Earthquake Resistant Design

Project 1: Modelling of an existing structure designed according to EC8 for low and high-intensity vibrations [Oct 2021 – Jan 2022]

The dynamic behaviour of an already existing four-storey R.C. building is analyzed for low and high-intensity vibrations using a commercial modelling software Midas Gen. The structure has been tested using the pseudo-dynamic technique in the ELSA Laboratory of the Joint Research Center at Ispra (Italy) and the results of the numerical and experimental results are compared.

Knowledge and experience acquired:

- In-depth understanding of modelling frame structures, static, dynamic, and non-linear static and seismic analysis.
- Utilizing commercial structural analysis programs to verify results from experimental outcomes.

Software tools: Midas Gen, MS-Excel, AutoCAD

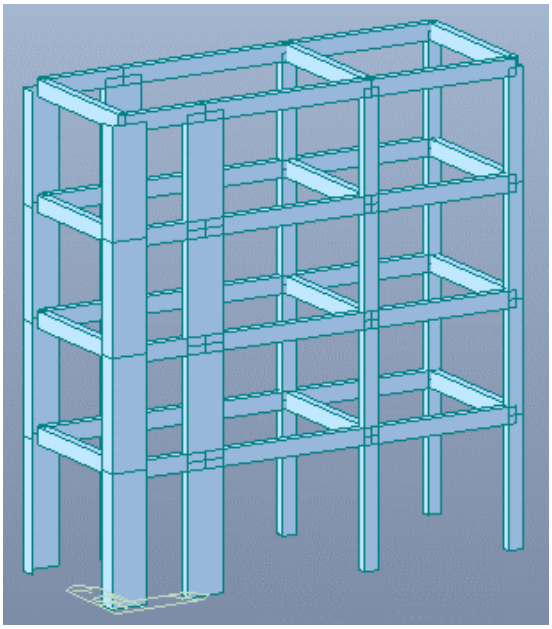


Figure 1. FEM model of four story building

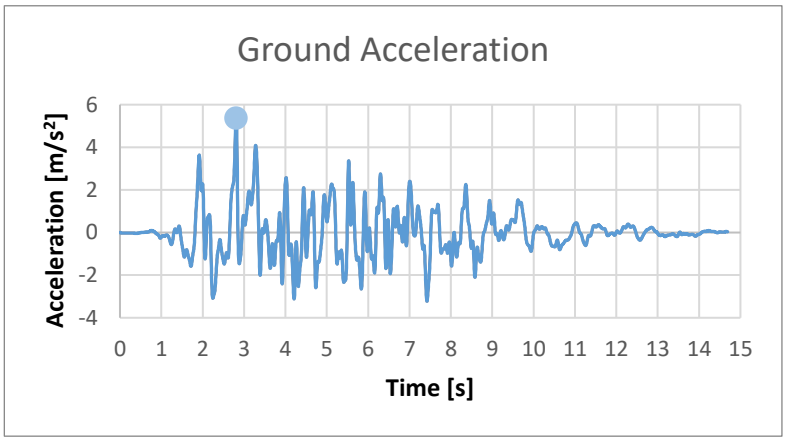


Figure 2. Ground acceleration

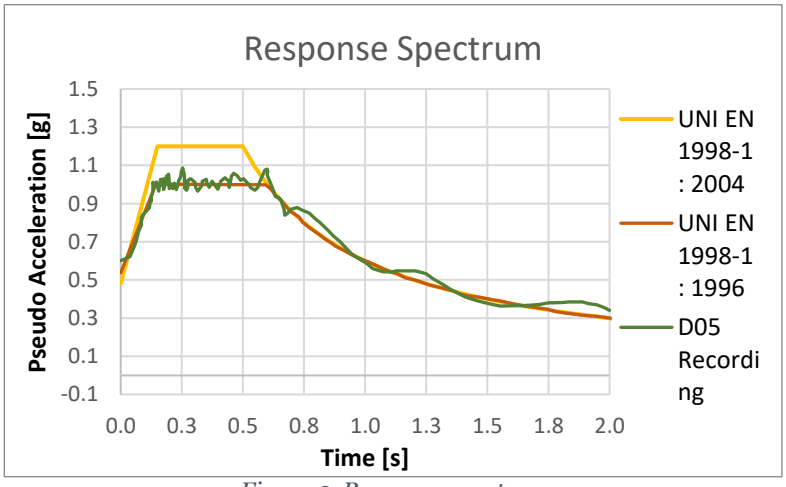


Figure 3. Response spectrum

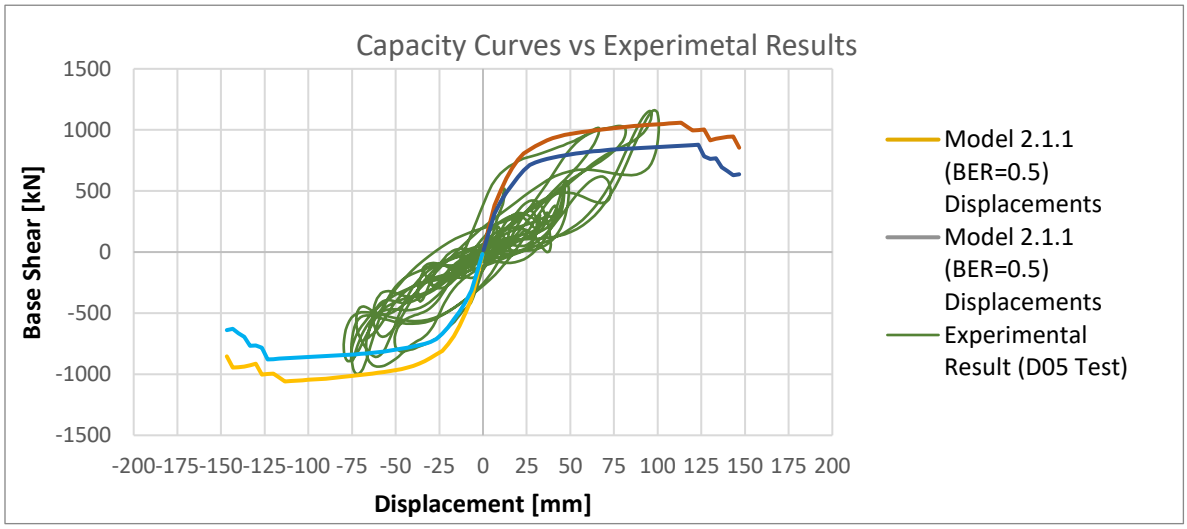


Figure 4. Pushover capacity curve Vs experimental result

Project 2: Seismic analysis and design of B+G+7 residential R.C. building [Oct 2021 – Jan 2022]

A new B+G+7 reinforced concrete building was designed for a medium ductility class (DCM) and soil type C, according to EC2, EC8, NTC18 requirements and national annex recommendation. Response spectrum analysis was performed to analyse the model for the seismic action. After the design choice and all procedural computations are performed, the detailed reinforcement design of the beams, columns, shear walls and cores are prepared.

Knowledge and experience acquired:

- A good knowledge of the codes of practice and International Codes.
- Preliminary structural design parameters framing layouts, material, and construction specifications in accordance with Eurocode (EC) and Italian standard (NTC18).
- Performing structural analysis and design of building components (beams, columns, shear walls and cores) according to Eurocodes requirements.
- Utilizing structural analysis finite element program to verify results from hand calculations.
- Generating detailed technical drawings using AutoCAD.
- Writing ad-hoc numerical codes on MS-Excel and Python to streamline processes, save time and increase accuracy in repetitive tasks.
- Evaluating priorities and organizing individual workloads to meet tight project deadlines.

Software tools: Midas Gen, AutoCAD, Python, MS-Excel

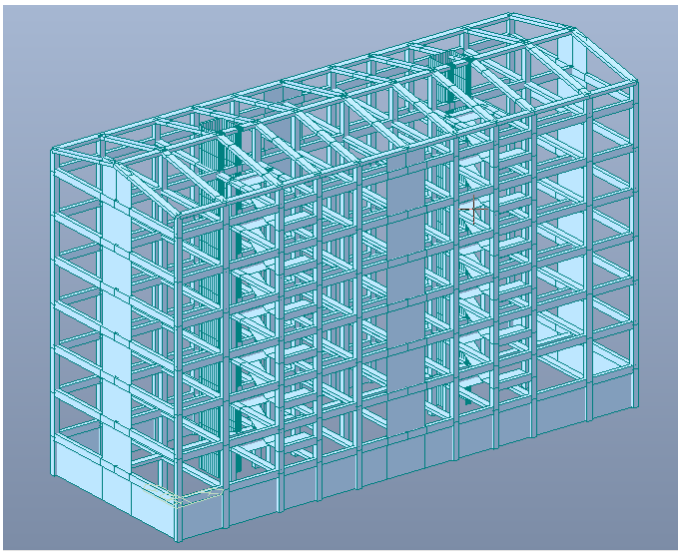
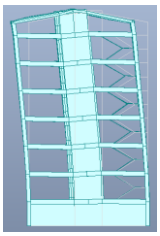


Figure 5. FEM model of the structure



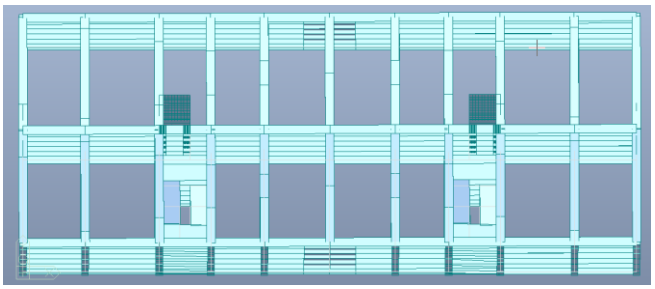


Figure 6. Mode 1 vibration mode of the structure

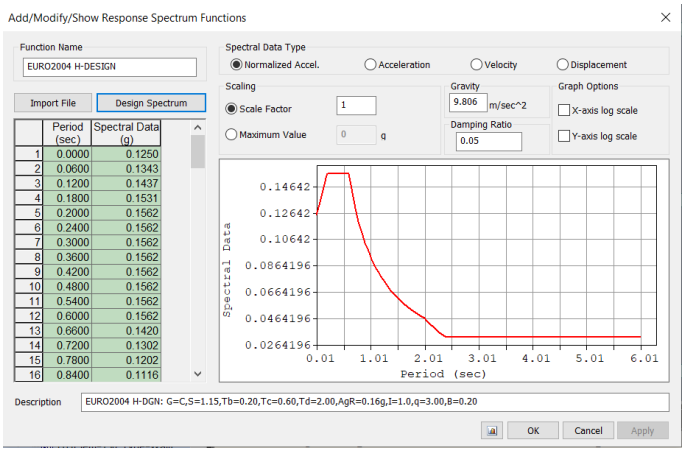


Figure 7. Horizontal design response spectrum

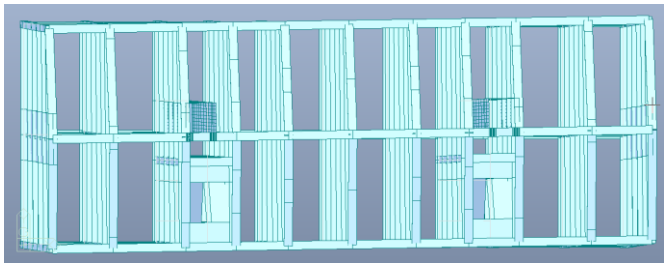


Figure 8. Mode 2 vibration mode of the structure

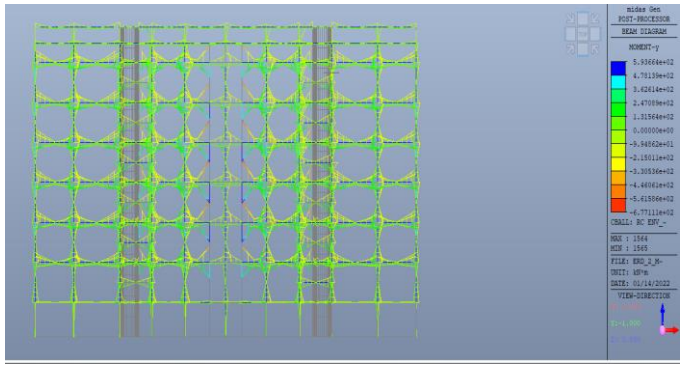


Figure 9. Bending moment diagram of the structure

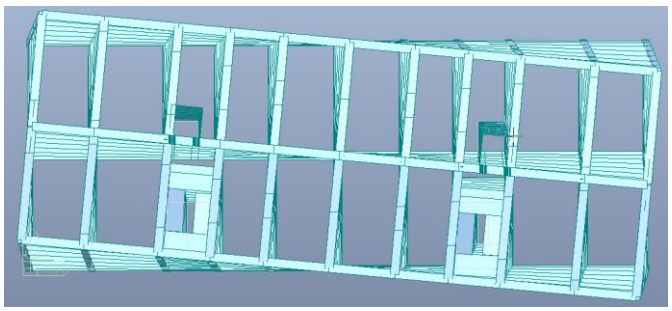


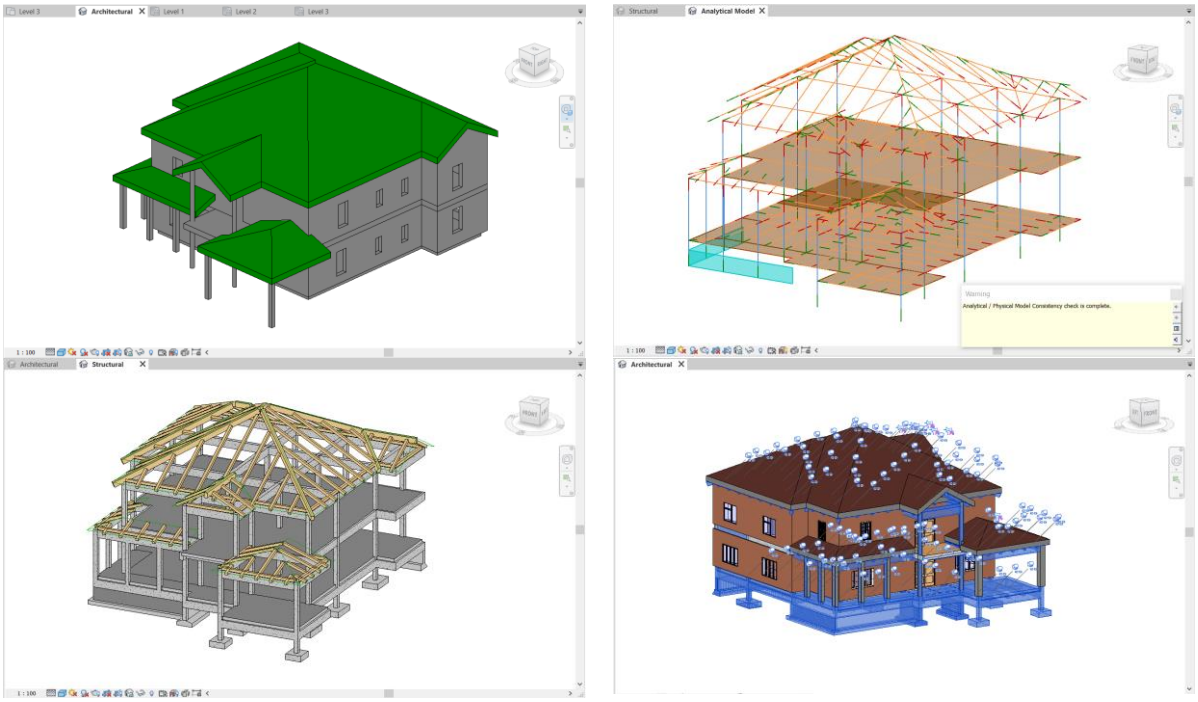
Figure 10. Mode 3 vibrational mode of the structure

BIM Fundamentals and applications

Knowledge and experience acquired:

- Coordinate Conceptual, Architectural, Structural and Federated model of G+1 residential building.
- Drawing production, quantity take-off, scheduling, clash detections and reporting.

Software tools: Autodesk Revit



Computational Structural Analysis (Feb 2021 – July 2021)

Project 1: Developed 2D frame program to assess the serviceability state of Railway bridge with Gerber joints.

A case study of the Gerber joint railway bridge is analyzed. The structural analysis of a simplified structural model is performed using the frame program that is developed as part of this project. Results from the structural analysis are then compared with field test deflection measurement using the three methodologies, under certain loading combinations. Finally, the developed program was able to provide a reliable result in terms of the quantitative load testing measurement. Moreover, the preliminary result of the structural modelling is also further used to improve the model aimed to reduce the relative error of the solution.

- Software tool: FORTRAN, MATLAB and MS-Excel

Figure 11. Railway bridge with Gerber Joint

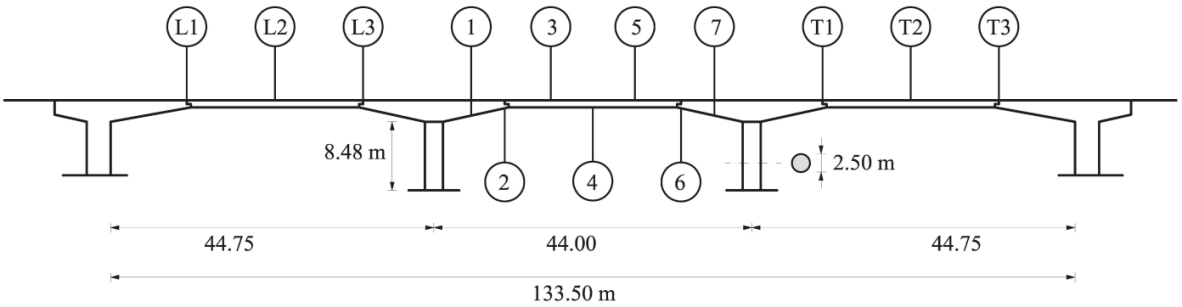


Figure 12. Structural scheme of the bridge

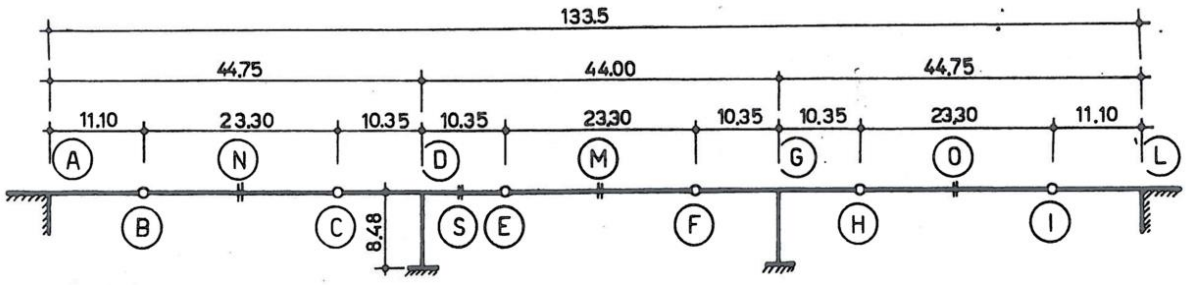
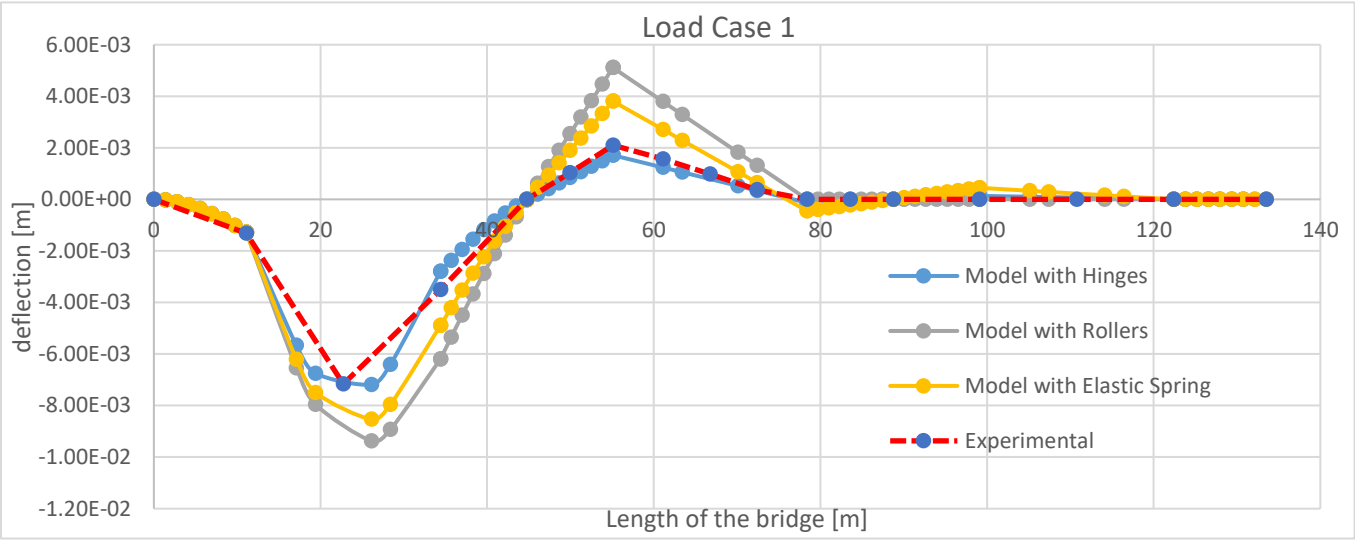
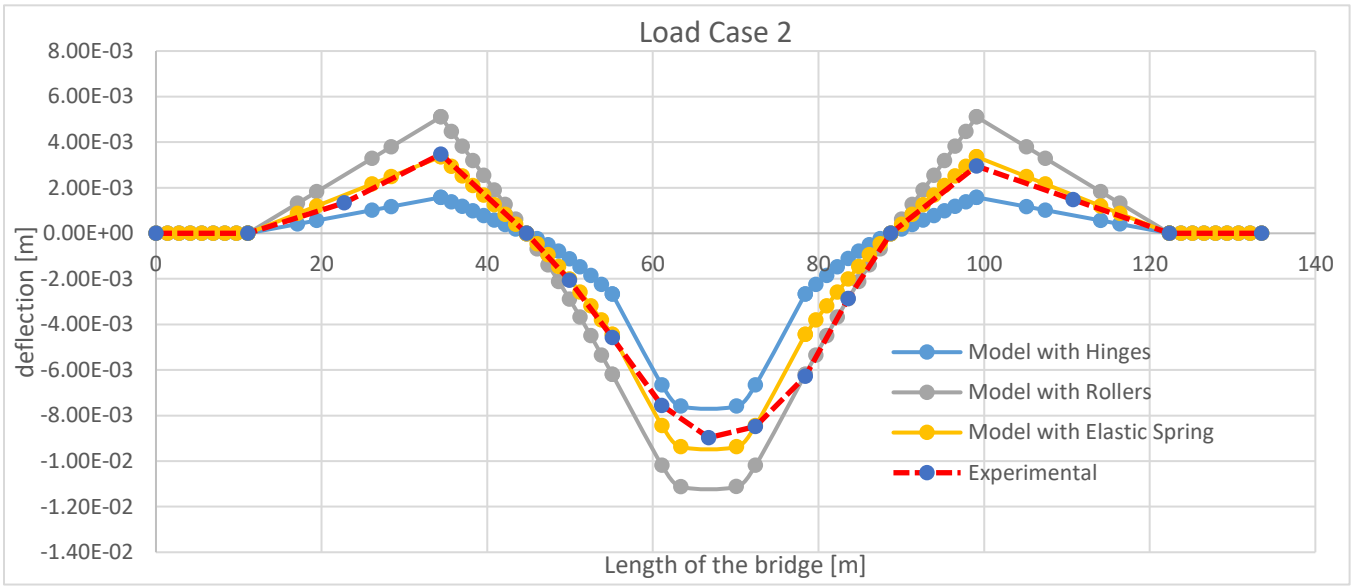
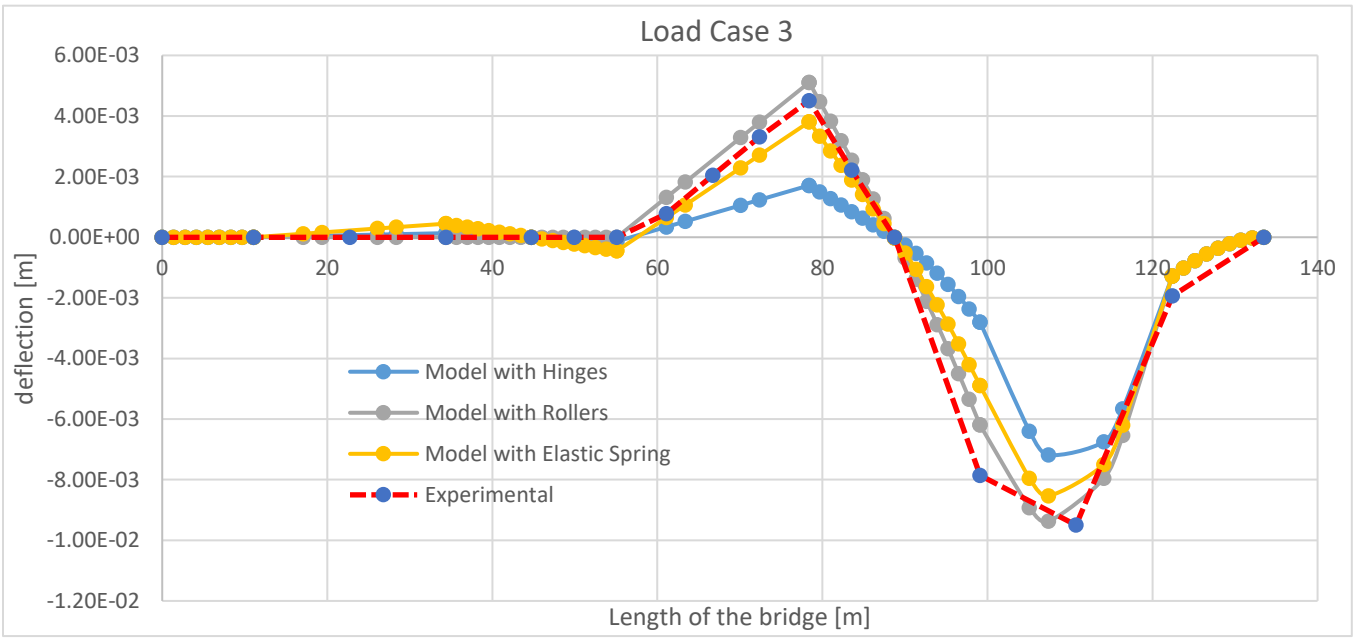


Figure 13. Structural model (a) Gerber joints modeled with hinge

Figure 14. Structual model (b) Gerber joints modeled with roller


Load Case 1
6.00E-03
4.00E-03
2.00E-03
0.00E+00
-2.00E-03
-4.00E-03
-6.00E-03
-8.00E-03
-1.00E-02
-1.20E-02
deflection [m]
0
20
40
60
80
100
120
140
Length of the bridge [m]
Model with Hinges
Model with Rollers
Model with Elastic Spring
Experimental


Load Case 2
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
-2.00E-03
-4.00E-03
-6.00E-03
-8.00E-03
-1.00E-02
-1.20E-02
-1.40E-02
deflection [m]
0
20
40
60
80
100
120
140
Length of the bridge [m]
Model with Hinges
Model with Rollers
Model with Elastic Spring
Experimental


Load Case 3
6.00E-03
4.00E-03
2.00E-03
0.00E+00
-2.00E-03
-4.00E-03
-6.00E-03
-8.00E-03
-1.00E-02
-1.20E-02
deflection [m]
0
20
40
60
80
100
120
140
Length of the bridge [m]
Model with Hinges
Model with Rollers
Model with Elastic Spring
Experimental

Project 2: Developed Isoparametric (ISOP4) FE program to study the response behaviour of Deep beams

This four node isoparametric element (ISOP4) based code was developed to study the structural response of the so-called discontinuity regions or "D-regions".

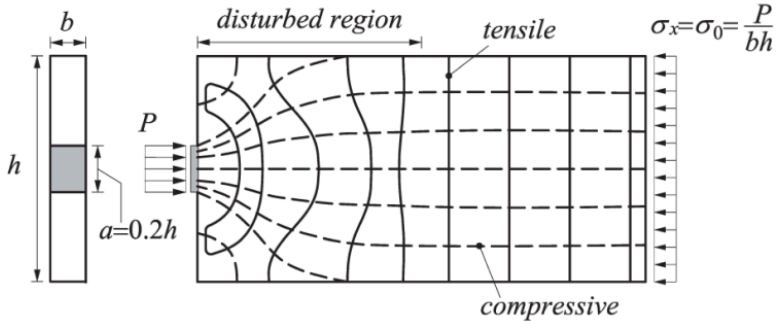


Figure 15. Geometry and loading condition of the structure

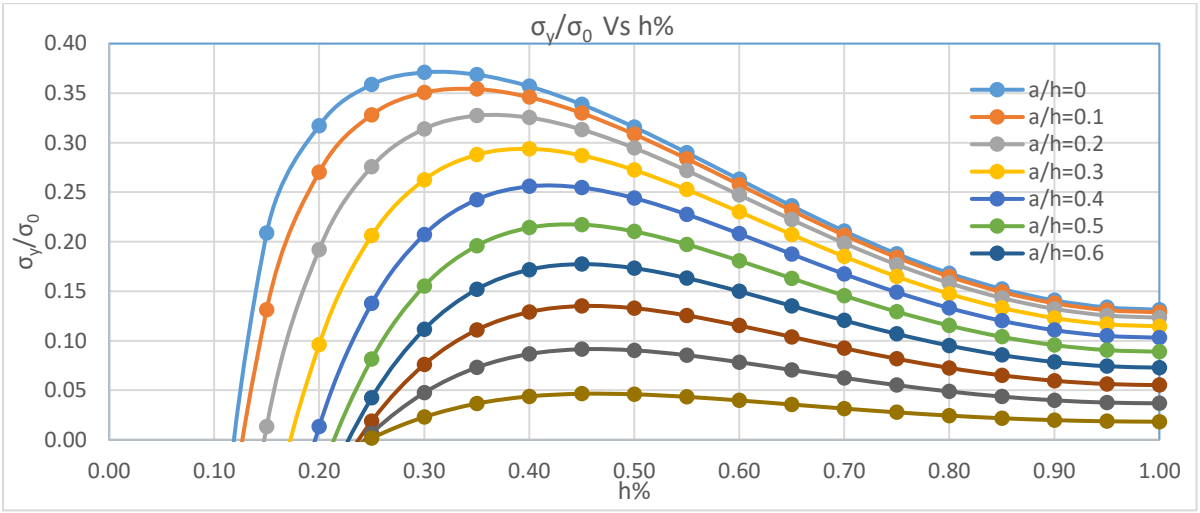


Figure 16. Diagram of normalized stress for varying a/b ratio

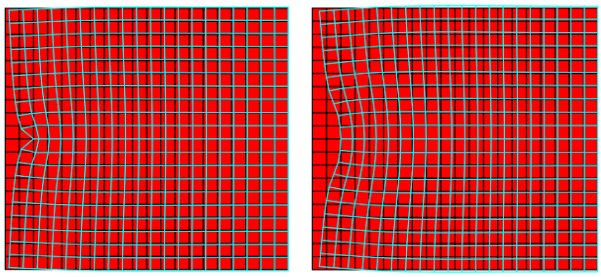


Figure 17. Deformed shape of different a/h ratio

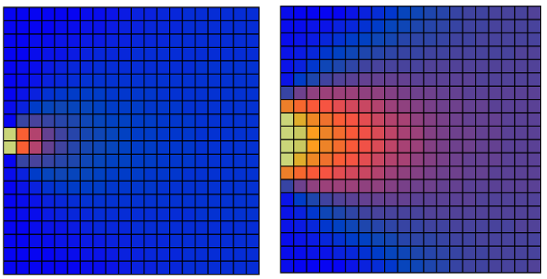


Figure 18. Normal stress of different a/h ratio