



HAL
open science

Active learning reliability analysis for the design of reinforced concrete rail bridges

Mouhammed Achhab, Pierre Jehel, Fabrice Gatuingt

► **To cite this version:**

Mouhammed Achhab, Pierre Jehel, Fabrice Gatuingt. Active learning reliability analysis for the design of reinforced concrete rail bridges. LMP(hD)'S Day (LMPS), Jun 2024, Gif-sur-yvette, France. hal-04613653

HAL Id: hal-04613653

<https://hal.science/hal-04613653v1>

Submitted on 16 Jun 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Active learning reliability analysis for the design of reinforced concrete rail bridges

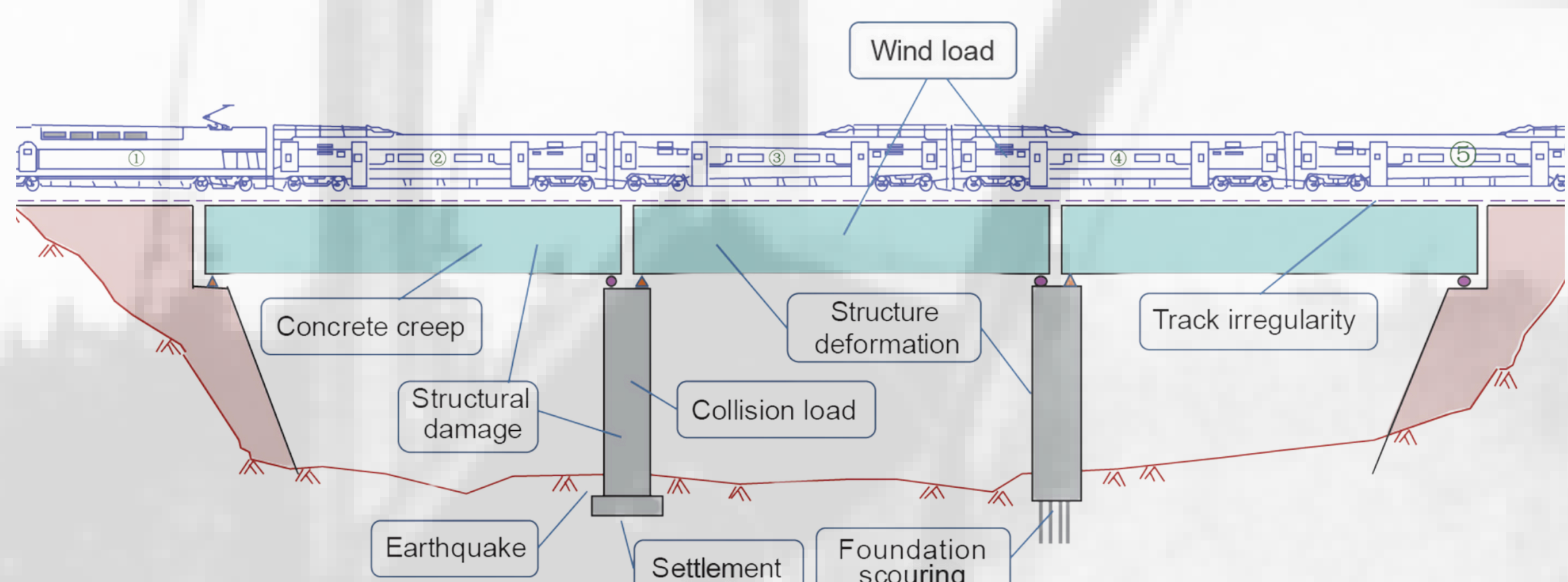
MOHAMMED ACHHAB¹ PIERRE JEHEL¹ FABRICE GATUINGT¹

¹ Université Paris-Saclay, CentraleSupélec, ENS Paris-Saclay, CNRS, LMPS – Laboratoire de Mécanique Paris-Saclay, 91190, Gif-sur-Yvette, France

Reliability analysis, Finite element model, active learning, surrogate model, reinforced concrete.

The design and analysis of reinforced concrete rail bridges is a challenging process, especially in the context of uncertainty propagation. A performant way to select the most performant design scenario is the emulation of the performance functions using surrogate modeling.

Introduction



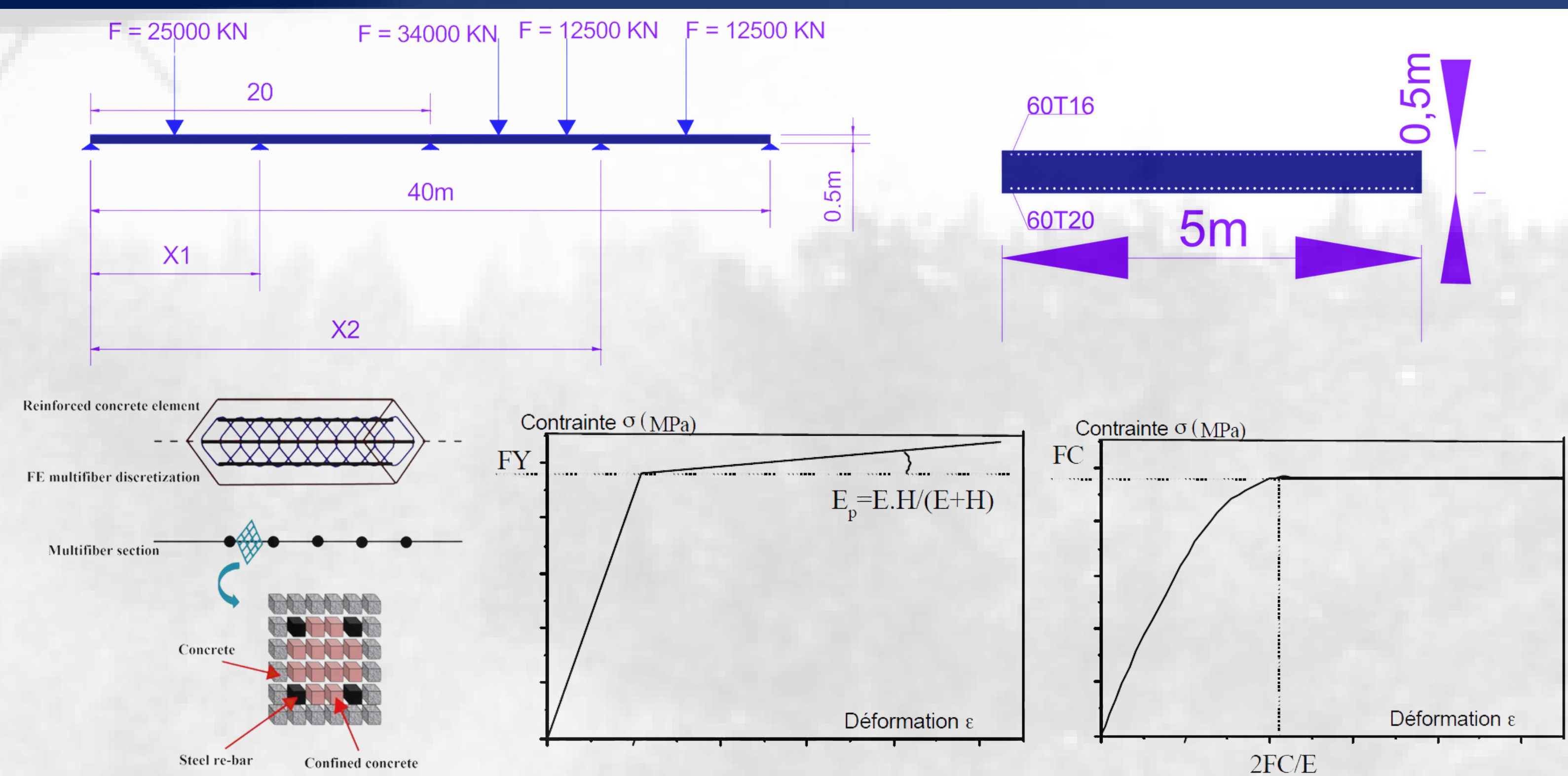
Sources of Uncertainties

Physical properties	Operational conditions	Lack of knowledge
Manufacturing tolerances	Loads uncertainties	Poor site investigations
Material strength	irregularities	Non-destructive tests

Performance Quantities of interest

Ultimate limit state	Service limit state
Stress	Deflection
Strain	Cracking control
Damage	Dynamic acceleration

Numerical model



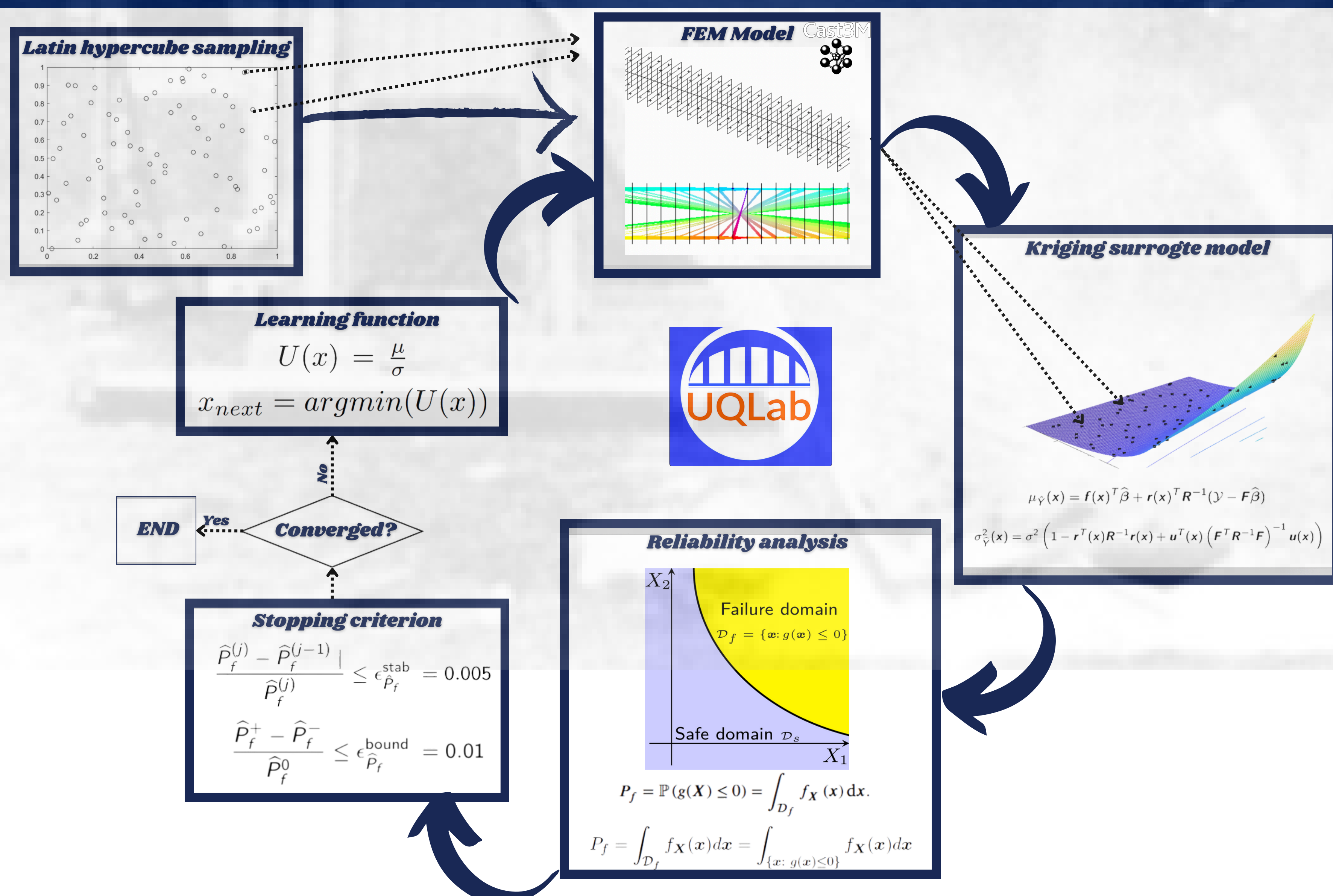
- Continuous reinforced concrete beam.
- Timoshenko Multi-fiber Cast3M finite element model
- Béton-Bael (concrete); plastic hardening (steel)

$$(\epsilon_x)_i = \epsilon_x - y_i \cdot \phi_z + z_i \cdot \phi_y$$

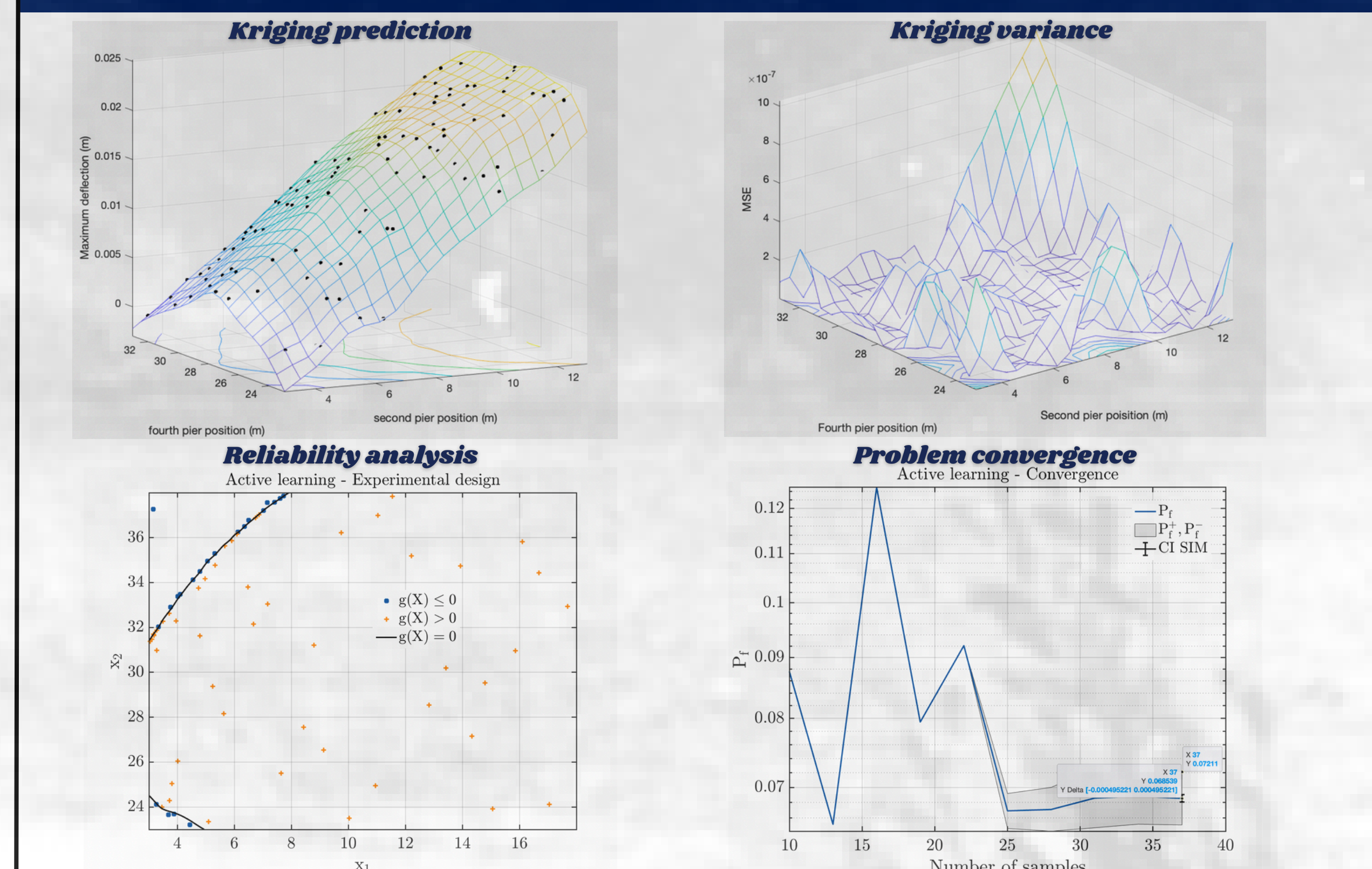
$$(\gamma_y)_i = \gamma_y - z_i \cdot \phi_x$$

$$(\gamma_z)_i = \gamma_z + y_i \cdot \phi_x$$

Methodology: Active learning reliability analysis



Results



Discussion

- Active learning reliability analysis is efficient for the design of complex structures
- More complex non-linear dynamic models should be considered.
- Civil Engineering structures are complex redundant structures: their failure can depend on the failure of multiple elements and about multiple quantities of interest. (System reliability to be considered).

References

Maliki Moustapha, Stefano Marelli, and Bruno Sudret. Active learning for structural reliability: Survey, general framework, and benchmark. *Structural Safety*, 96:102174, 2022.

Nan Zhang, Yuan Tian, and He Xia. A train-bridge dynamic interaction analysis method and its experimental validation. *Engineering*, 2(4):528–536, 2016.

MINERVE: methods and tools for sectoral collaboration and digital continuity over the life cycle of railway infrastructure
The MINERVE project is funded by the French Government in the France 2030 framework