Wrocław University of Technology

The Force Method

The Force Method

1. You need to designate the degree of static indeterminancy. You can use two different formulas:

A) the first method:

$$n_h = (3m+r)-3j$$

The degree of static indeterminancy

the number of members

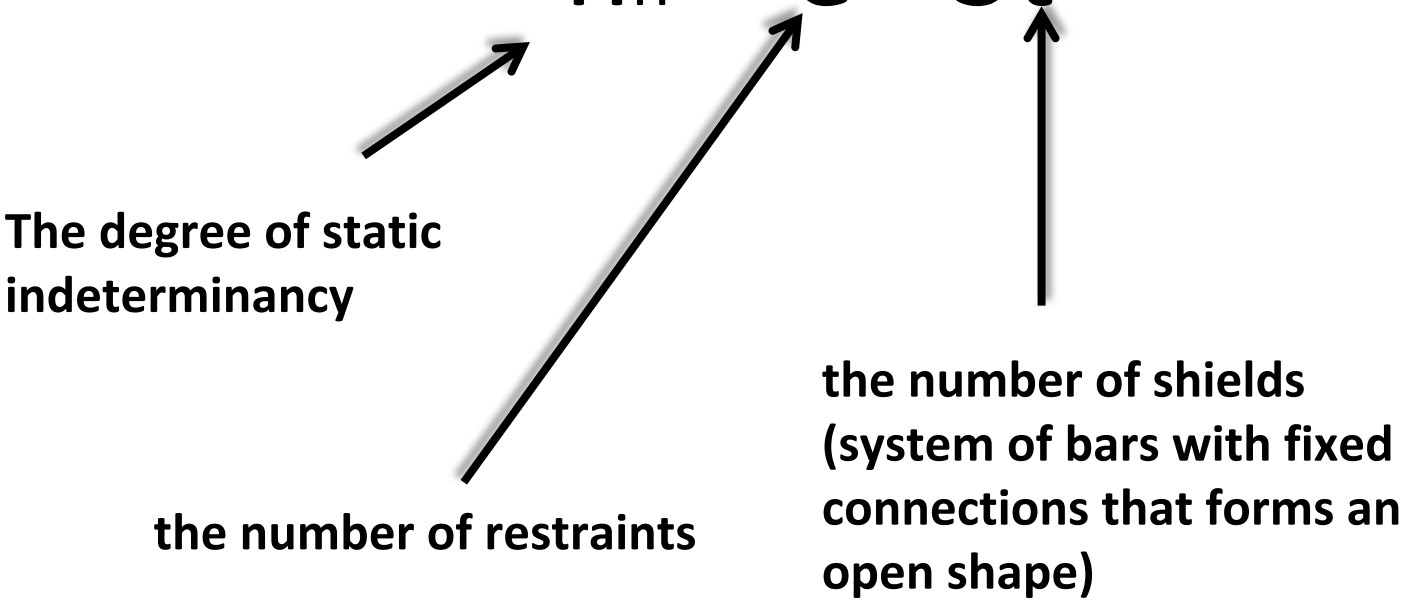
the number of unknown reactions

The number of joints

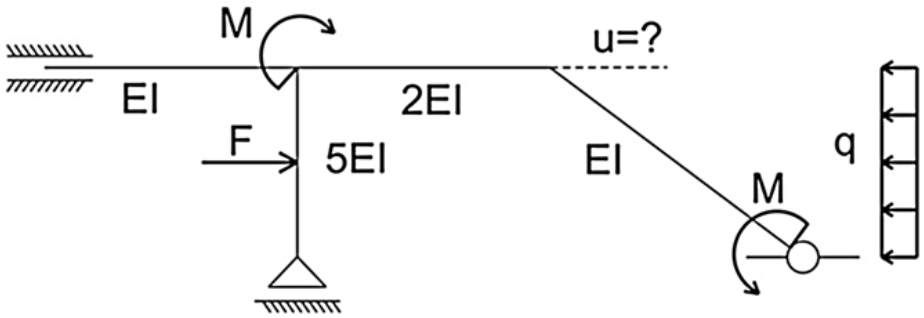
The Force Method

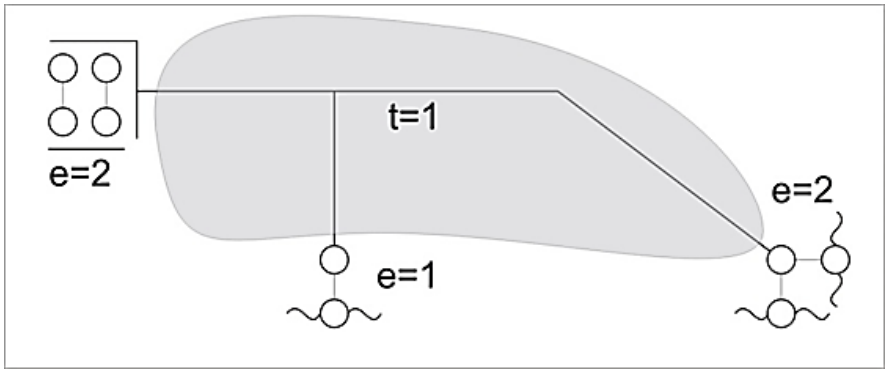
B) the second method:

$$n_h = e - 3t$$



Designation of the degree of static indeterminancy using the second method





$n_h \geq e - 3t$

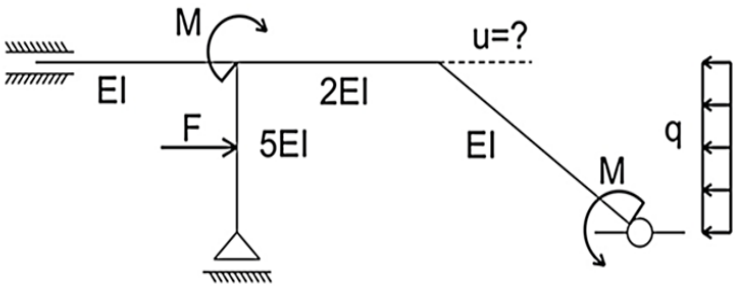
$n_h \geq 5 - 3 \times 1$

$n_h \geq 2$

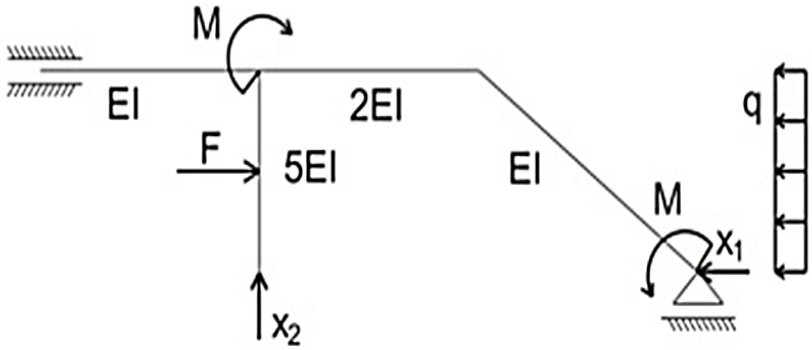
2. Creation of a primary structure when nh=2.

The primary structure is obtained by releasing restraints corresponding to redundant reactions. Note that by removing an appropriate number of redundants (nh) from the original indeterminate frame, the resulting one (primary structure) has to be stable and determinate.

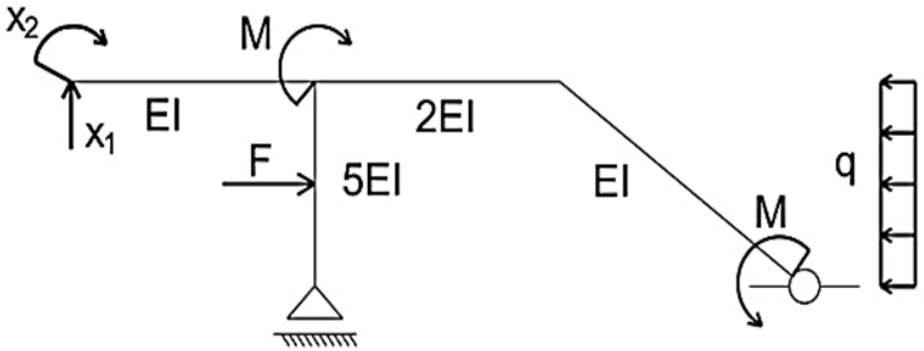
Given structure:



Primary Structure:



A different possible primary structure:



Now implement the primary structure to Robot software.

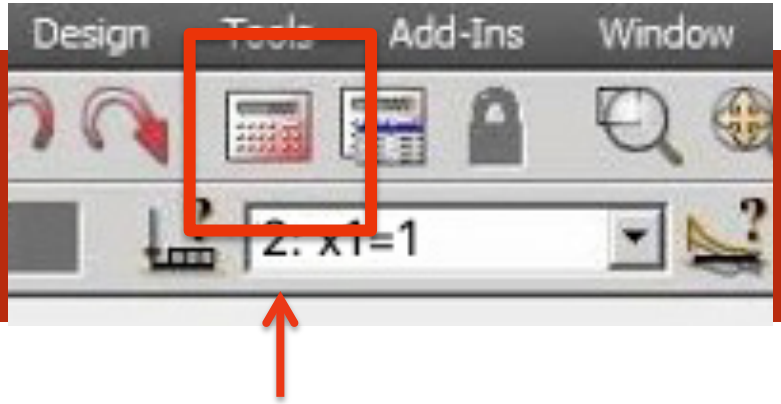
Create 4 load cases:

1. **SW (self-weight)**
2. **ML**
3. **x1=1**
4. **x2=1**

In load case 2 - „ML” - you implement the mechanical loading (M, q, F)

In load case 3 - „x1=1” – you implement a nodal force x1 = 1kN

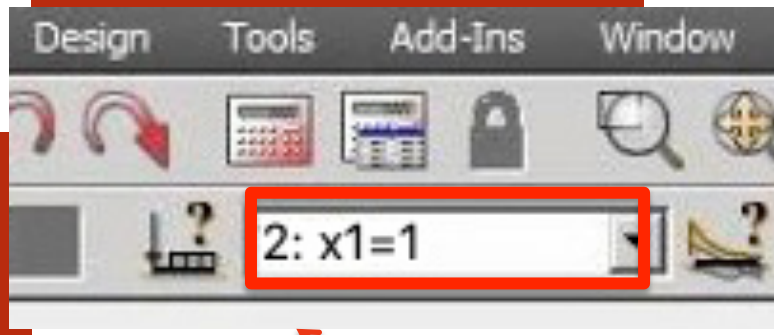
In load case 4 – „x2=1” – you implement a nodal force x2 = 1 kN

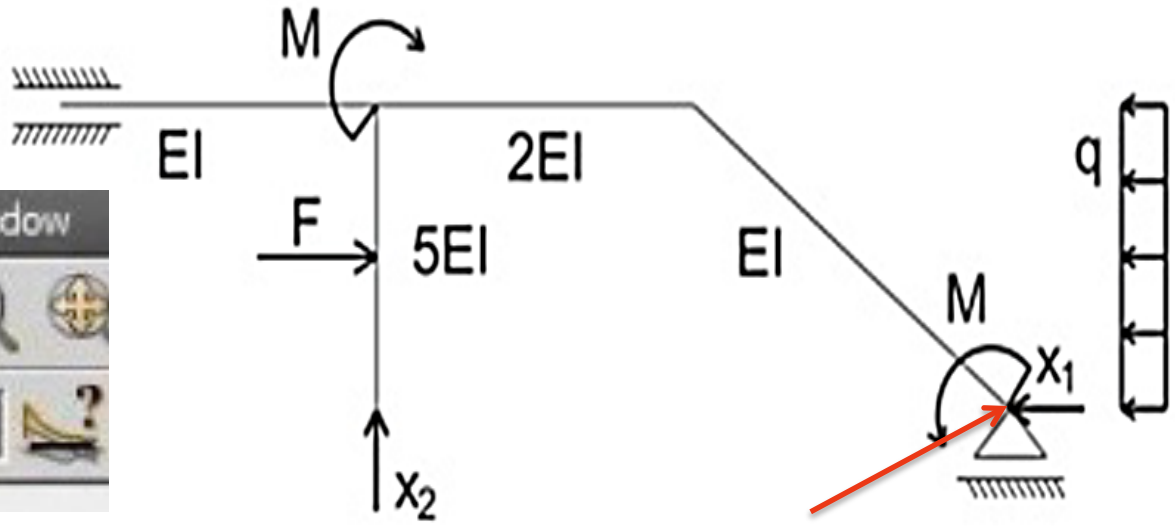


Now solve the structure by clicking the red calculator and then read the values of flexibility coefficients:

$$\begin{cases} \delta_{11}x_1 + \delta_{12}x_2 + \delta_{1F} = 0 \\ \delta_{21}x_1 + \delta_{22}x_2 + \delta_{2F} = 0 \end{cases}$$

delta 11
delta 12
delta 1F
delta 22
delta 21
delta 2F





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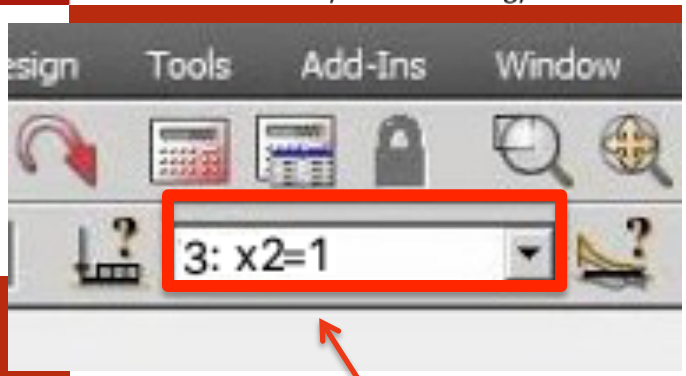
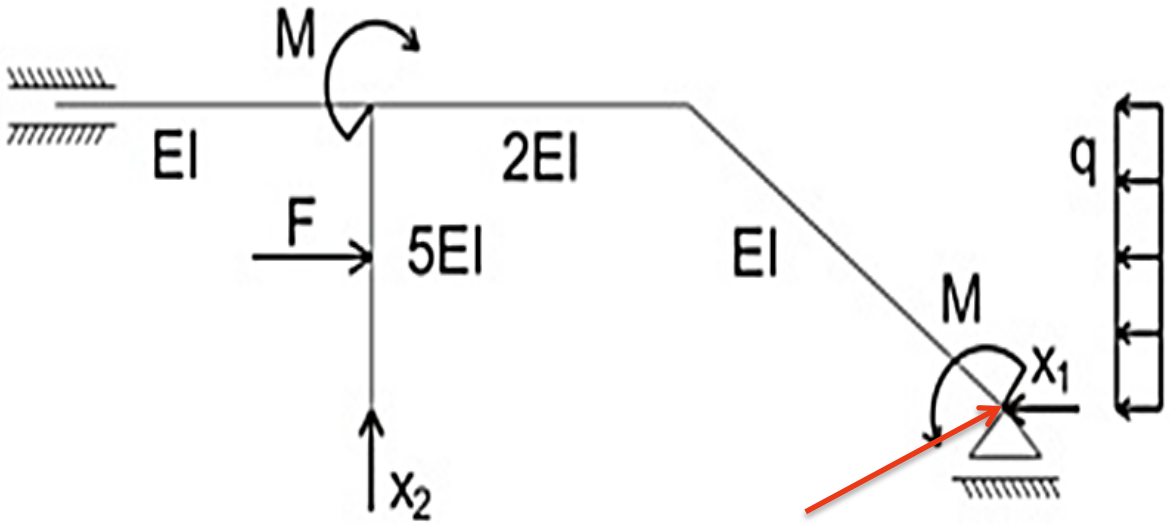
In order to read the value of **delta 11**, you will need to select in the middle window the load case „x1=1”.

Afterwards, click with the right button of your mouse in the node where x1 is located and select „object properties” and choose the tab „displacements”.

Because x1 acts in the UX direction (horizontal), you need to read the value in this direction.

Delta 11 – is the value of displacement in the node where the force x1 is located and is due to the x1=1.





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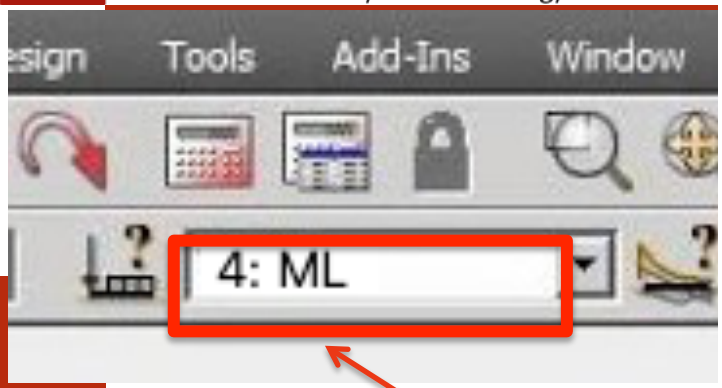
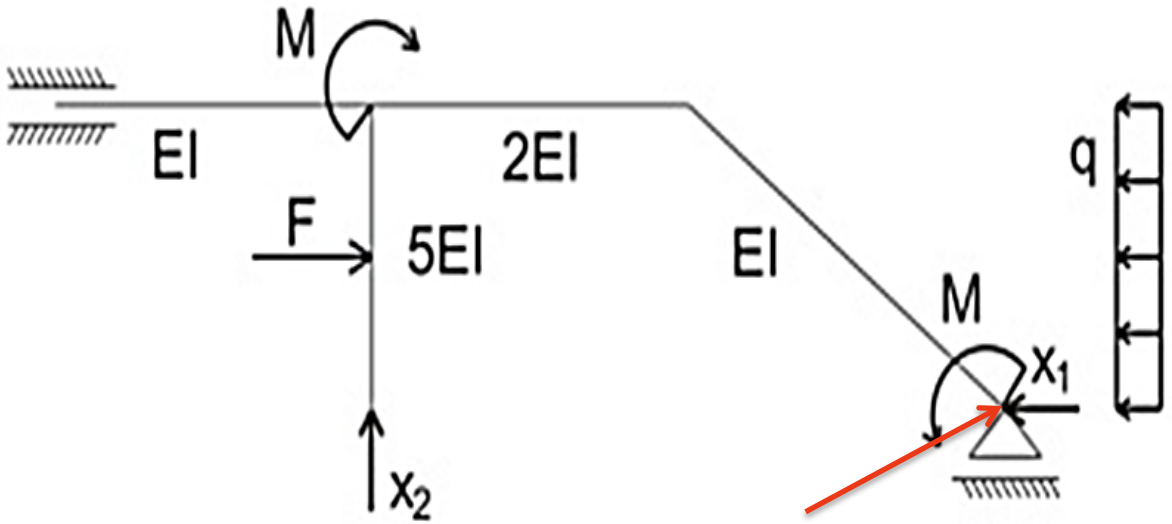
In order to read the value of **delta 12**, you will need to select in the middle window the load case „x2=1”.

Afterwards, click with the right button of your mouse in the node where x1 is located and select „object properties” and choose the tab „displacements”.

Because x1 acts in the UX direction (horizontal), you need to read the value in this direction.

Delta 12 – is the value of displacement in the node where the force x1 is located and is due to the x2=1.





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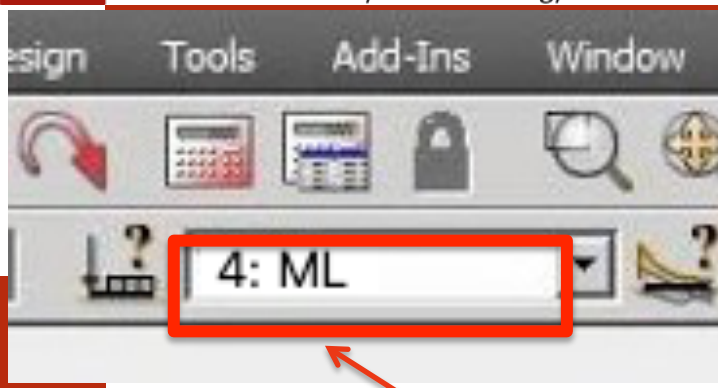
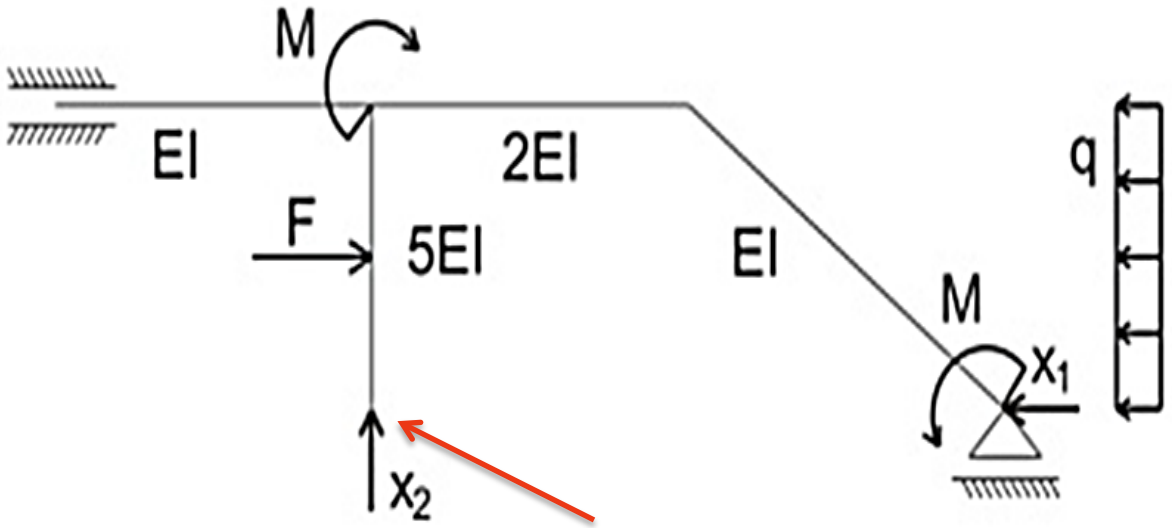
In order to read the value of **delta 1F**, you will need to select in the middle window the load case „ML”.

Afterwards, click with the right button of your mouse in the node where x1 is located and select „object properties” and choose the tab „displacements”.

Because x1 acts in the UX direction (horizontal), you need to read the value in this direction.

Delta 1F – is the value of displacement in the node where the force x1 is located and is due to the mechanical loading.





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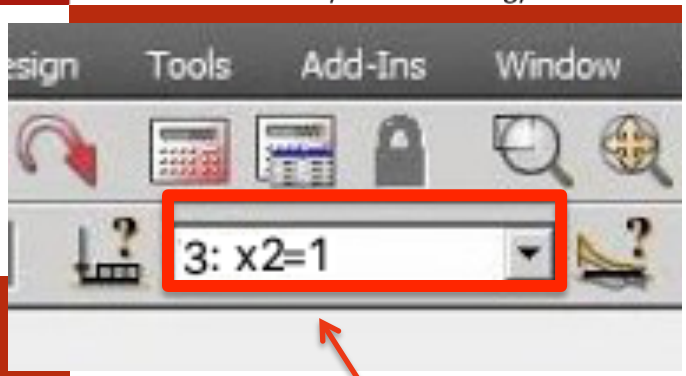
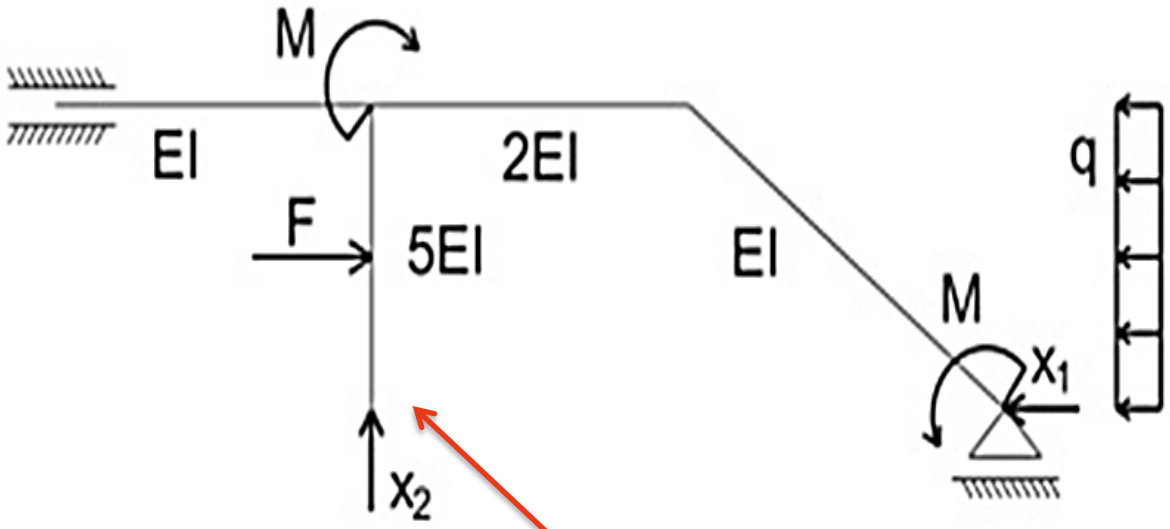
In order to read the value of **delta 2F**, you will need to select in the middle window the load case „ML”.

Afterwards, click with the right button of your mouse in the node where x2 is located and select „object properties” and choose the tab „displacements”.

Because x2 acts in the UY direction (vertical), you need to read the value in this direction.

Delta 2F – is the value of displacement in the node where the force x2 is located and is cause by mechanical loading.





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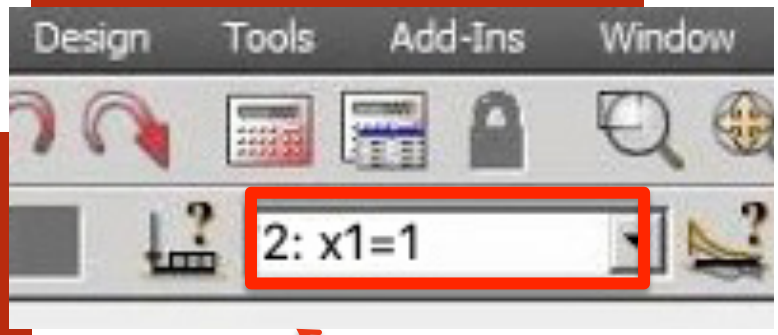
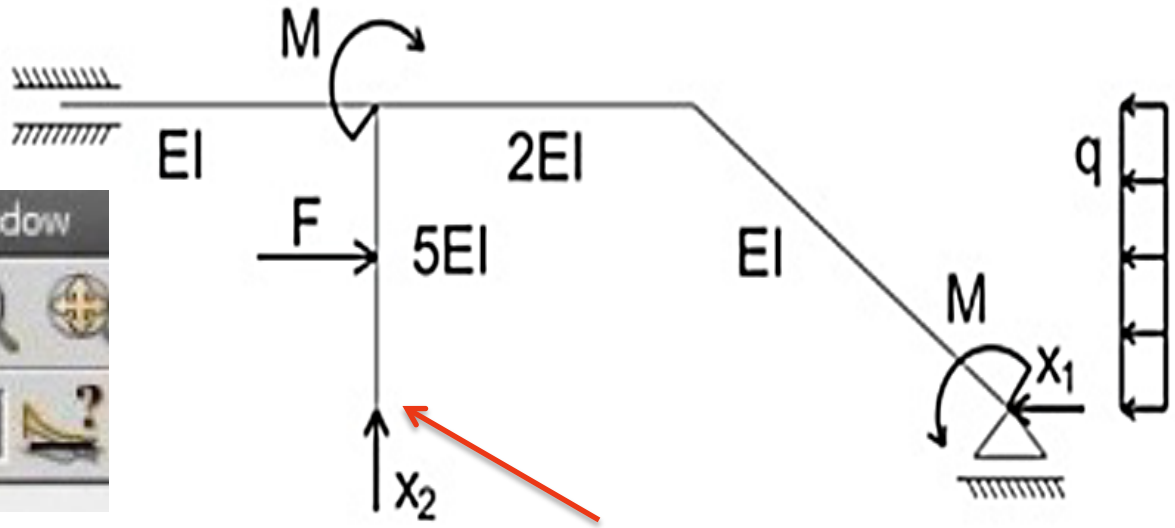
In order to read the value of **delta 22**, you will need to select in the middle window the load case „x2=1”.

Afterwards, click with the right button of your mouse in the node where x2 is located and select „object properties” and choose the tab „displacements”.

Because x2 acts in the UY direction (vertical), you need to read the value in this direction.

Delta 22 – is the value of displacement in the node where the force x2 is located and is due to the x2=1.





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In order to read the value of **delta 21**, you will need to select in the middle window the load case „x1=1”.

Afterwards, click with the right button of your mouse in the node where x2 is located and select „object properties” and choose the tab „displacements”.

Because x1 acts in the UY direction (vertical), you need to read the value in this direction.

Delta 21 – is the value of displacement in the node where the force x2 is located and is due to the x1=1.