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

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

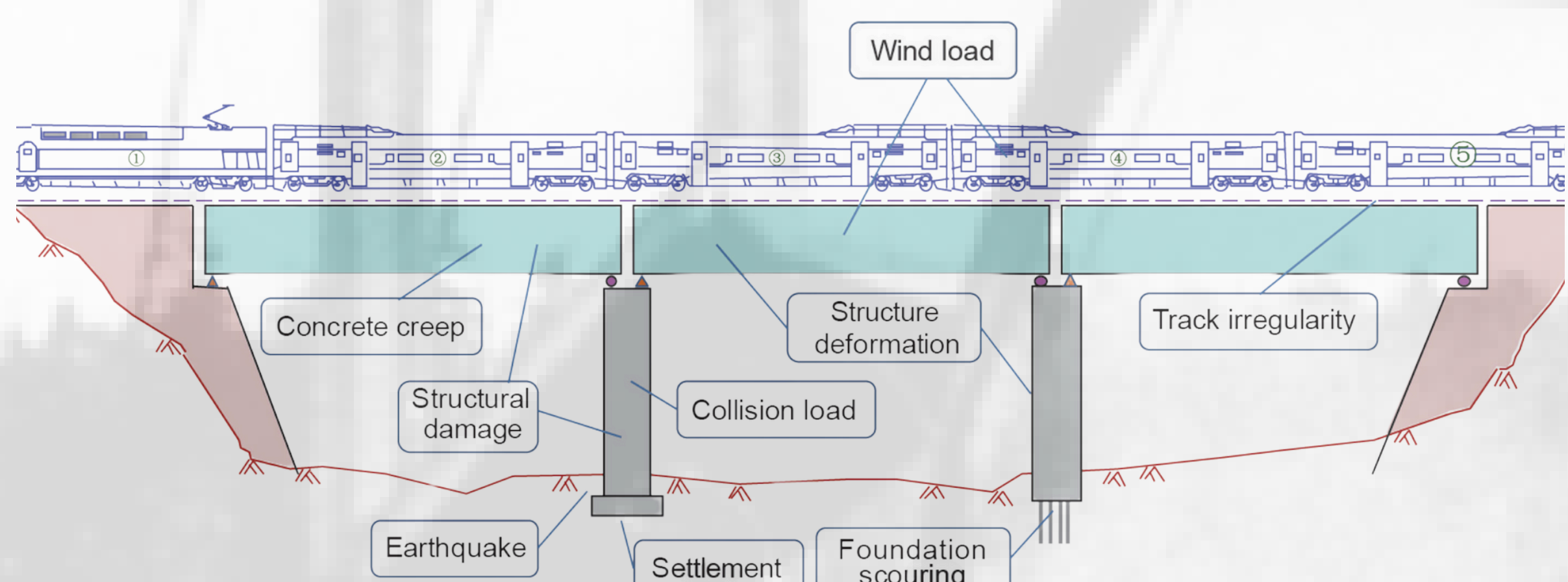
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## Reliability analysis, Finite element model, active learning, surrogate model, reinforced concrete.

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



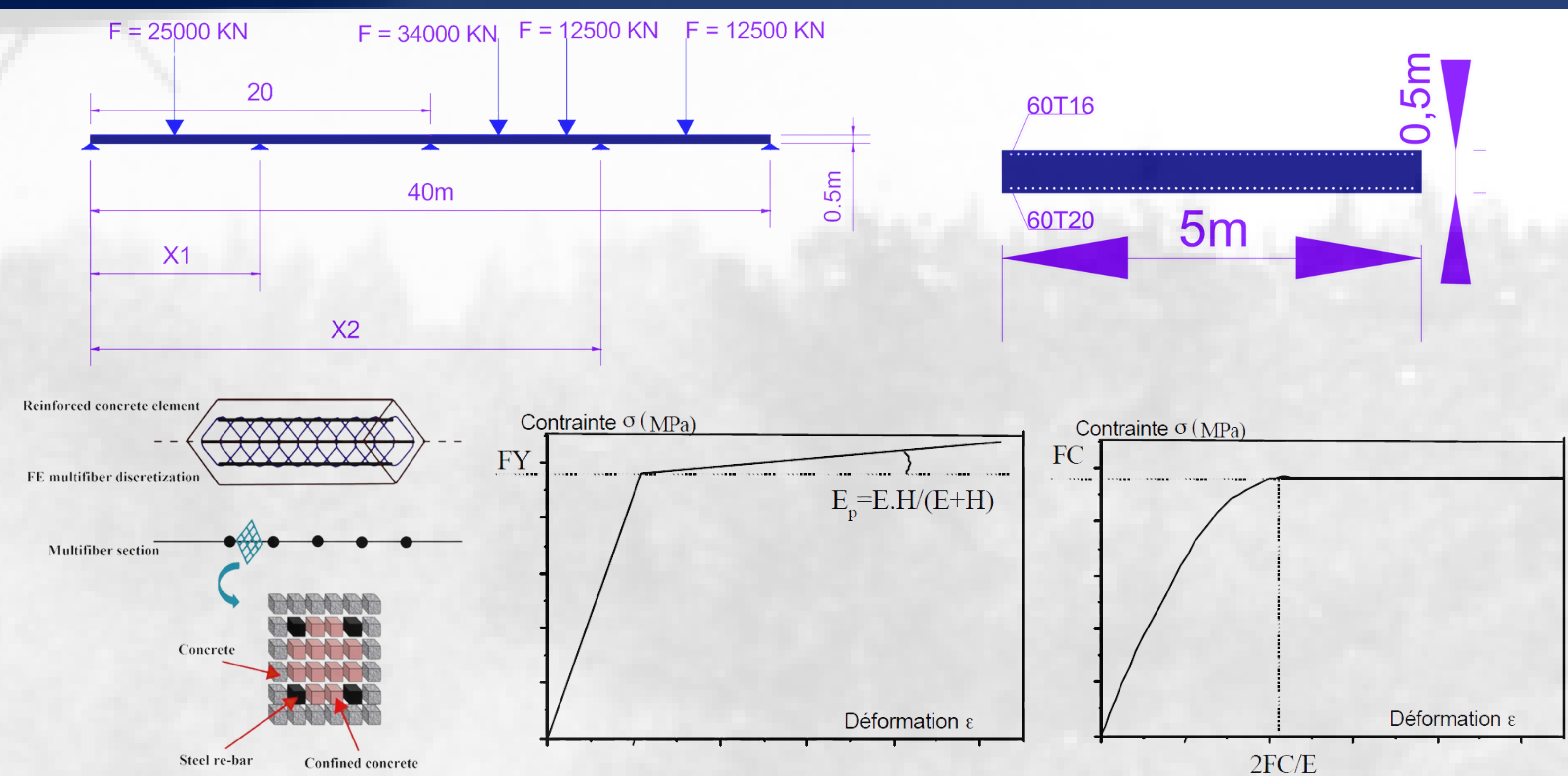
#### Sources of Uncertainties

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



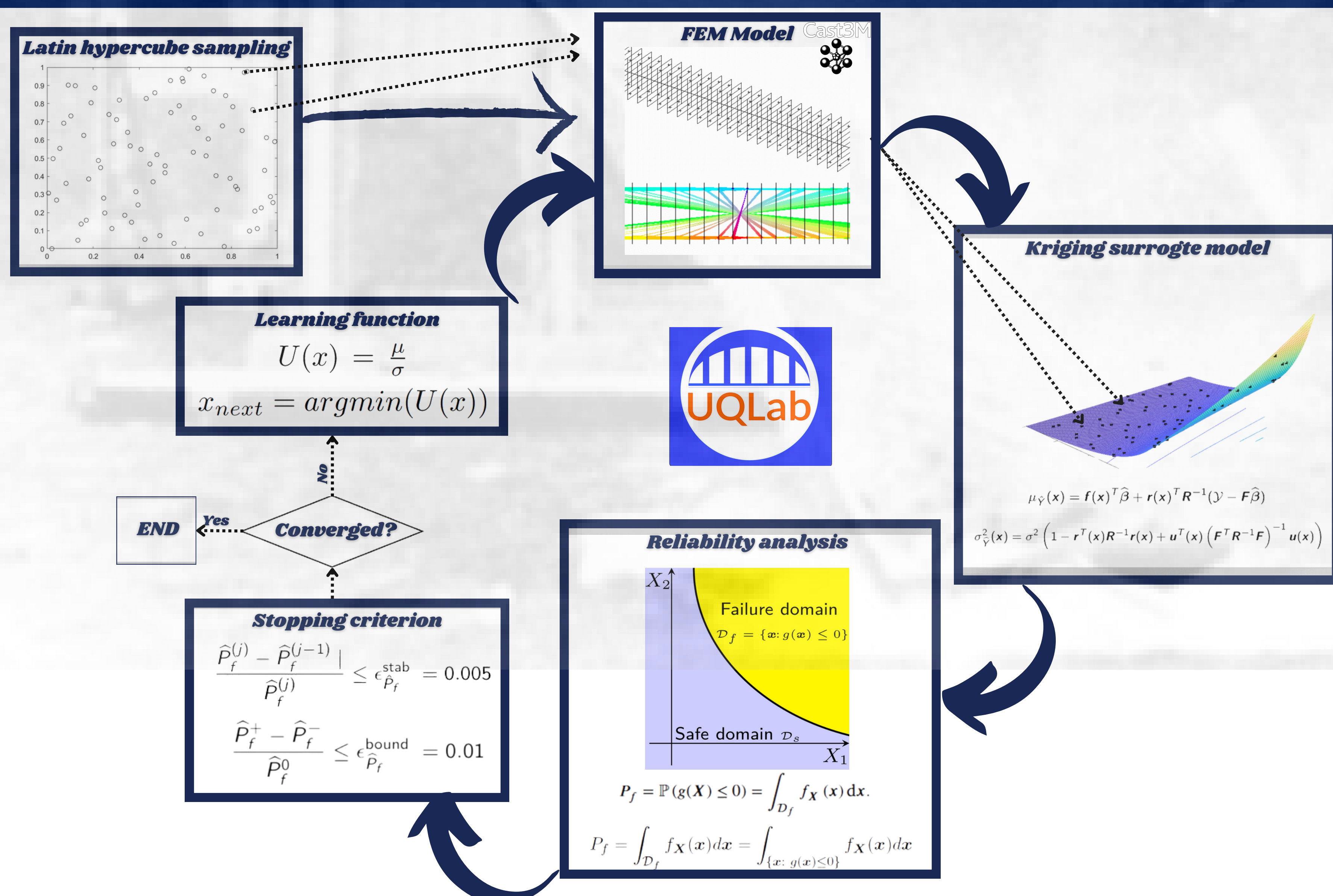
- Continuous reinforced concrete beam.
- Timoshenko Multi-fiber Cast3M finite element model
- Béton-Bael (concrete); plastic hardening (steel)

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

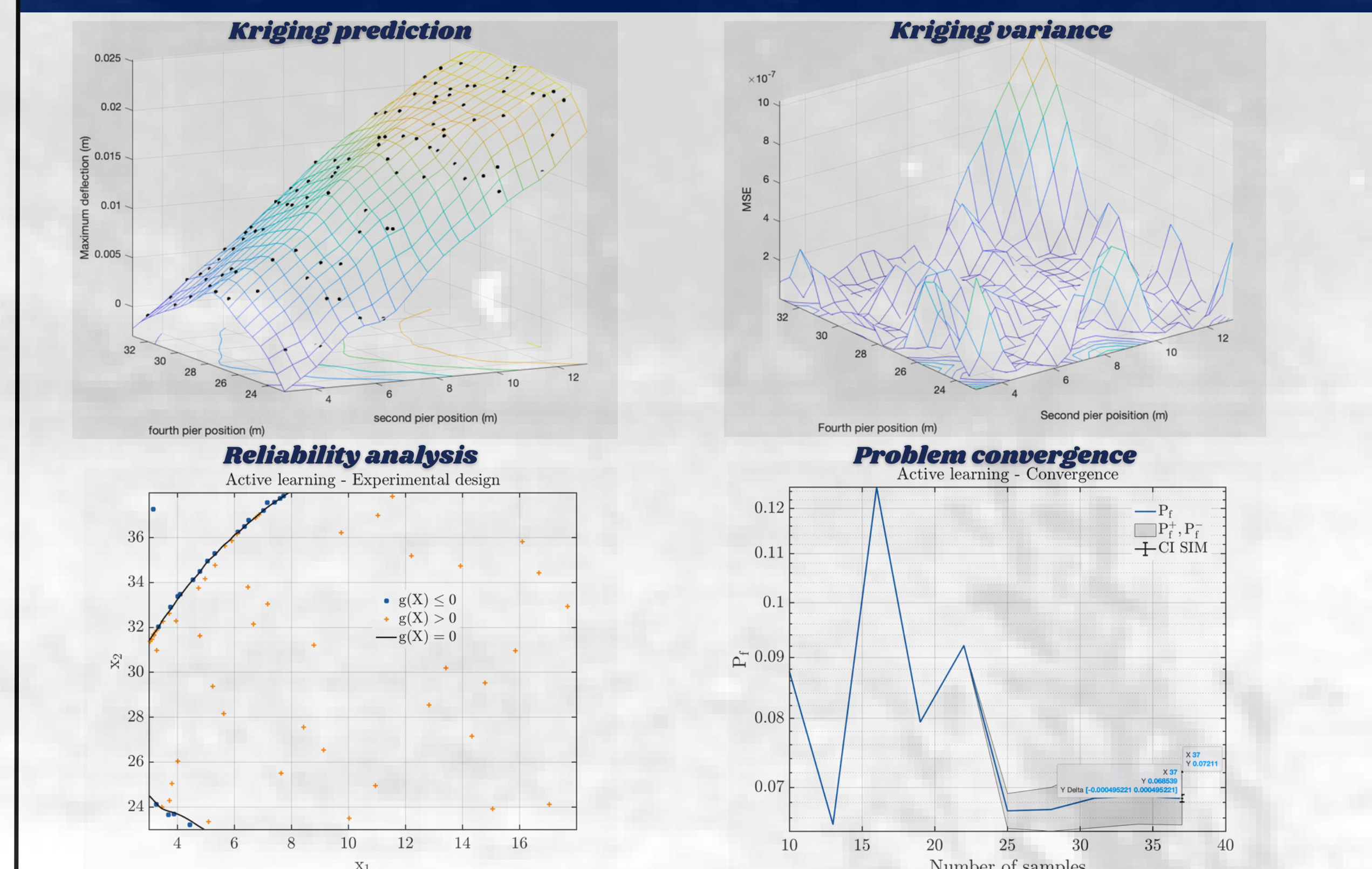
$$(\gamma_y)_i = \gamma_y - z_i \cdot \phi_x$$

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

### 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  
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