# Mini-project 2
# Design of a 2d truss crane

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Project organization:

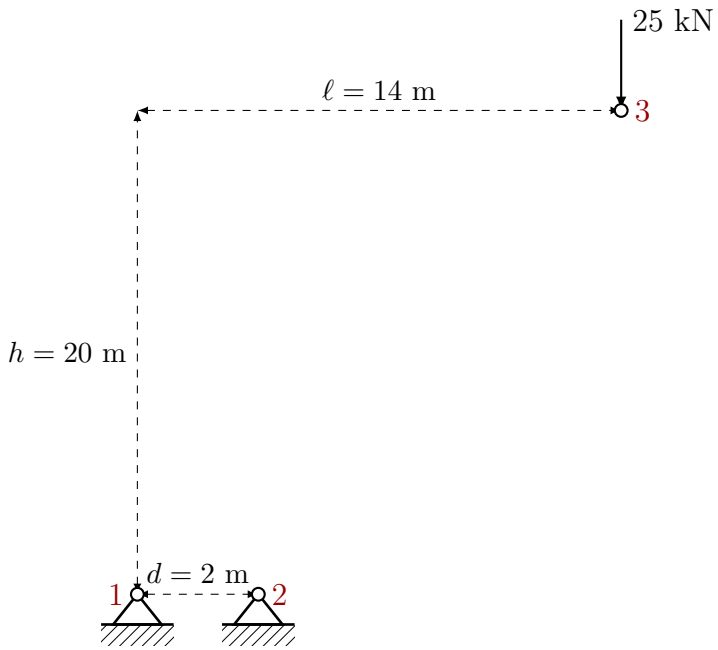
- Groups: 3 to 4 students
- 20% of final grade
- Pdf report: maximum 10 pages
- Programming language: `MATLAB`
- Submission: November 28, 2025
- Total workload: 40h (approx. 10h per student)

Your task is to design a crane truss structure for three different materials and make sure each individual structure you created fulfils the detailed static and dynamic requirements. The crane must lift a vertical point load of 25 kN applied at the tip of the jib (node 3), which extends vertically $h = 20$ meters above the ground level and horizontally $\ell = 14$ meters from the base left support (node 2). The two supports at the base (nodes 1 and 2) are fixed to the ground and are separated by a distance of $d = 2$ meters.

### Anchor points and load configuration

The crane is fixed at the following supports on a horizontal plane:

- Base left: (0, 0)
- Base right: (2, 0)



### Crane design requirements

The crane must be modeled as a planar truss. All joints are idealized as frictionless pinned connections. You are required to perform both a static and a dynamic analysis for each of the three materials listed below, treating each case as a distinct crane design. A distinct truss design must be developed for each of these three materials.

| Material | E (GPa) | Density (kg/m$^3$) | Cross-Sectional area |
|---|---|---|---|
| Structural steel | 200 | 7850 | 15–50 cm$^2$ |
| Aluminum alloy | 69 | 2700 | 20–70 cm$^2$ |
| Engineered wood | 12 | 600 | 30–100 cm$^2$ |

### Static analysis

Each crane design must satisfy the following:

1. The structure must remain fully elastic with displacements below **60 mm**.
2. The total material volume must not exceed:
   - Structural steel: **1 m$^3$**,
   - Aluminum alloy: **1.7 m$^3$**,
   - Engineered wood: **2 m$^3$**.

### Dynamic analysis

A separate modal analysis must be performed for each of the three trusses designs corresponding to the different materials. The following requirement must be satisfied:

3. Compute the first three natural frequencies and mode shapes. The first natural frequency must *not* fall within **0 to 5 Hz**.

*Bonus*: To ensure dynamic stability and avoid resonance with common excitation sources, you should aim for a first natural frequency **above 20 Hz**, where feasible.

### Deliverables

1. `MATLAB:`
   - Nodes and elements definitions
   - Stiffness and mass matrices assembly
   - Static and modal analysis
   - Plots and visualizations
2. **Report:**
   - Crane layout with labeled pins and bars,
   - Summary of `MATLAB` results (displacements, stresses, frequencies and mode shapes),
   - Discussion of your findings.