Wrocław University of Technology

The Displacement Method

The Displacement method

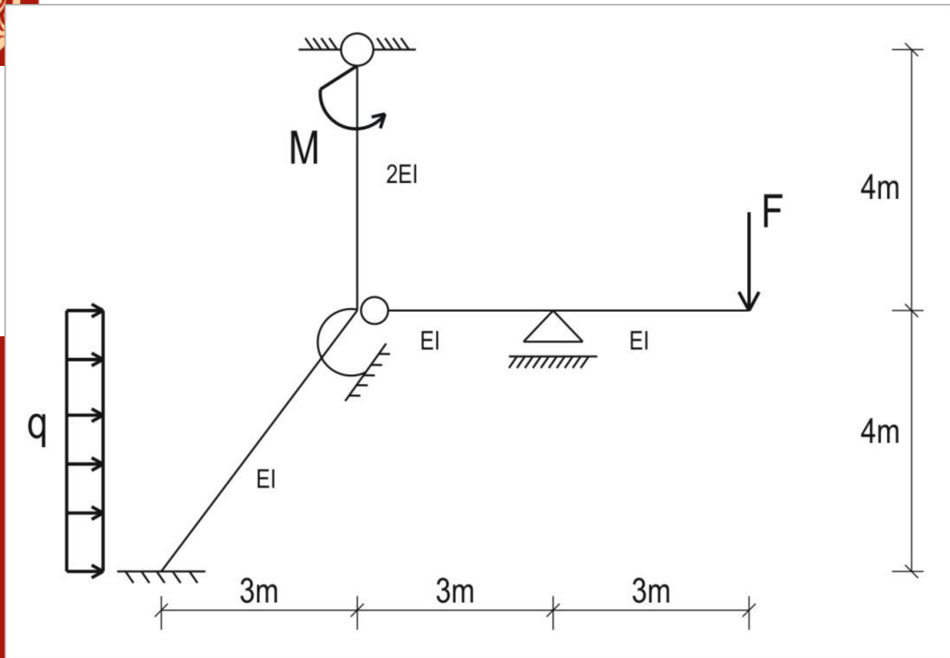
1. Designation of the degree of kinematical indeterminacy

$$n_g = n_\Delta + n_\varphi$$

The degree of kinematical indeterminancy

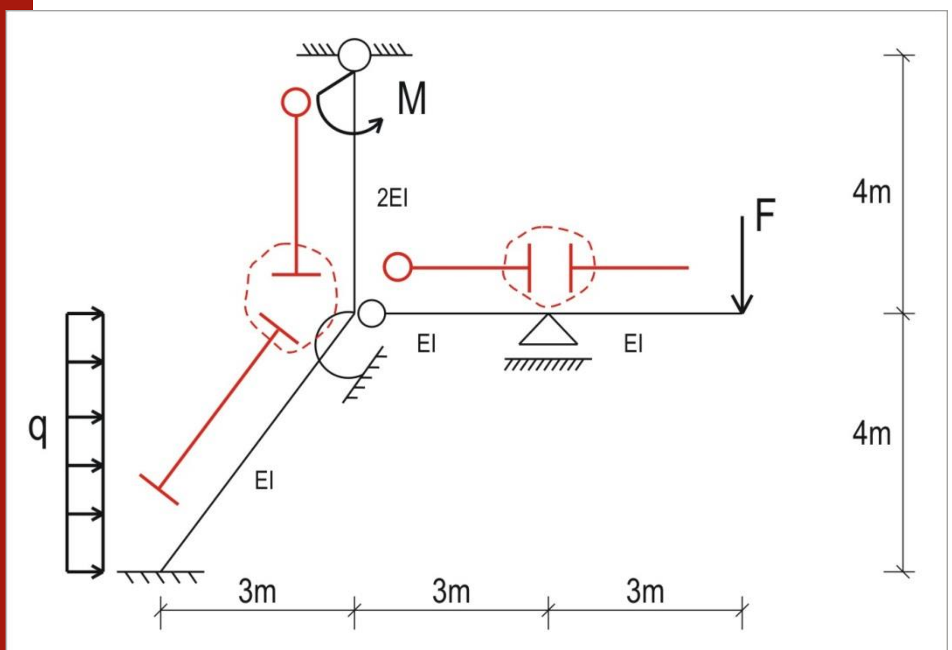
The number of unknown displacements

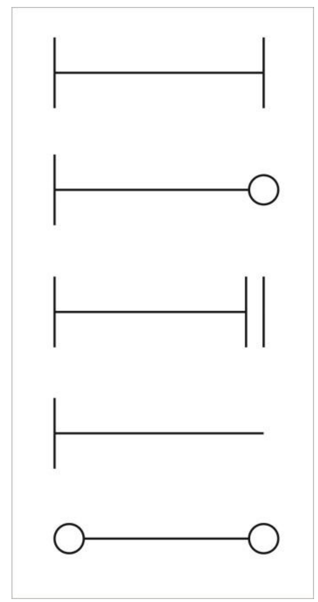
The number of unknown rotations



$n_g = n_\Delta + n_\varphi$

Division of the structure into members for which slope-deflection equations are known





f - f, „fixed - fixed" el.

f - p, „fixed - pinned" el.

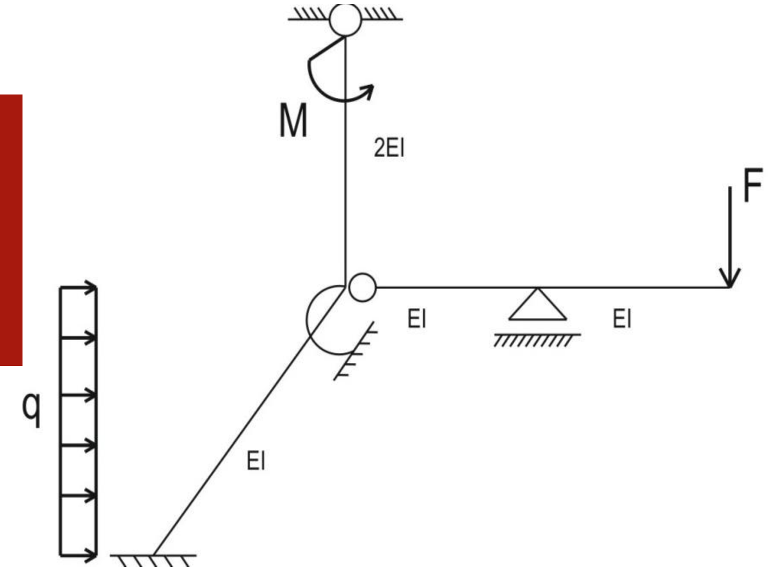
g - f, „glade - fixed„ el.

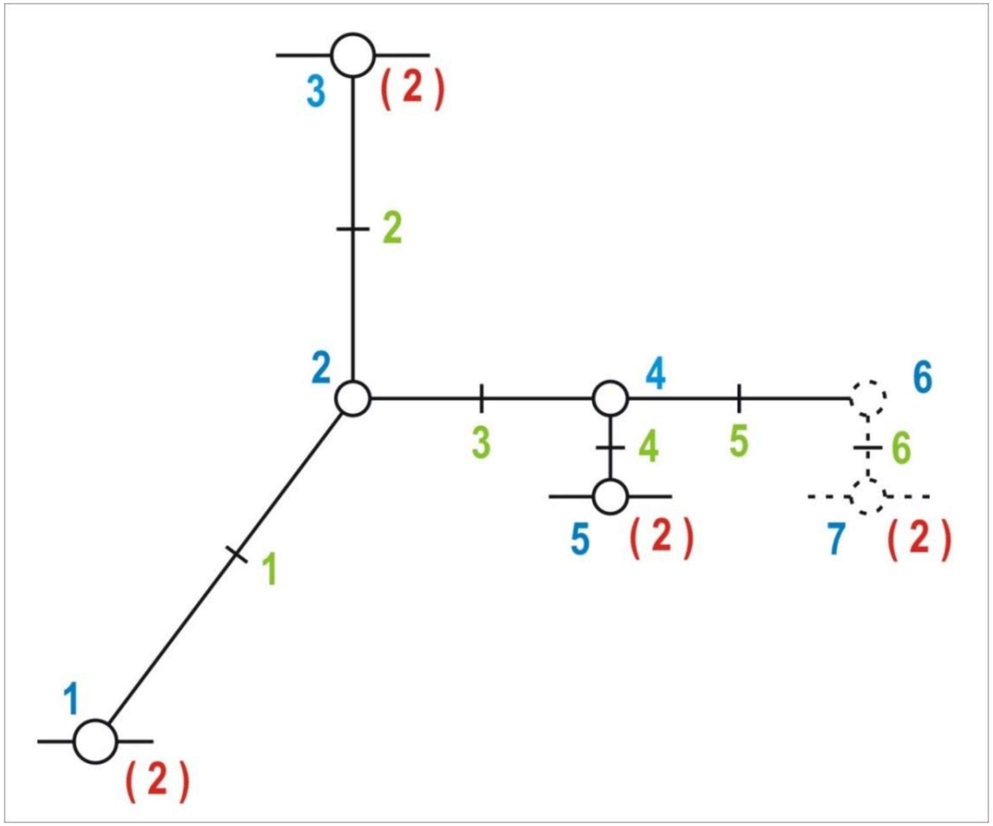
fe - f, "free end - stiff" (cantilever element)

p-p, „pinned-pinned” el.

$n\varphi = 2$

The pin jointed model of the given structure is shown in the figure below





$$n_\Delta = 2w - (p + r)$$

where w - number of joints, p - number of members, r - number of support reactions

$$n_g = n_\Delta + n_\phi$$

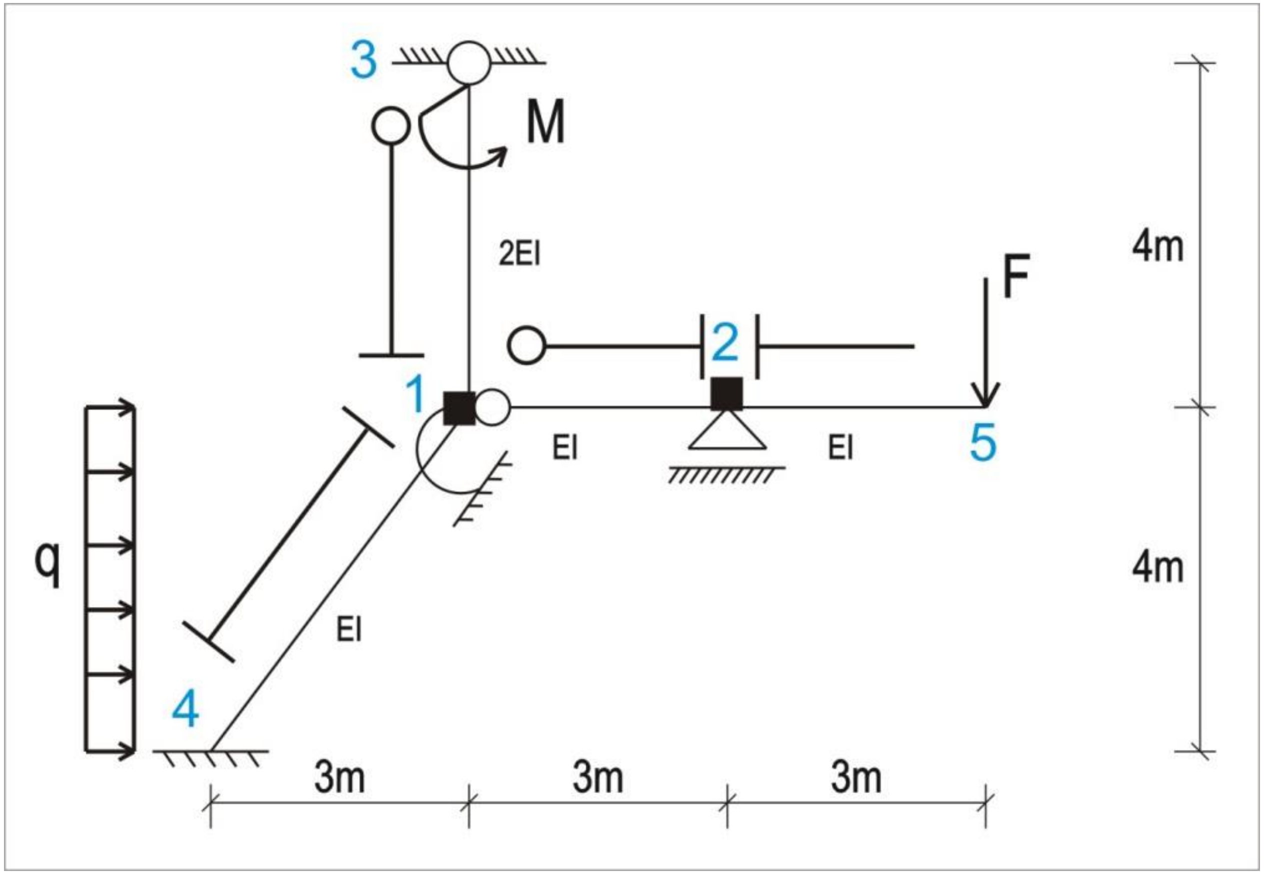
$$n_\varphi = 2$$

$$n_\Delta = 0$$

$$n_\Delta = 2 \times 7 - (6 + 8) = 0$$

3. A PRIMARY STRUCTURE OF THE DISPLACEMENT METHOD –

A Primary structure is created from the given structure by adding nφ rotational constraints and nδ translational constraints (in this example only rotational constraints). Such a procedure turns the given system into a kinematically determinated system.

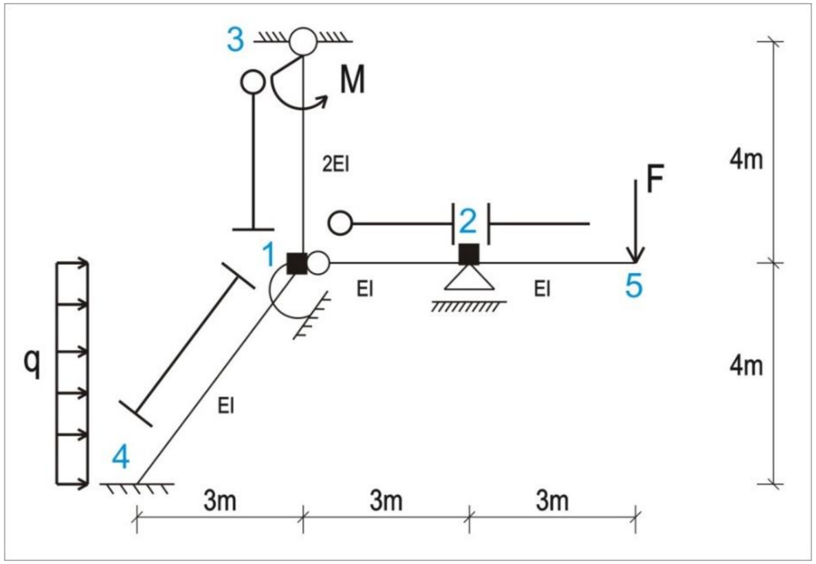


Implement the primary structure into Robot.

M = 40kNm
F = 20kN
q = 10kN/m
kφ = 20 EI/m

Create two load cases:

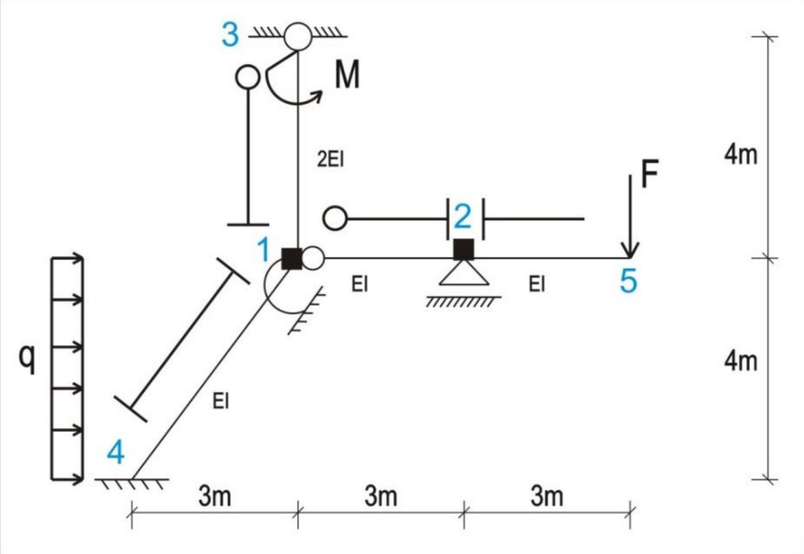
1. **SW – self-weight of the structure**
2. **ML – mechanical loading**



Implement the primary structure into Robot.

In order to implement ■

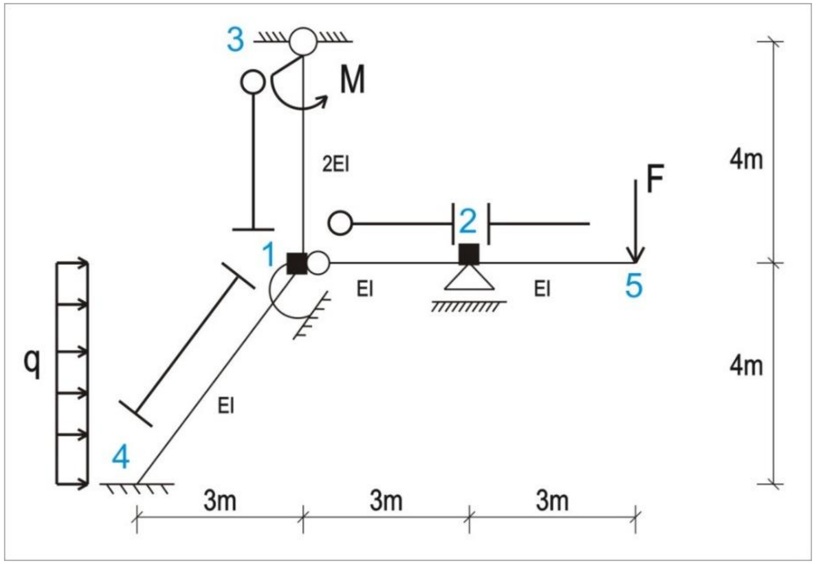
Click on the „supports” icon on the left of your screen.
Then create a new support.
Mark „RY” as fixed.
Add this support in the nodes where ■ should occur.



Solve the structure using the icon of the „red calculator”

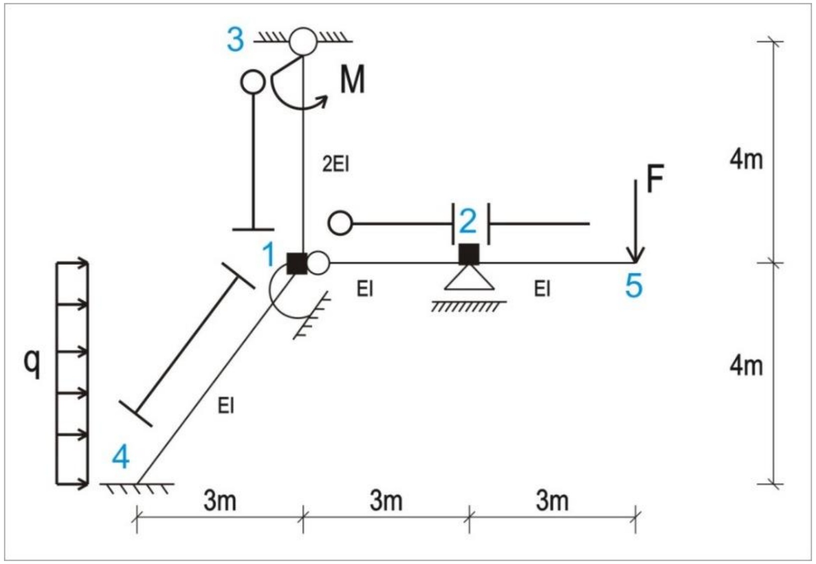
Now read the values of coefficients:

K10 =
K20 =



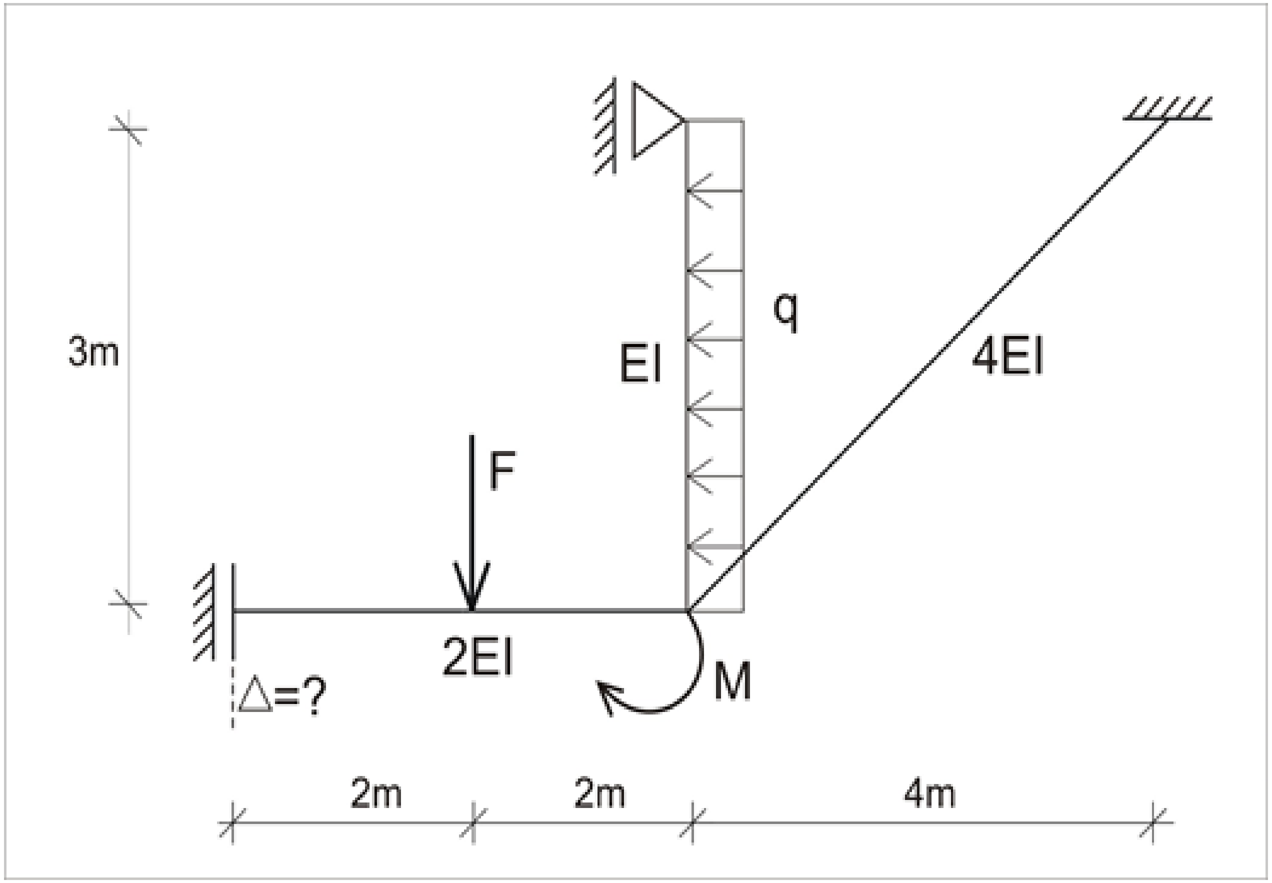
In order to read the values of these coefficients click Results / then „Diagrams for bars” / and then „Reactions”

Now select MY and „Descriptions”



K10 – is the value of the moment reaction in node 1 due to ML (mechanical loading)
K20 – is the value of the moment reaction in node 2 due to ML (mechanical loading)

TASK 2.

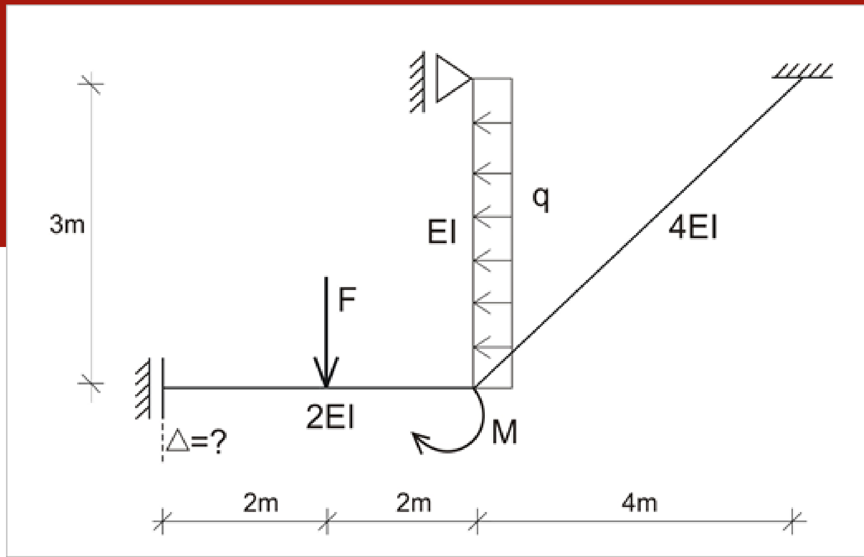


M = 30kNm

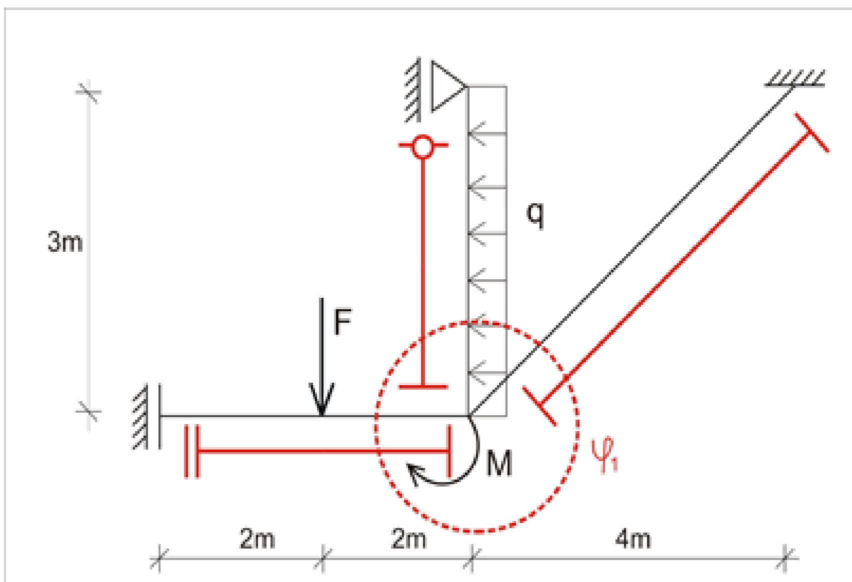
F = 20kNm

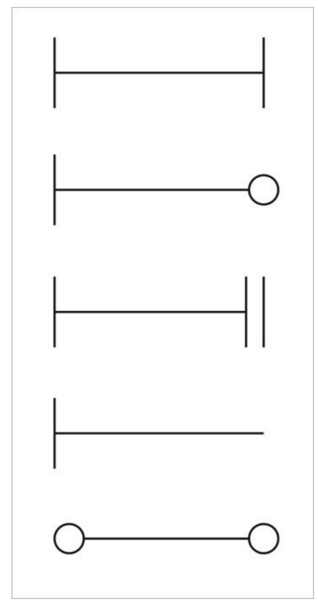
q = 10kN/m

$$n_g = n_\Delta + n_\varphi$$



Division of the structure into members for which slope-deflection equations are known





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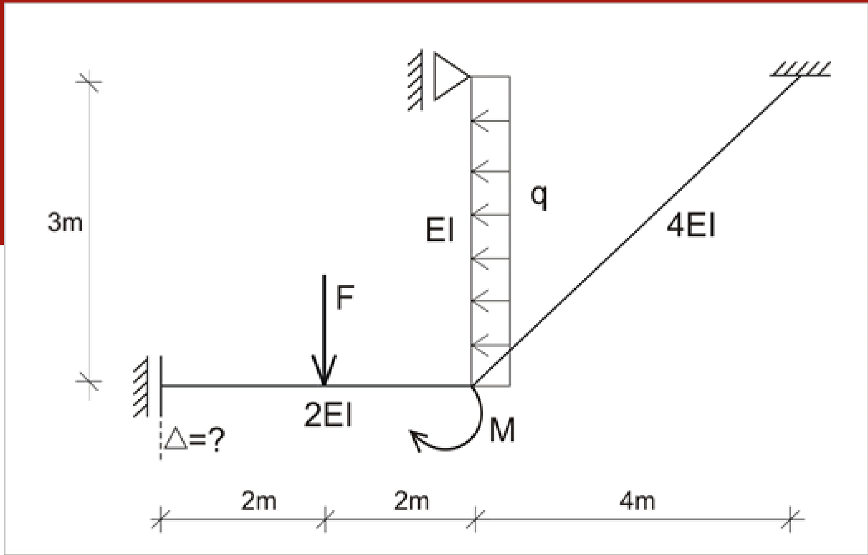
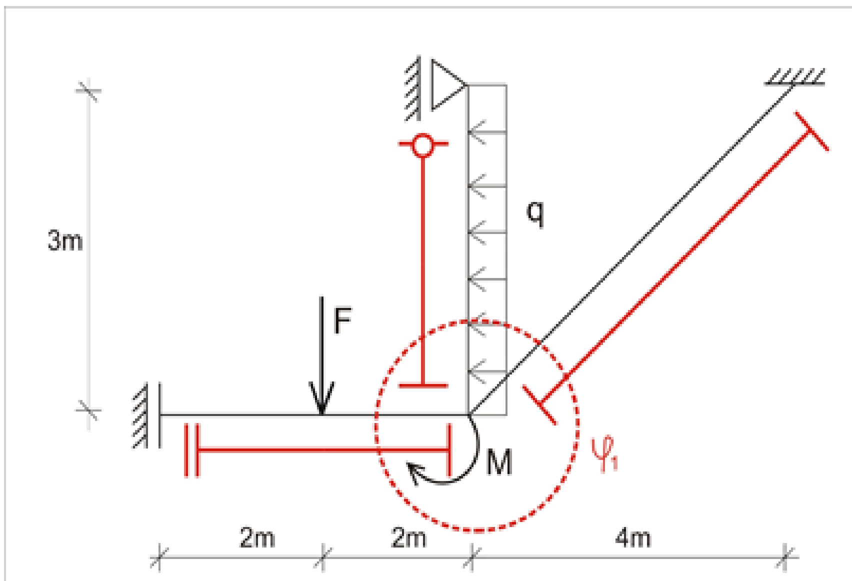
$$n\varphi = 1$$

$$n_g = n_\Delta + n_\varphi$$





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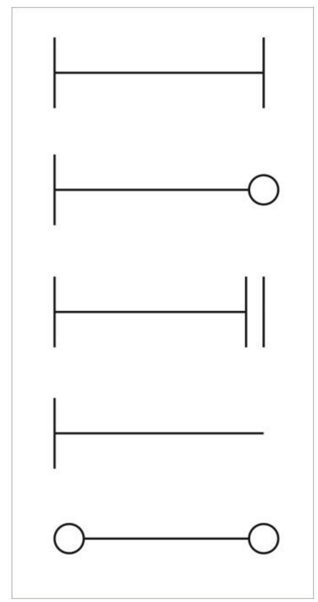

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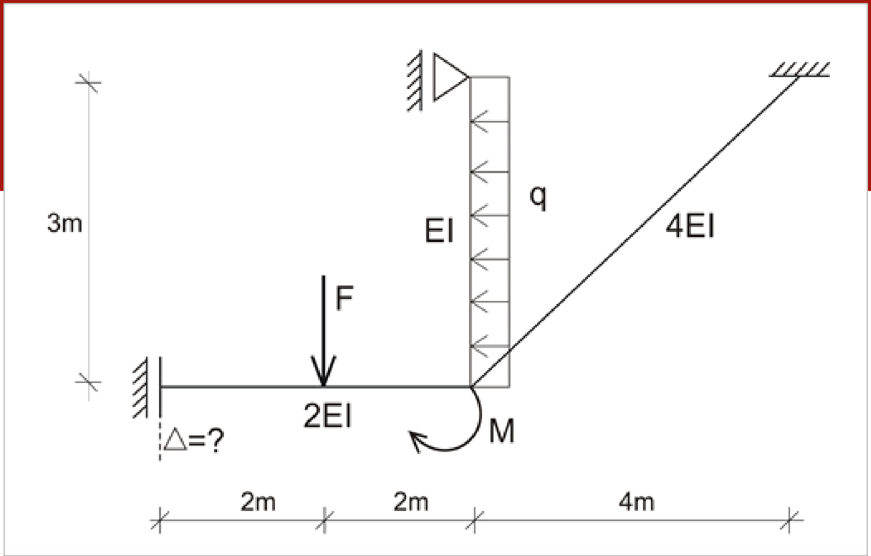

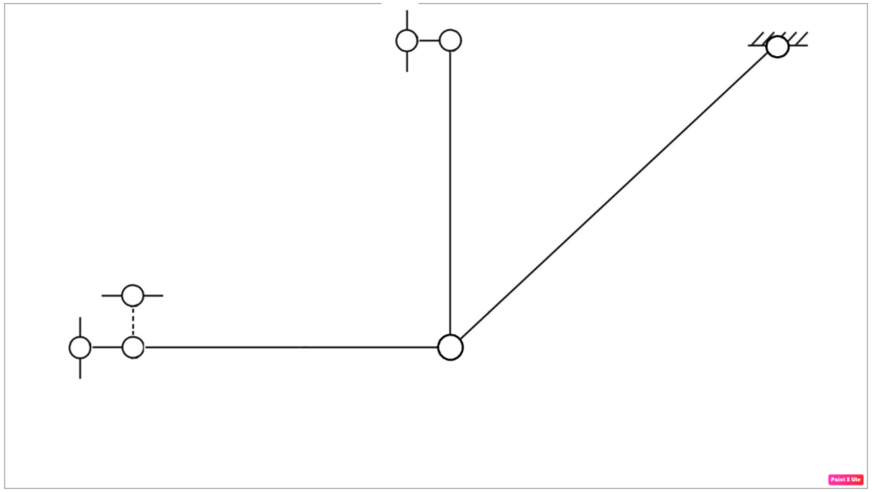

$$n_\Delta = 2w - (p + r)$$

where w - number of joints, p - number of members, r - number of support reactions

$$n_g = n_\Delta + n_\varphi$$

$$n_\varphi = 1$$

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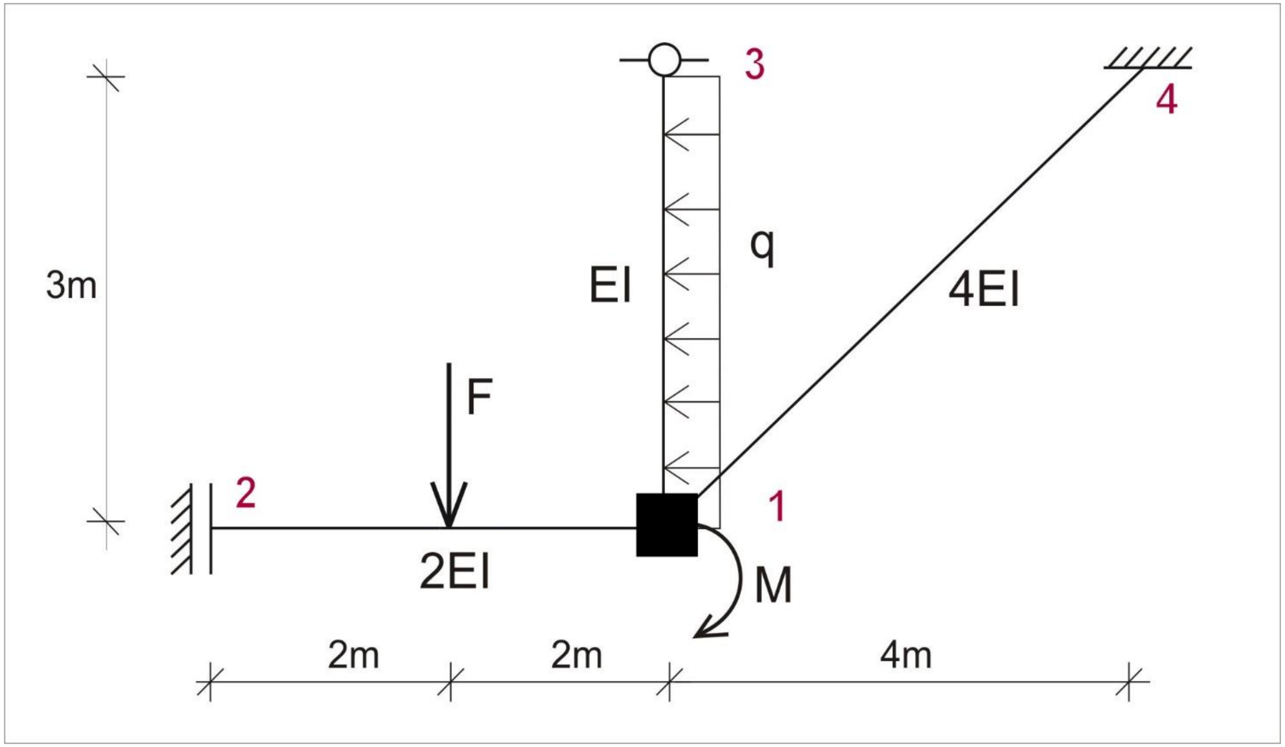
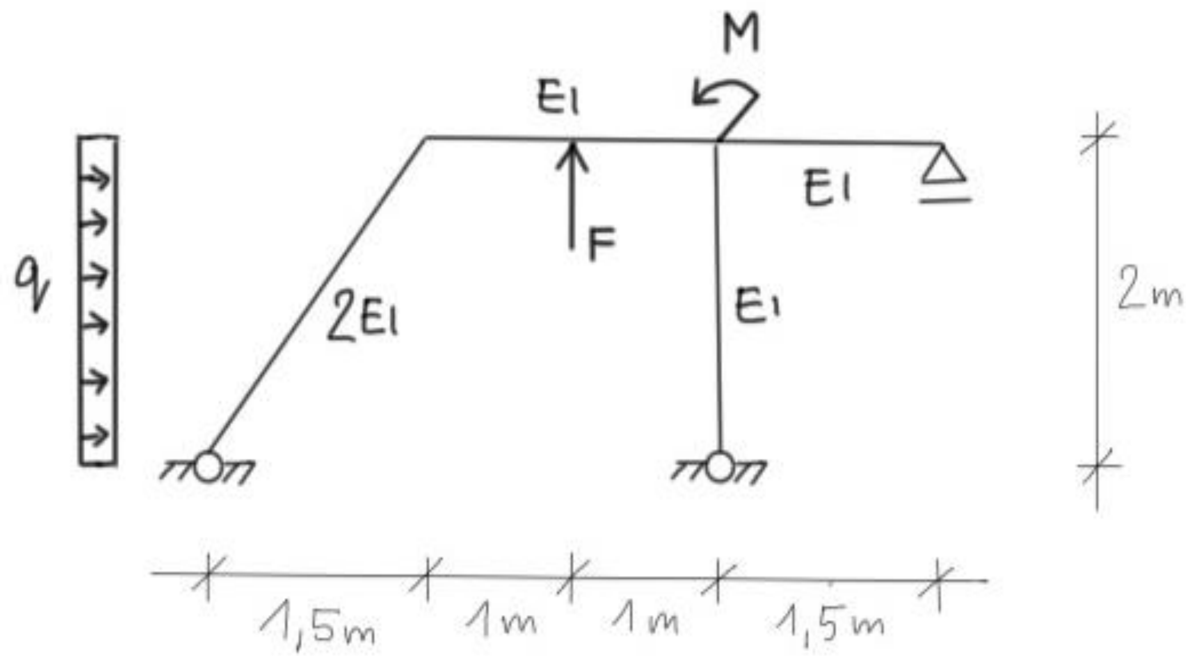


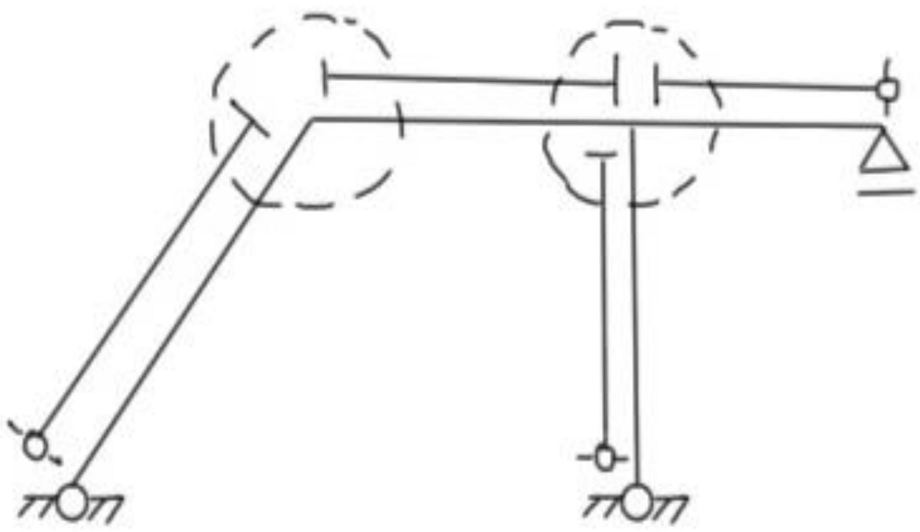
M = 30kNm
F = 20kNm
q = 10kN/m

TASK 3

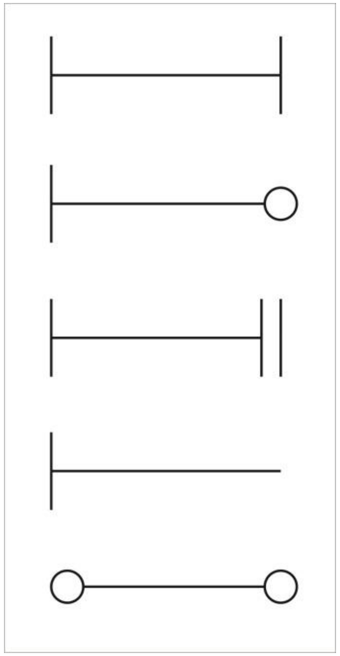


M = 80kNm
F = 30kNm
q = 20kN/m

Division of the structure into members for which slope-deflection equations are known

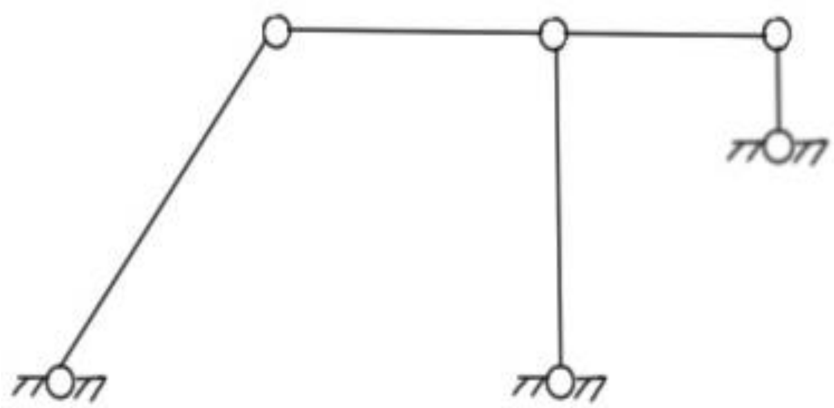


TYPES OF MEMBERS:



$n_\varphi = 2$

$$n_g = n_\Delta + n_\varphi$$



$$n_\Delta = 2w - (p + r)$$

where w - number of joints, p - number of members, r - number of support reactions

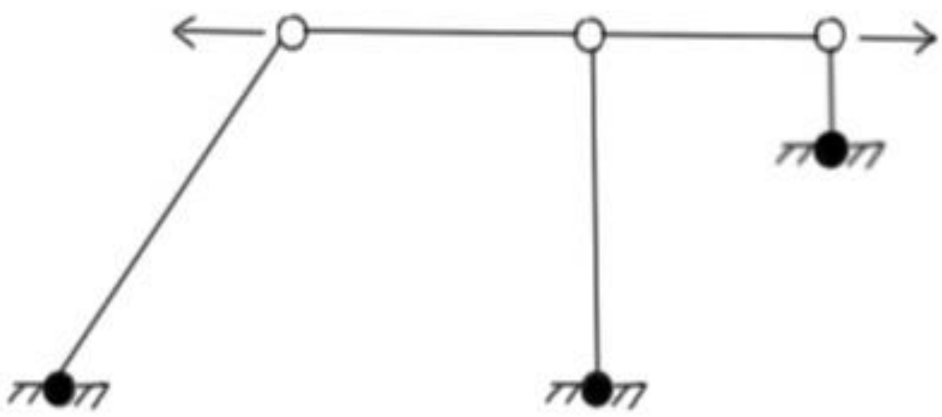
$$n_\Delta = 2 \times 6 - (5 + 6) = 1$$

$$n_\varphi = 2$$

$$n_\Delta = 1$$

$$n_g = n_\Delta + n_\varphi$$

$$n_\Delta = 2w - (p + r)$$

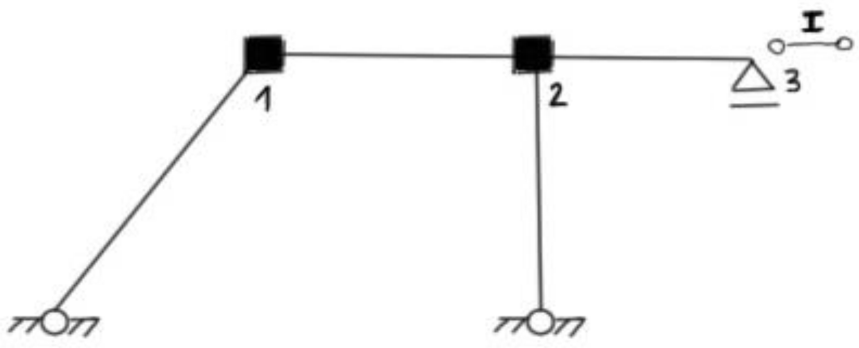


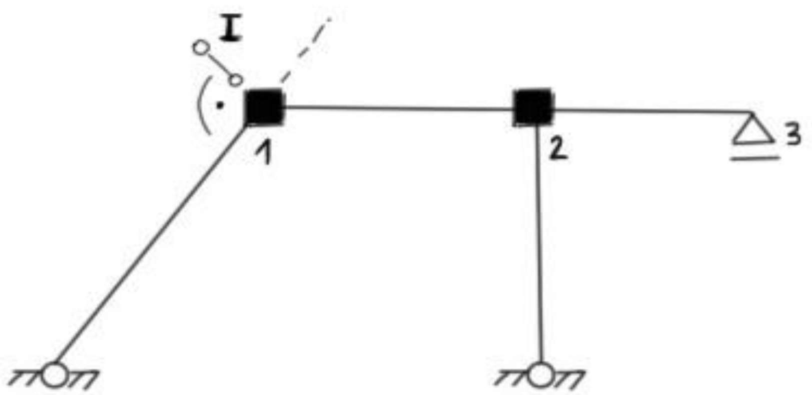
$n_\varphi = 2$

$n_\Delta = 1$

$$n_\Delta = 2 \times 6 - (5 + 6) = 1$$

THE PRIMARY STRUCTURE





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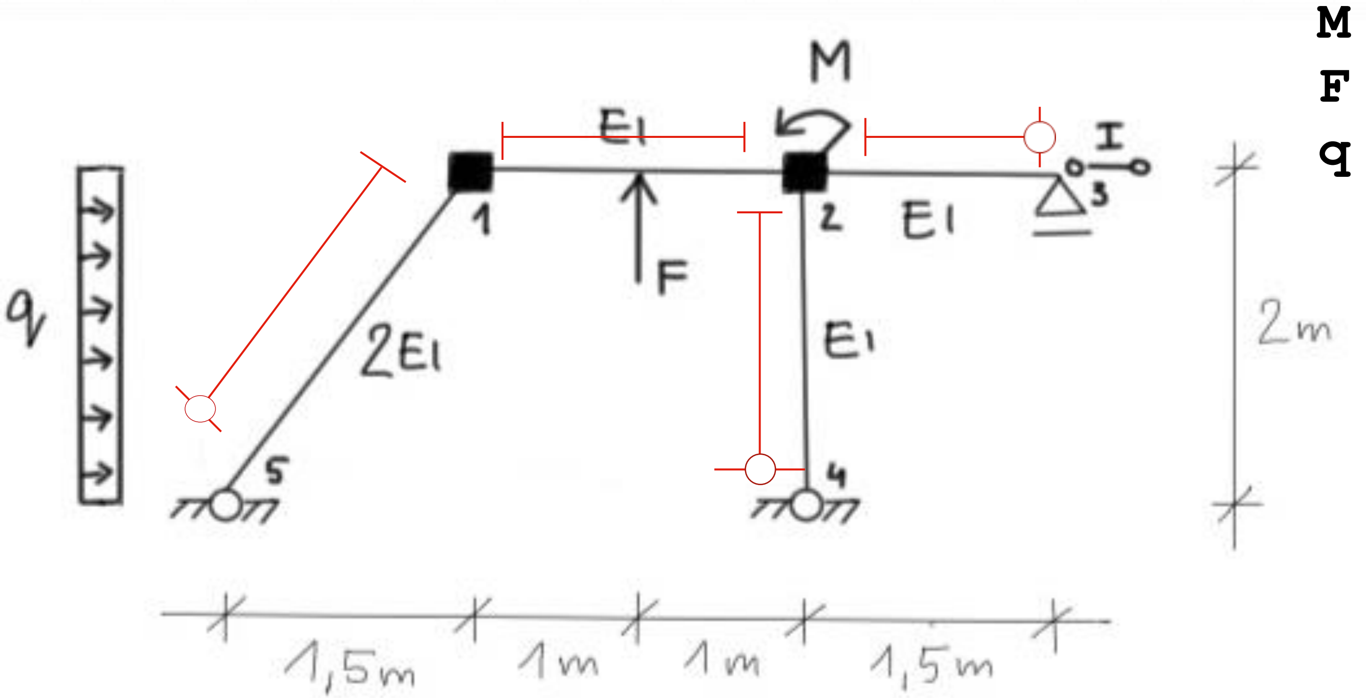

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