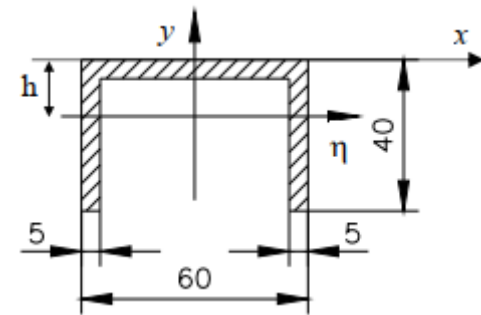
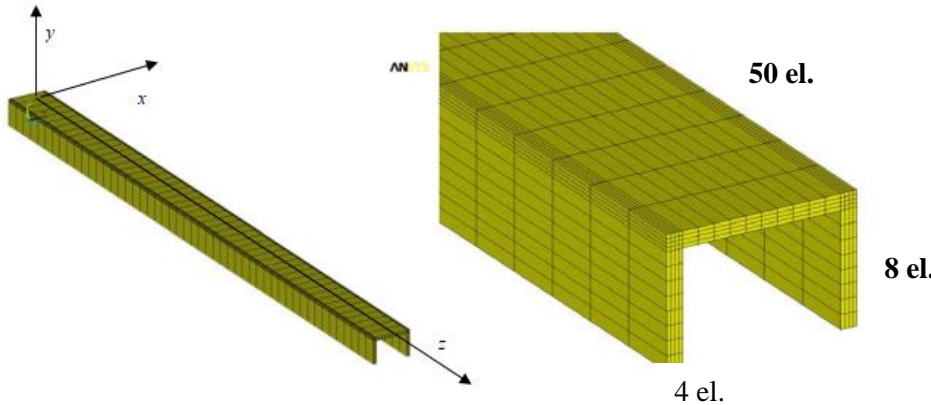


# Exercise 1

## Free Vibration = Modal Analysis

<b>Channel section</b> 60 x 40 x 1000 mm (5 mm wall thickness)  <b>Cantilever beam:</b> Built-in at the left end (As an option : Analysis without support = <i>free-free</i> )	<b>Material:</b> steel $E=200$ GPa, $\nu=0.3$ , $\rho=7800$ kg/m <sup>3</sup>
---	---



$$J=J_{\eta}=1.0097 \cdot 10^{-7} \text{m}^4$$

$$A=0.65 \cdot 10^{-3} \text{m}^2, \quad h=13.27 \text{mm}$$

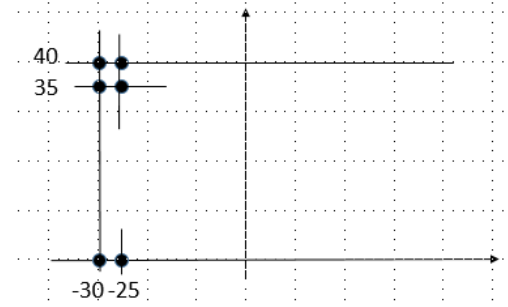
### Subsequent steps:

#### Preprocessor (set preliminary information):

0. Selection of system of Units (pure SI or modified-SI)
1. Element type (*Element Solid185, K2 option – Enhanced Strain*)
2. Material + **density !!** ( $\rho=7.8e-9$  t/mm<sup>3</sup> OR  $\rho=7800$  kg/m<sup>3</sup>)

#### Prep / Modeling (creating "underlying" geometry)

3. Characteristic 6 Points of Section Geometry (see picture)
  - a. Create / KeyPoints /in Active CS
  - b. **Check it out!:** List / Keypoints (how many you expect??)
4. Remaining Points by Symmetrical Reflection
  - a. Reflect/Keypoints (select by "Box")
  - b. **Check!:** List / Keypoints (how many you expect??)
5. Surface Creation: Create quadrilateral Surfaces (counter-clockwise picking sequence starting e.g. from the bottom left Keypoint)
  - a. Create / Areas / Arbitrary / Thru Keypoints
  - b. **Check!:** List / Areas (how many you expect??)
6. Create solid geometry by extruding a surface by 1000 mm along the z-axis
  - a. Operate / Extrude / Areas / by XY offset (select either via "Box" or PickAll)
  - b. **Check!:** List / Volumes (how many you expect??)



#### Merge geometry items and numbering (merging coincident points)

7. Preprocessor / Numbering Control / Merge Items (select All)

## FEM Mesh Generation (Regular = Mapped)

8. Display LINES and set the division on the lines). Set the division into 4, 10, 8 and 50 elements (see the picture)
  - a. *Plot / Lines*
  - b. *Preprocessor / Meshing / Mesh Tool* (select in turns the lines divided into 4 elements, later into 10, into 8 and finally into 50 – compare the picture for meshing density !!)  
**Check!**: (*is the division on the lines correct?*)
9. Mesh Generation on Solids
  - a. *Preprocessor / Meshing / Mesh Tool / Mesh Volumes* (select **All**)  
**Check!**: is the division into elements "mapped"? – *are the elements of the HEXA type????*
10. Merge Numbering: *Preprocessor / Numbering Control / Merge Items* (select All)

## Analysis settings (SOLUTION module) and solution

11. *Analysis type* (set **25 modes**. In **Options set** : *EXPAND, Elemental Solution*)
12. Loads and boundary conditions (attention there are **no loads**; BC: beam built-in into the wall)
13. *Solution / Solve (Current Loadstep)*

## Postprocessing of the results

14. General Postprocessing
  - a. Results Summary (in Modal Analysis – Ansys substeps mean eigenfrequencies)
  - b. Read Results
  - c. Result Viewer – (preferred option)
  - d. Animation also controlled by the command : *Plot Controls / Animate*

## Presentation of the results:

1. Frequency Table (in Hz)
2. Plots of deformation of several modes of vibrations, ie. eigenvectors (try to name them, i.e. 1<sup>st</sup> mode of bending in vertical plane, or : Torsion, etc)
3. For some eigenvectors - map of DISPLACEMENT (for the characteristic component of the displacement, e.g. vertical or horizontal)
4. For some modes - STRESS map (characteristic component, e.g. axial = Sigma<sub>z</sub>).  
Turn your attention: it is so-called modal stress distribution = just the shape, NOT values
5. Check for "high" frequency modes (e.g. 18, 19, 25...) Are they smooth enough?

Drawings should be on a **WHITE** background (e.g. *Plot Controls / Style / Colors / Reverse Video*)

- What is the meaning of the displacement VALUE in eigen-modes (e.g. max displacement) ?
- What is the meaning of the stress VALUE in eigen-modes? (e.g. max vonMises stress) ?

## **As an OPTION / Modification:**

Remove the boundary conditions, i.e. the fix in the wall (you get so-called "free-free" configuration)  
Compare eigen-frequencies and modes – compare to the previous one. Draw some general conclusions.  
Have you obtained **six rigid-body modes** (eigenfrequency $\approx$ 0)?