Abstract

Habilitation thesis:

"*Life-Cycle Oriented Design for Bridge Deconstruction, Bridge Rehabilitation, and New Efficient and Innovative Integral Railway and Road Bridge Structures*"

This habilitation thesis synthesizes the research and academic activities in the field of civil engineering carried out between 2004–2025, following the public defense on 27.02.2004 of the PhD thesis entitled *"Safety in Operation and Rehabilitation of Metallic Bridges"*, a joint doctoral program UPT – TUM. Title obtained: Doctor of Engineering, Faculty of Civil Engineering and Architecture, Politehnica University of Timișoara, with the distinction *magna cum laude*.

The work is structured into three distinct parts. The first part presents a synthesis of scientific, academic, and professional works, the second part outlines the author's research, and the third section describes strategies for the evolution and development of the author's teaching and research career.

Part I – Scientific, Academic, and Professional Achievements

The habilitation thesis (Chapter 1) highlights the main scientific, academic, and professional achievements obtained in recent years since the doctoral defense. Research conducted over these years is grouped into the following areas:

- Structural safety through the application of fracture mechanics principles to verify metallic structures – analyses and laboratory tests in fracture mechanics.
- Rehabilitation of long-service-life bridge structures – including historical monument bridges.
- LCC analysis for bridge structures, durability, structural robustness, and sustainability; standards as European norms.
- Welded metallic structures: welding procedures and details, choice of material quality for welded bridge components, structural compliance regarding corrosion and fatigue, stress and deformation control.
- Deformation analyses / determination of camber during technological phases of bridge construction.
- Innovative and efficient solutions for integral railway and road bridges validated through in situ tests with load convoys and monitoring, including modular structures.

Additional research directions include quality management and control of metallic bridge fabrication, new joining methods, and implementation of BIM technology in bridge design.

Results of these studies are published in scientific articles, books, research and design contracts, and international cooperation agreements. Academic achievements also include teaching activities, professional training, positions, and responsibilities. The author's professional prestige is validated by specialized publications, research contracts, and scientific papers, as well as memberships in national and international professional organizations, journal and conference reviews, awards, and diplomas.

Published works are indexed in international databases such as Web of Science, Scopus, Google Scholar, Copernicus.

Hirsch indices:

- Web of Science – H-index = 4 (67 citations)

- Scopus – H-index = 5 (94 citations)
- Google Scholar – H-index = 9 (257 citations)

Part II – Research Directions

Chapter 2.1 – Bridges

- Structural safety via fracture mechanics applied to old metallic bridges (esp. riveted bridges) to determine residual service life and safety levels.
- Experimental studies on samples from old bridges (e.g., Șag-Timișeni, Arad).
- Modern methodology proposed for defect acceptability and fatigue evaluation (FAD diagrams, Paris law).
- Case studies: Traian Bridge (Arad), Săvârșin road bridge, Câmpina–Predeal railway bridges.
- Rehabilitation of over 80 metallic, concrete, or masonry bridges, including historical monuments (e.g., Prahova railway bridge, Băile Herculane stone bridge from 1864).
- Aim: extend service life by 30–50 years while preserving historical and architectural character.

Chapter 2.2 – Welded Metallic Structures

- Studies on welding technologies, material selection, anticorrosion, fatigue, stresses, and deformations.
- Practical examples: Câmpina–Predeal railway bridge deformation correction using flame straightening.
- Deformation and camber analyses during construction phases; examples include composite steel–concrete bridges and complex road overpasses.

Chapter 2.3 – Innovative Integral and Composite Bridges

- Over 400 bridge projects since 1997, many first-of-their-kind in Romania.
- Development of modular, prefabricated steel–concrete composite bridges (VFT, VFT-WIB, VTR/SSF Rapid).
- Advantages: reduced weight, rapid execution, durability, minimal maintenance.
- Examples: Orăștie–Sibiu highway, A0 North, Sebeș–Turda, Deva–Orăștie.
- Innovations: VFT solutions eliminating traditional connectors, modular spans up to 55 m, hot-dip galvanization (200 μm) for 100-year durability.
- Integral/semi-integral bridges eliminating bearings and expansion joints for lower maintenance and improved seismic/traffic resilience.
- Implemented in Romania (12+ VTR bridges, 14 VFT-WIB bridges), cited internationally.

Part III – Career Development Strategies

1. **Introduction** – Career oriented toward both teaching and research/design, emphasizing industry collaboration, grants, curriculum adaptation, and practical application of results. Values: feedback, transparency, openness, teamwork.
2. **Scientific Career Development** – Objectives: publishing in high-impact journals, conference participation, securing grants, student involvement, national and international collaborations.
    - Research focus: bridge structures (fracture mechanics), innovations in road/rail bridges, welding/disimilar joints, bridge compendium.
    - Notable achievement: VTT patented modular low-deck bridge method (rapid assembly, prefabrication, low cost, adaptability).

3. **Teaching Career Development** – Objectives: improving teaching methodology, active student involvement, course updates, interactive discussions. Participation in international mobilities (DAAD, Erasmus, CEEPUS). Guest professors invited from TU Munich, TU Graz, USA, Germany, Japan, etc. Industry integration in education. Emphasis on interdisciplinarity and labor market adaptability.

Conclusion:

The thesis presents a strategic vision combining scientific and academic activities, industrial cooperation, and technological innovation—particularly in bridges and metallic structures.

The habilitation thesis concludes with the list of bibliographical references associated with the three parts presented in chapters 1, 2 and 3.