCOVI



A. VILLA

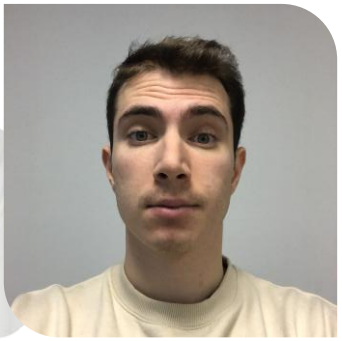
UNIVERSITÀ DI PARMA

PhD FELLOWS
3 – 40th cycle


M. CEDRO


F. DE COLA


G. FURLOTTI


M. GRISENTI


R.M. DE ROSA


H. JING


A. KARTHIKA


S. KHAIIATALI


R. MACALUSO


K. FATIMA


F. MARRELLA


R. ROGATO


M. VITHANA


C.L. MBOUGOUE MABAPGAP

3 – 41st cycle PhD FELLOWS



O. BROGNOLI



R. GHELFI



W. HUSSAIN



D.M. MEQUANINT



C. MERABTI



P. SHAYKHOLESLAMI

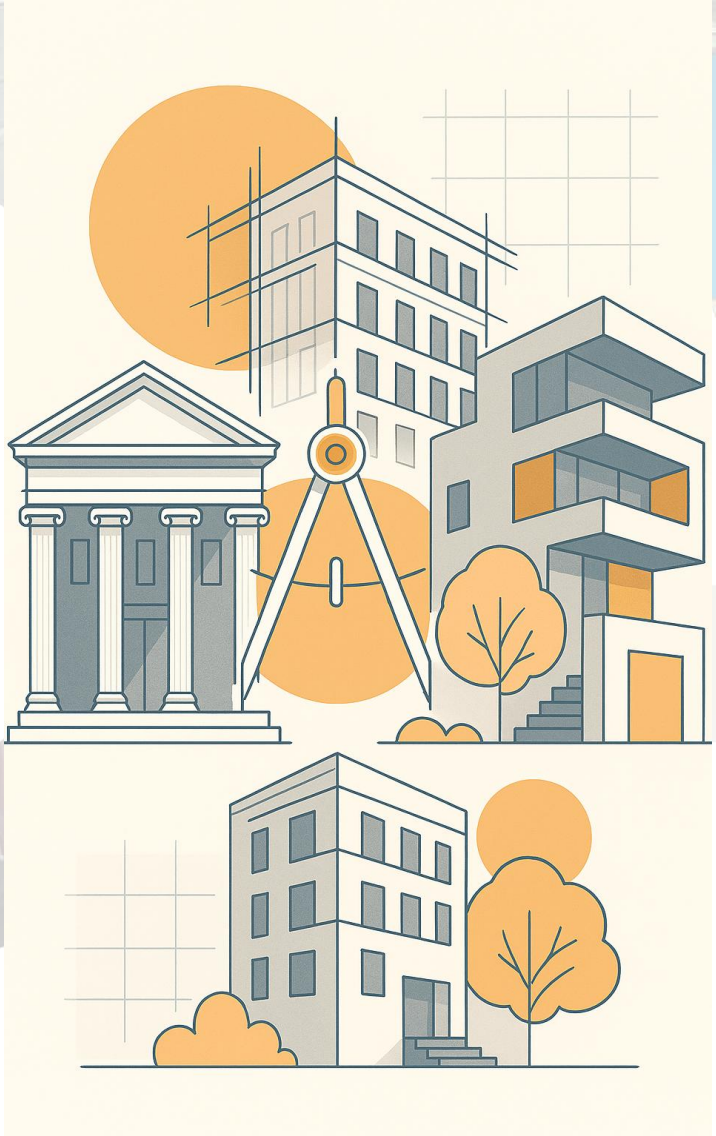


N. YARAHMADI

5 ARCHITECTURE THEMATIC AREAS

Architectural research within the doctoral programme focuses on the analysis, design, and transformation of the built and urban environment, addressing its cultural, social, and environmental dimensions. Key thematic areas include:

- Architectural theory, history, and criticism, with emphasis on contemporary architecture, urban spaces, and their cultural and social interpretations
- Urban regeneration, landscape studies, and territorial transformation processes in relation to spatial, environmental, and infrastructural dynamics,
- Surveying, representation, and advanced graphic and digital methodologies applied at building and urban scales
- Architectural and cultural heritage: critical knowledge, conservation practices, adaptive reuse strategies, and valorisation processes
- Architectural Engineering and Technology: sustainable and regenerative design, construction, and retrofit for existing building stock.



4 INFRASTRUCTURES
THEMATIC AREAS

Key thematic areas include:

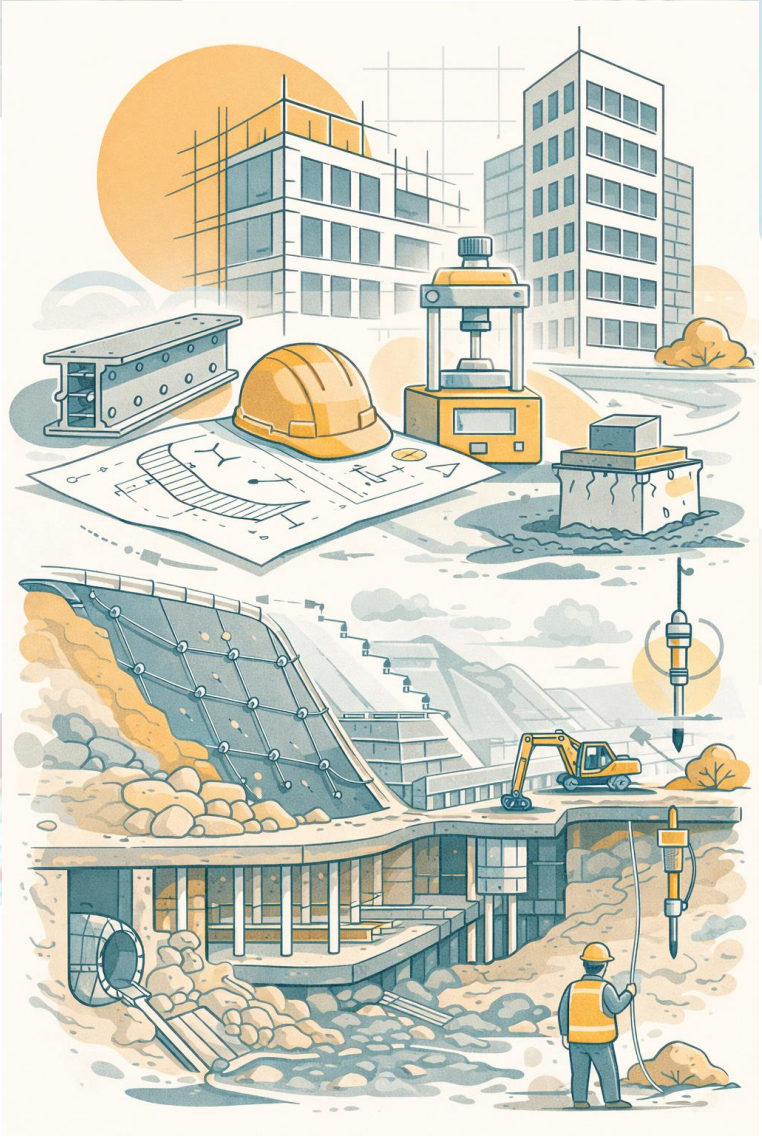
- The training of experts in the area of
- transport infrastructures;
- The development of expert knowledge in the field of surveying, managing and analysing spatial data related to the control and monitoring of displacements and strains at all scales;
- The in-depth study of topics related to fluid mechanics, maritime hydraulics, hydraulic infrastructures, hydraulic land protection and surface and groundwater;
- The development of skills in water and waste management and treatment, monitoring and mitigation of pollution and climate change and the study of their impacts on water resources and infrastructure.



4 STRUCTURES THEMATIC AREAS

Key thematic areas include:

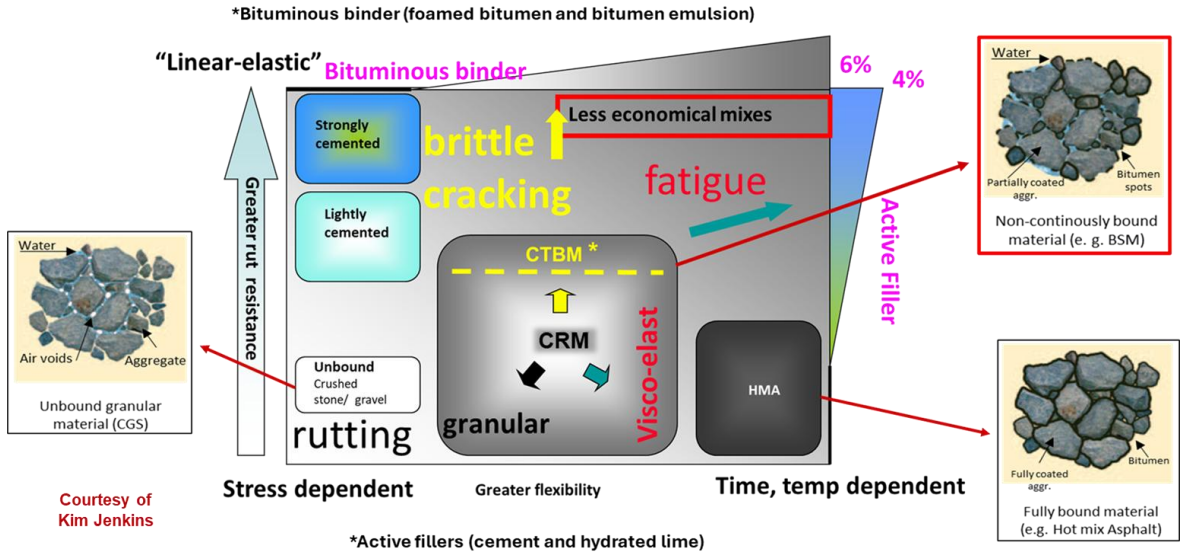
- The development of specific skills in the mechanics of solids, materials and structures to tackle complex problems in engineering, architecture and other applied sciences;
- The development of advanced theories and techniques aimed both at the structural conception and design of new buildings and at the verification and structural rehabilitation of existing ones;
- Training of specialised skills in the characterisation of the mechanical behaviour of soils and rocks; in-depth study of topics relating to the stability of slopes (natural and artificial) and underground excavations;
- Design of foundation structures and works involving interaction with soils and rocks.



INFLUENCE OF COMPACTION METHODS AND ACTIVE FILLERS ON PHYSICAL-MECHANICAL BEHAVIOR AND PERFORMANCE OF COLD RECYCLED MIXTURE

UNIVERSITÀ DI PARMA

Fausto Bisanti | Tutor: Gabriele Tebaldi | Co-Tutor: Elena Romeo



Cold recycling technologies are increasingly adopted for asphalt pavement rehabilitation due to their environmental benefits, including reduced greenhouse gas emissions and limited material transport. These technologies produce cold recycled mixtures (CRMs), which can incorporate up to 100% reclaimed asphalt pavement without heating aggregates. CRMs exhibit intermediate mechanical behavior between hot mix asphalt and unbound materials, with properties strongly influenced by stress state, moisture, and confining pressure. This research aimed to improve the understanding of CRM mechanical behavior by focusing on two key factors: compaction method and active filler type and content. Laboratory investigations compared modified Proctor, gyratory compaction, and vibratory hammer methods through volumetric and mechanical tests. Results showed that both the magnitude and application of compaction energy significantly affect mixture properties, with gyratory compaction providing the highest performance, and moisture content playing a critical role.

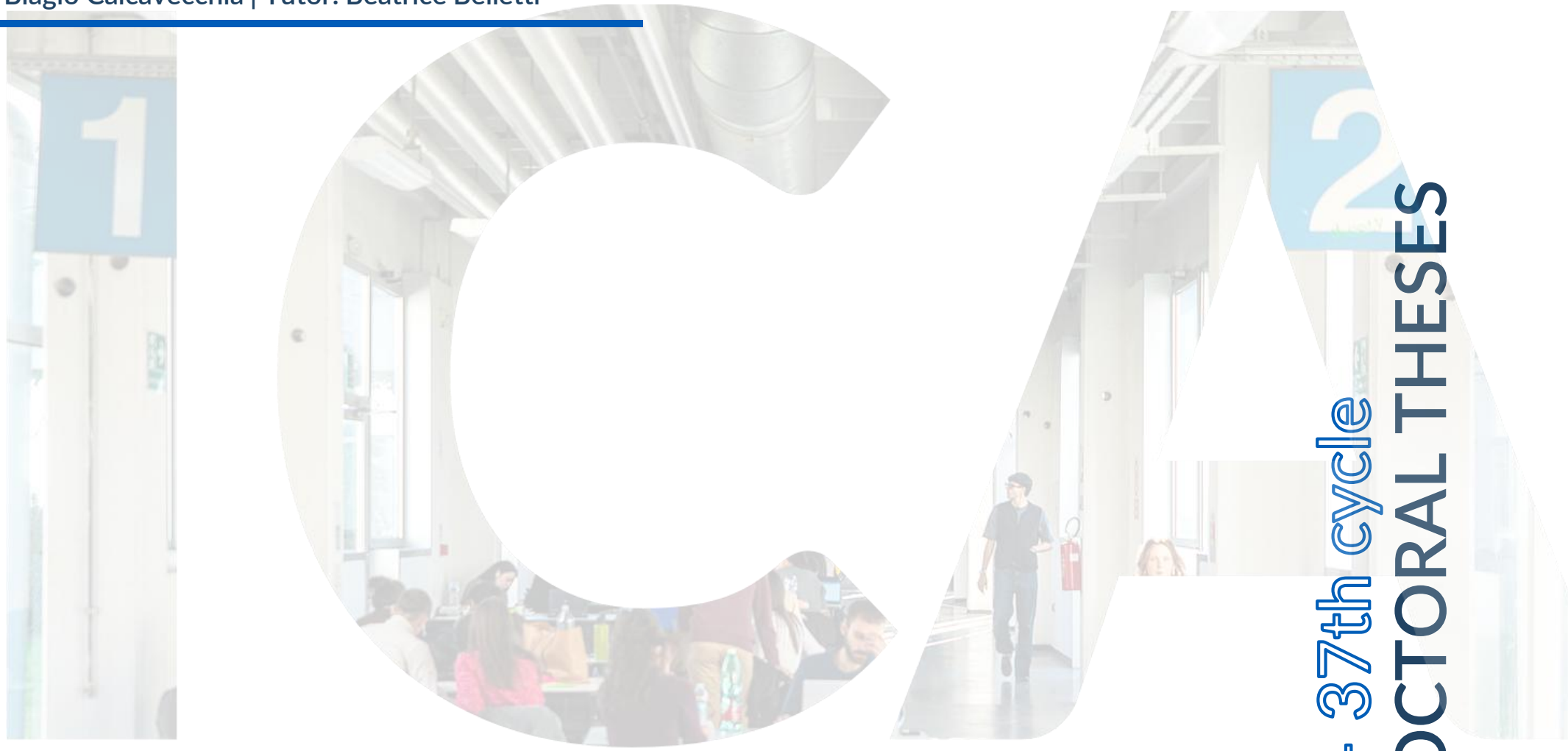
Particular attention was given to the role of active fillers, specifically cement and hydrated lime, used at different dosages in mixtures stabilized with foamed bitumen or bitumen emulsion. Results demonstrated that filler type and content strongly influence strength, stiffness, and ductility. Cement contents above 1.5% increased cohesion and stiffness but also brittleness, while hydrated lime showed optimal performance between 2% and 3%, providing a balanced mechanical response.

Overall, this research provides practical guidance for optimizing CRM design and enhancing long-term pavement performance.

5 - 37th cycle
DOCTORAL THESES

STRUCTURAL ASSESSMENT OF CORRODED DAPPED-END BEAMS

Biagio Calcavecchia | Tutor: Beatrice Belletti



5 – 37th cycle
DOCTORAL THESES

NARRATIVE SEQUENCES AND THREADS IN THE LANDSCAPE

Designing spaces for autonomous driving.
Jože Plečnik's Ljubljana and regeneration strategies in the transition of cities towards new mobility systems

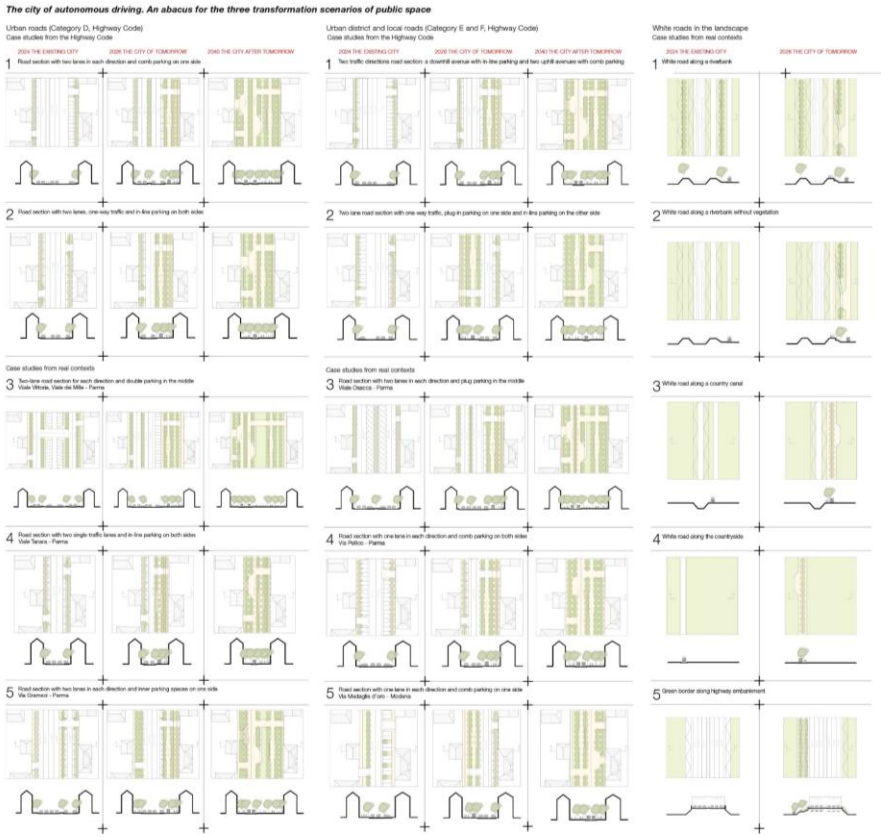
Giorgia Carpi | Tutor: Dario Costi

UNIVERSITÀ DI PARMA

This research explores tools for urban design to guide the sustainable transformation of contemporary cities, drawing on investigations conducted within the *Smart City 4.0 Sustainable Lab*. Technological innovation is interpreted as an opportunity to activate strategies of urban regeneration and renaturation, supporting the transition from the *city of cars* to the *city of people*. The *Urban Strategic Design* methodology proposes an integrated approach capable of reconnecting natural and anthropic landscapes through new networks of public spaces and cycle-pedestrian mobility.

In this context, autonomous driving is investigated as a potential catalyst for urban regeneration. Design explorations suggest that the city of autonomous mobility should be conceived primarily as an urban landscape project, where routes for autonomous vehicles can act as green infrastructures linking urban nodes and reinforcing territorial identities. This perspective integrates environmental design, mobility networks and spaces of sociality within a system of landscape-based mobility corridors.

The research also reflects on historical precedents, recognising in the work of Jože Plečnik in Ljubljana an exemplary approach to urban design centred on the construction of places for people. Plečnik's work highlights the coherence between architecture, landscape and public space as a key reference for guiding contemporary urban transformations.



5 - 37th cycle
DOCTORAL THESES

ADATTAMENTO AL CAMBIAMENTO CLIMATICO NELLE PRATICHE DI RIGENERAZIONE URBANA

Marianna Ceci | Tutor: Michele Zazzi



5 - 37th cycle
DOCTORAL THESES

Forecasting Landslide behavior with Deep Learning Algorithms for Early Warning purposes

UNIVERSITÀ DI PARMA

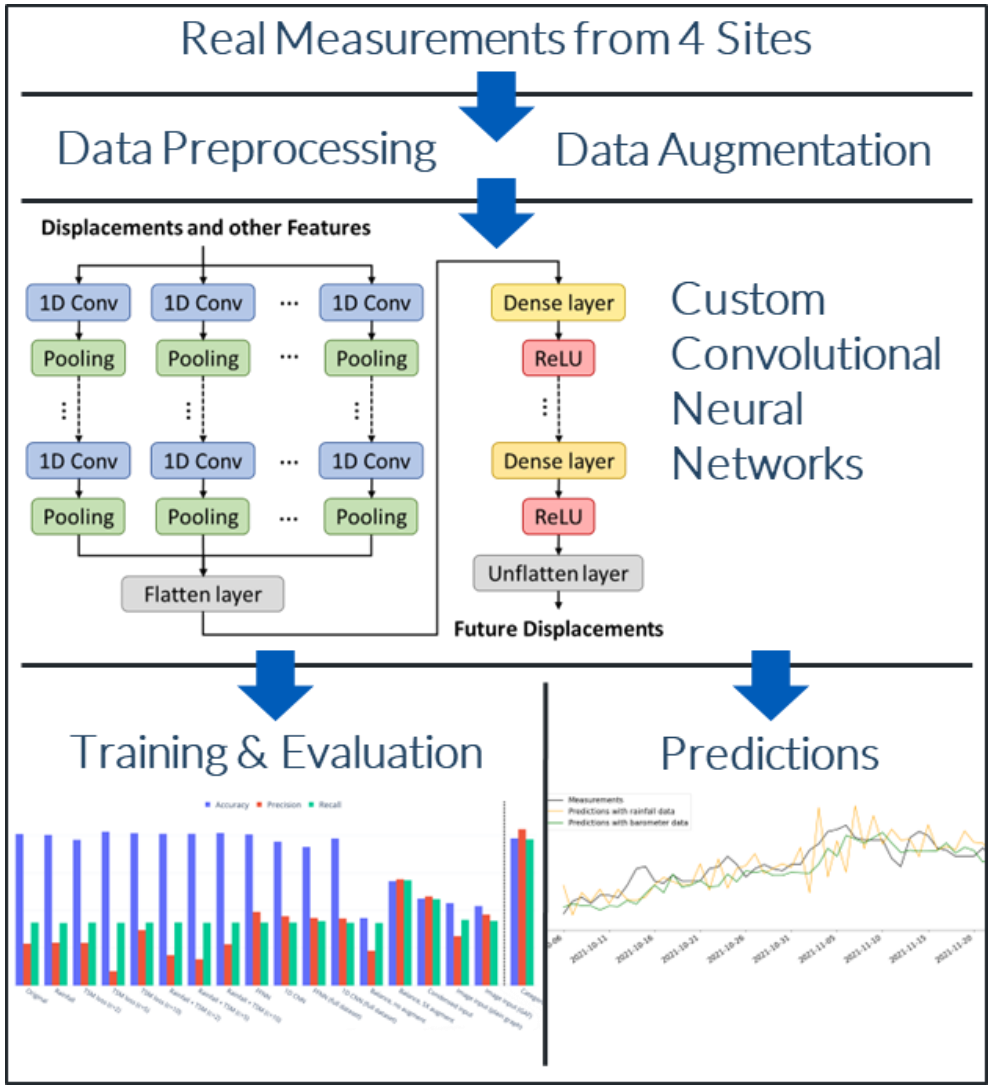
Marco Conciatori | Tutor: Andrea Segalini | Co-Tutor: Alessandro Valletta

Development of a Deep Learning algorithm for landslide forecasting. It uses past displacements and other optional information to predict the next displacements. Many versions of this algorithm are tested, changing input data, underlying Neural Network, loss function, and other characteristics.

Development of a Deep Learning algorithm for tree species recognition from drone images. This is achieved with models pre-trained on ImageNet and subsequently fine-tuned on task-specific images. The output produced can be used as additional input for the landslide forecasting algorithm.

Development of various auxiliary functions like custom loss for Neural Network training, custom metrics for better evaluation, automatic hyperparameter space search, data cleaning and processing, data augmentation.

Test of both algorithms on real world data with presentation and discussion of the results.



5 – 37th cycle
DOCTORAL THESES

CLIMATE CHANGE ADAPTATION IN URBAN REGENERATION PRACTICES.
THE CONTRIBUTION OF SOIL DESEALING IN REDUCING THE URBAN PLUVIAL FLOOD RISK

UNIVERSITÀ DI PARMA

Ilaria De Noia | Tutor: Michele Zazzi

Over the past century, urbanisation has significantly increased soil sealing and land consumption, intensifying phenomena such as the urban heat island and urban flooding. Combined with rising temperatures and heavier rainfall due to climate change, these dynamics threaten the environmental, social, and economic sustainability of European and Italian cities. Among climate change adaptation strategies, soil desealing – i.e., the removal of impervious surfaces to restore soil permeability - has emerged as a promising approach to reduce surface runoff, mitigate urban heat, and restore ecosystem services.

This research defines priorities and criteria for implementing soil desealing, aimed at mitigating urban pluvial flood risk with a focus on medium-sized Italian cities. The study reviews scientific literature as well as legislative and strategic frameworks at European, national, and regional levels, highlighting the need for an integrated and multi-scalar approach to urban planning.

The methodology combines quantitative and qualitative analyses, including assessments of urban flood risk, potential damages, and urban transformation opportunities, together with participatory activities involving citizens of different ages. The case studies of Parma and Brescia provide practical insights into identifying priority areas for interventions and testing participatory approaches. The thesis ultimately proposes guidelines for integrating soil desealing into urban regeneration practices, considering both institutional perspectives and citizen engagement.



Objective 1
Definition of priority areas for soil desealing

Objective 2
Definition of intervention criteria for soil desealing

I LITERATURE REVIEW*

II METHODOLOGY

III APPLICATIVE CASE STUDIES

IV CONCLUSIONS

Drafting of the urban pluvial flood risk and damage maps

Drafting of the transformation potential maps

Investigating the role of citizens' involvement

*activity carried out with Dr. Marianna Ceci

Research internship @AmbienteParco Science Centre

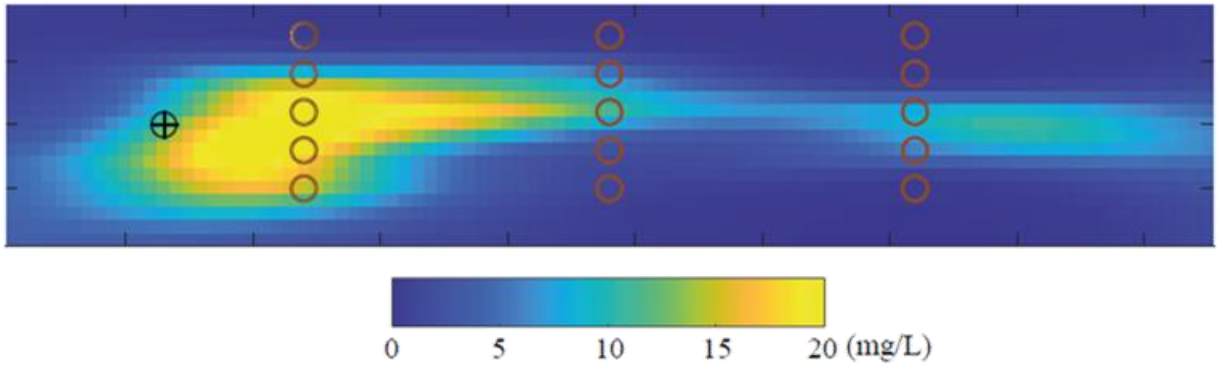
Visiting research period @Eindhoven University of Technology

Applied research experience @Centre for Environmental Ethics

5 – 37th cycle
DOCTORAL THESES

MAPPING THE INVISIBLE: GEOSTATISTICAL BREAKTHROUGHS FROM RAINFALL ANALYSIS TO AQUIFER CHARACTERIZATION

Camilla Fagandini | Tutor: Andrea Zanini



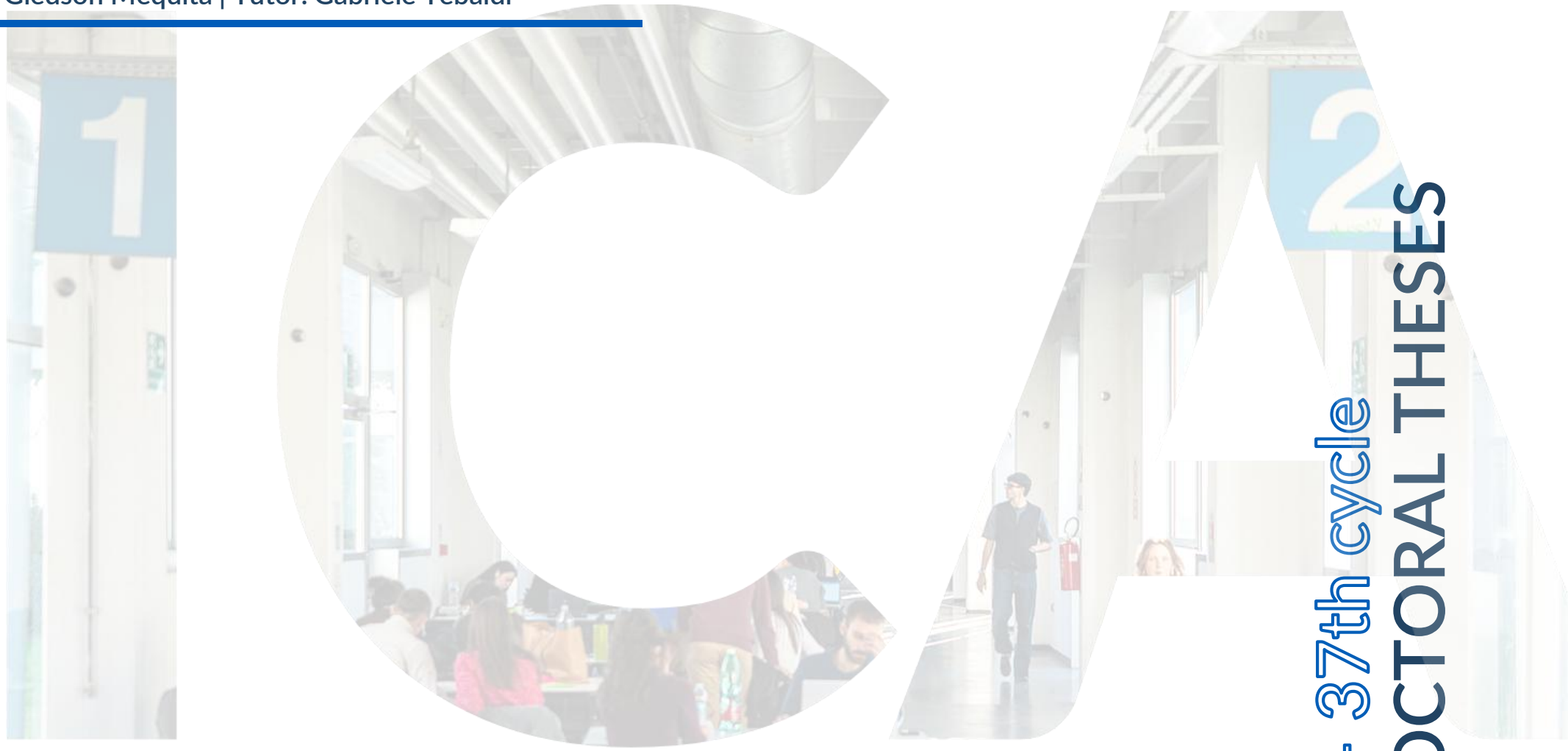
The thesis develops innovative methodologies to support groundwater management, focusing on geostatistics, inverse modelling, and laboratory experiments. It addresses three areas: gap-filling of daily precipitation time series, subsurface inverse modelling, and controlled experimental investigations.

First, a novel geostatistical approach for filling gaps in daily precipitation data is introduced and compared with linear interpolation. Tested in Mantova (Italy) and southern Portugal, the method uses monthly instead of daily semi-variograms, improving computational efficiency without reducing accuracy. Strengths and limitations of both approaches are discussed. The thesis then presents three applications of inverse modeling for subsurface characterization using synthetic cases that integrate hydrological and geophysical data. Methods such as the Ensemble Smoother with Multiple Data Assimilation are applied to estimate properties like hydraulic conductivity and electrical resistivity. A key contribution is replacing the traditional forward model with a Convolutional Neural Network to reduce computational time. Results show that combining hydrological and geophysical data improves model accuracy and reduces uncertainty. Finally, laboratory sandbox experiments validate these findings using electrical resistivity tomography and concentration data.

Overall, the research advances integrated approaches for subsurface characterization and provides a foundation for future developments.

MECHANICAL EFFECTS OF RECYCLED PACKAGING PLASTIC IN BITUMINOUS BINDERS AND MIXTURES

Gledson Mequita | Tutor: Gabriele Tebaldi



5 - 37th cycle
DOCTORAL THESES

ANALYSIS AND ASSESSMENT OF VEGETATION'S CONTRIBUTION TO THE PREVENTION OF RISKS ASSOCIATED WITH THE TRIGGERING AND DEVELOPMENT OF RAINFALL INDUCED SHALLOW LANDSLIDES (SOIL SLIPS)

Salvatore Misiano | Tutor: Lorella Montrasio



5 - 37th cycle
DOCTORAL THESES

MECHANICAL BEHAVIOR OF POLYMER-BASED MATERIALS AND STRUCTURES UNDER EXTREME CONDITIONS: EXPERIMENTS AND MODELING

UNIVERSITÀ DI PARMA

Matteo Montanari | Tutor: Andrea Spagnoli

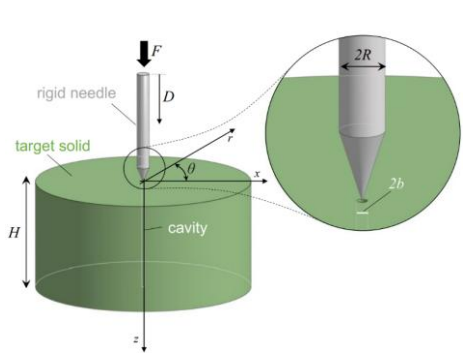
Polymer-based materials are everywhere: from medical devices and aerospace components to soft robotics and lightweight structural systems. Their extraordinary flexibility and ability to undergo large deformations make them ideal for many advanced applications, but also challenging to understand and predict from a mechanical standpoint.

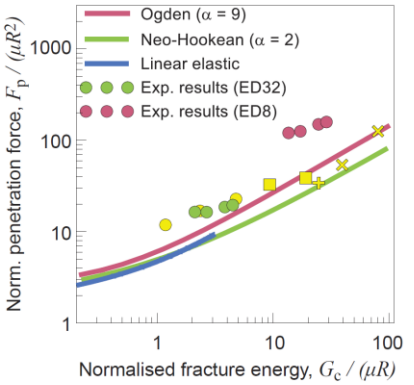
This thesis investigates how polymeric materials deform, fail, and can be engineered into innovative structures by combining experiments, theoretical modeling, and numerical simulations. The mechanics of puncturing in soft solids is explored through needle–penetration experiments and fracture-mechanics-based models, highlighting the role of crack propagation, friction, and adhesion. The response of soft elastomeric membranes under indentation is then analyzed through analytical models and experiments, revealing how defects and lubrication conditions influence puncture resistance.

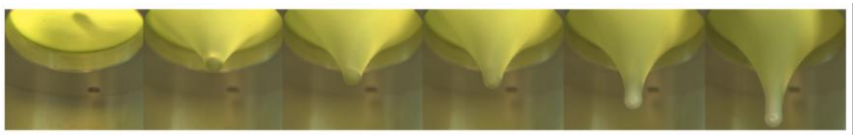
The work further examines 3D-printed lattice metamaterials, showing that the introduction of a soft secondary infill can significantly enhance stiffness, strength, and energy absorption even in the presence of manufacturing defects. Finally, the wrinkling behavior of bilayer structures with orthotropic substrates is investigated, demonstrating how surface patterns can be tuned through controlled material orientation.

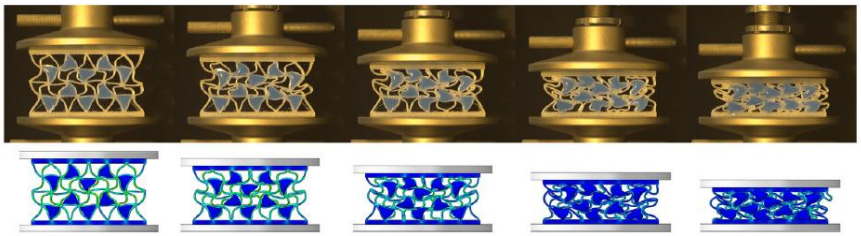
Together, these results contribute to a deeper understanding of how polymer-based systems can be designed for safer, smarter, and more resilient applications.











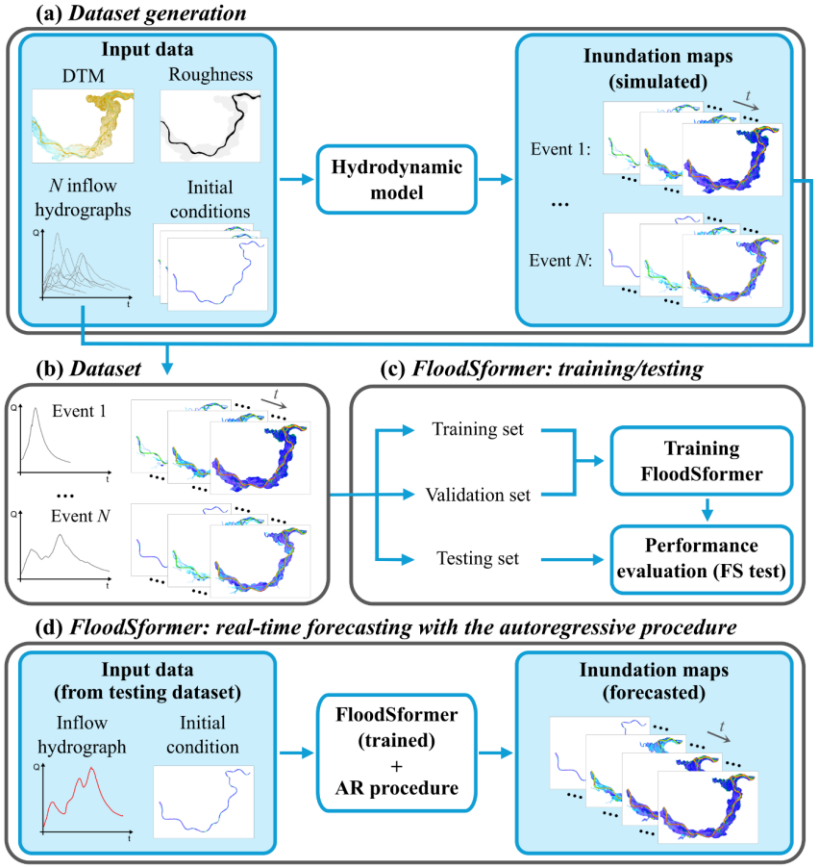
5 - 37th cycle
DOCTORAL THESES

A DEEP LEARNING FRAMEWORK FOR REAL-TIME FORECASTING OF 2-D INUNDATION MAPS: THE FLOODSFORMER MODEL

UNIVERSITÀ DI PARMA

Matteo Pianforini | Tutor: Renato Vacondio

The thesis contributes to the advancement of data-driven models for flood forecasting by developing a deep-learning framework for real-time prediction of the spatiotemporal evolution of two-dimensional inundation maps over complex, large-scale topographies. Unlike traditional flood forecasting approaches, which are often computationally expensive and time-consuming, the proposed model, named FloodSformer (FS), leverages state-of-the-art deep learning techniques by integrating autoencoder and transformer architectures. This combination enables the model to efficiently extract and process complex spatiotemporal information from sequences of water depth maps and upstream inflow discharges to predict future inundation maps through an autoregressive approach. The FS model was tested on a wide range of scenarios, including dam-break and river flood events, using both synthetic and real-world case studies. Results show that the model can accurately forecast long-duration flood events over complex bathymetries with up to millions of computational cells. Predictions are produced within minutes, with physical-to-computational time ratios reaching 10,000. Moreover, the model achieves predictive accuracy comparable to traditional hydrodynamic models, with average root mean square errors of 10–20 cm across real-world test cases. In conclusion, the FS model is a versatile and high-performing tool for flood prediction, with significant potential for applications in flood risk management and emergency response planning.



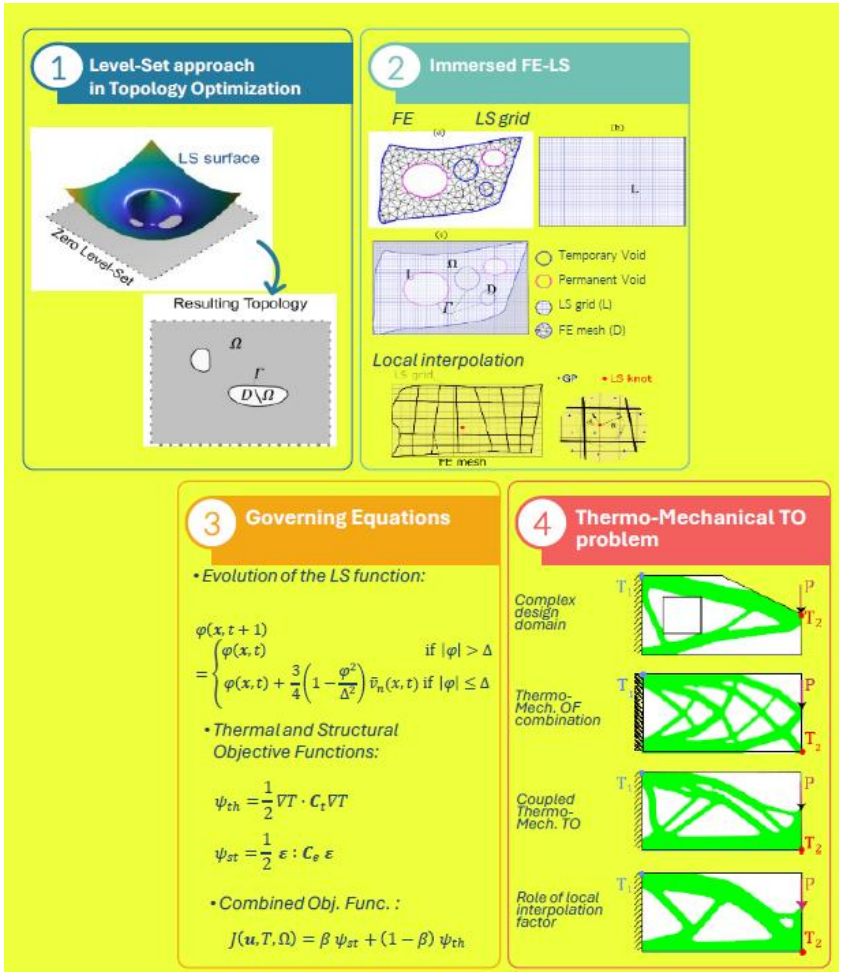
2025 - 37th cycle
DOCTORAL THESES

THERMO-MECHANICAL OPTIMIZATION OF MATERIALS AND STRUCTURES

Farzad Tatar | Tutor: Roberto Brighenti

This thesis presents a comprehensive study of topology optimization and its applications in structural and thermal systems. It combines theoretical developments, computational implementation, and practical validation to improve efficiency, accuracy, and versatility in solving complex thermo-mechanical design problems. The central contribution is the development of an immersed level set topology optimization framework in which the finite element mesh and the level set grid are treated independently, allowing accurate representation of structural boundaries without the need for adaptive meshing.

The study introduces improved strategies for transferring field variables between computational grids, refined convergence criteria, and interpolation techniques that balance computational cost and accuracy. The results demonstrate a robust and flexible framework suitable for complex engineering design problems and future extensions to nonlinear materials, multiscale structures, and advanced manufacturing applications.

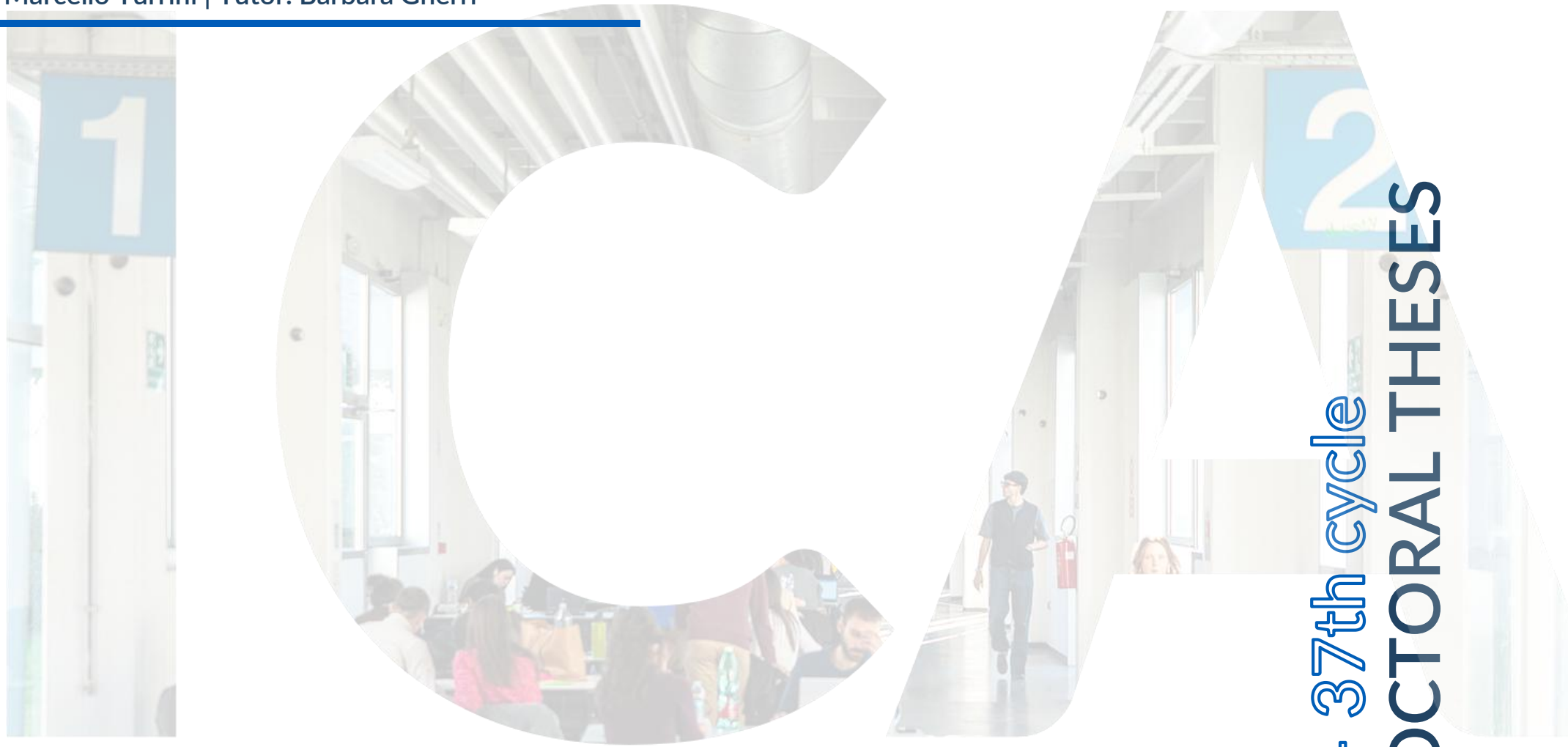


5 - 37th cycle
DOCTORAL THESES

USING UNIVERSAL THERMAL CLIMATE INDEX VARIATIONS AS A MULTI-SCALAR METRIC FOR ASSESSING BUILT-ENVIRONMENT RESILIENCE UNDER CLIMATE CHANGE

UNIVERSITÀ DI PARMA

Marcello Turrini | Tutor: Barbara Gherri



5 - 37th cycle
DOCTORAL THESES