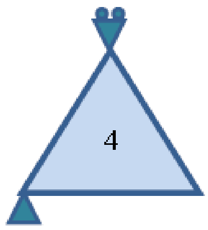
Calculate for the next structures: its external, internal and global degree of static indeterminacy and explain its implications.

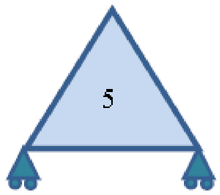
<u>Triangular plate (I)</u>



EDSI = R − EDOF = 3 − 3 = 0

Furthermore, its **reaction forces are not concurrent in a point**, then the system is **entirely linked**, which means its reactions forces can support any external force system and they can be determined because its EDSI is equal to zero.

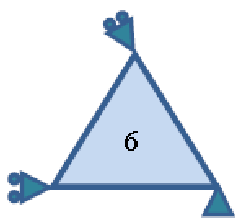
<u>Triangular plate (II)</u>



EDSI = R − EDOF = 2 − 3 = −1

Thus, the system is partially linked which means that the reactions can only support some external force systems. It is also called **mechanism.**

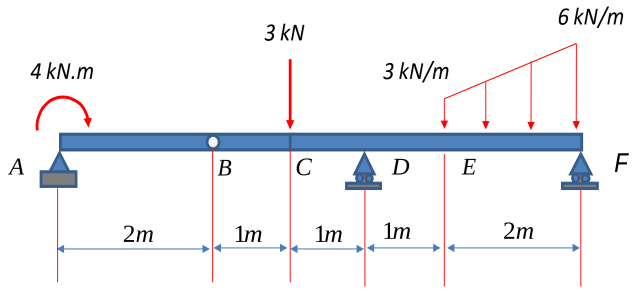
<u>Triangular plate (II)</u>



EDSI = R − EDOF = 4 − 3 = 1

However, all reaction forces are concurrent in the bottom right corner, and as a result the structure is **partially linked or mechanism.**

<u>Beam (I)</u>



EDSI = 4 − 3 = 1

IDOF = 3(2 − 1) = 3

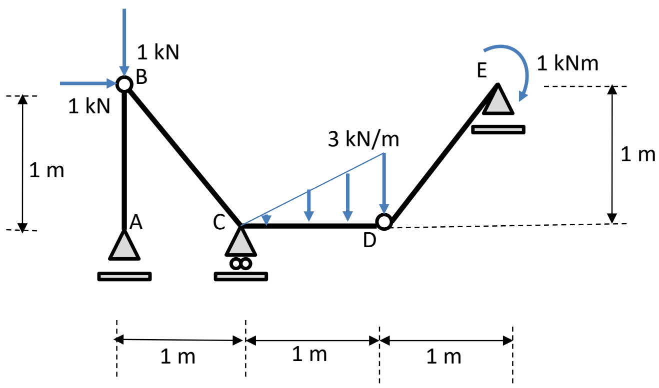
IL = 2(2 − 1) = 2

IDSI = 2 − 3 = −1

DSI = EDSI + IDSI = 1 − 1 = 0

The structure is completely linked and the reactions are statically determined.

<u>Beam (II)</u>



EDSI = 5 − 3 = 2

IDOF = 3(4 − 1) = 9

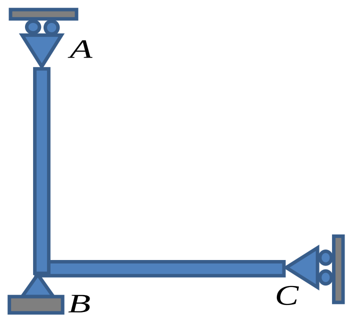
IL = 2[2(2 − 1)] + 3(2 − 1) = 7

$\text{IDSI} = 7 - 9 = -2$

$\text{DSI} = \text{EDSI} + \text{IDSI} = 2 - 2 = 0$

The structure is completely linked and the reactions are statically determined.

<u>Frame (I)</u>



<u>There are no internal links, just external, so:</u>

Since we have four reactions forces (two of the pin support and another two due to the couple of simply support) and three degrees of freedom (the beam can move upwards, downwards and can rotate about the perpendicular axis) and then:

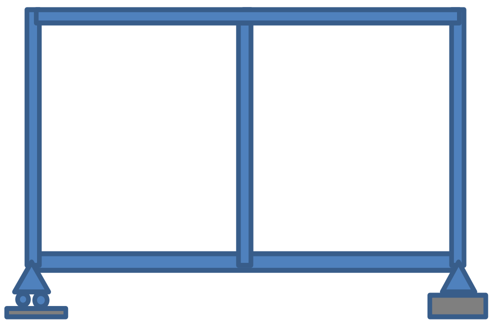
$\text{EDSI} = 4 - 3 = 1$

This means that the structure is statically indeterminate and it would not be possible to determine reaction forces (4 unknown factors and 3 equations of equilibrium).

EDSI greater than zero is a necessary but not sufficient condition in order to demonstrate that the structure is stable or not. Additionally, we will check the structure by inspection. A quick look to it shows it is completely linked. For example, add a vertical descending load at point B, and then the structure does not meet the criteria of equilibrium because the balance of moments at point B is different from zero.

However, if the new force applied is a horizontal one at the same point, then it is clear the structure meet the requirements of equilibrium because sum of vertical and horizontal forces and moments are null.

<u>Frame (II)</u>



$\text{EDSI} = \text{R} - \text{EDOF} = 3 - 3 = 0$

$\text{IL} = 2[2.(2-1)] + 2[2.(2-1)] + 2[2.(2-1)]$

$\text{IL} = 24$

$\text{IDOF} = 3.(7-1) = 18$

$\text{IDSI} = \text{IL} - \text{IDOF} = 6$

$\text{DSI} = \text{EDSI} + \text{IDSI} = 6$

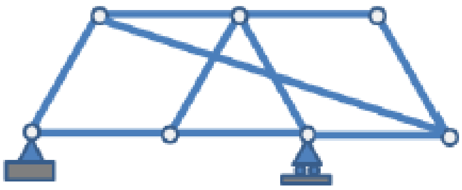
Alternatively:

$\mathbf{DSI} = \mathbf{3m} + \mathbf{r} - \mathbf{3j} = 3.7 + 3 - 6.3 = 6$

<u>Note from the author:</u> prior equation changes from trusses to frames. There are not a lot of exercises solved using this one but as far as I have seen on the internet. If you have any difficulty with it, you might always use the general method using $\mathbf{IL} = \mathbf{3}[(\mathbf{m} - \mathbf{1})]$, where «m» are the numbers of members attached.

Thus the structure is completely linked but its reaction forces cannot be determined using the equations of equilibrium.

Truss (I)



$\mathrm{EDSI} = \mathrm{R} - \mathrm{EDOF} = 3 - 3 = 0$

$\mathrm{IL} = 2[2(2-1)] + 4[2(3-1)] + 2(4-1) = 26$

$\mathrm{IDOF} = 3.(10-1) = 27$

$\mathrm{IDSI} = \mathrm{IL} - \mathrm{IDOF} = -1$

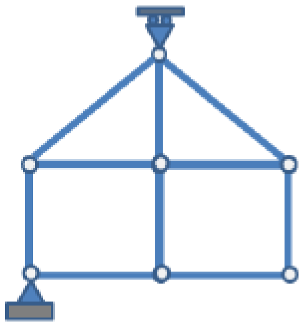
$\mathrm{DSI} = \mathrm{EDSI} + \mathrm{IDSI} = -1$

Alternatively:

$\mathrm{DSI} = \mathrm{r} + \mathrm{m} - 2\mathrm{j} = 3 + 10 - 2.7 = -1$

The DSI of the structure is less than zero therefore it is **partially linked** (mechanism). It also means is unstable due to the existence of a pattern of displacement.

Truss (II)



$\mathrm{EDSI} = \mathrm{R} - \mathrm{EDOF} = 3 - 3 = 0$

$\mathrm{IL} = 2.[2.(2-1)] + 4.[2.(3-1)] + 2(4-1)$

$\mathrm{IL} = 26$

$\mathrm{IDOF} = 3.(10-1) = 27$

$\mathrm{IDSI} = \mathrm{IL} - \mathrm{IDOF} = -1$

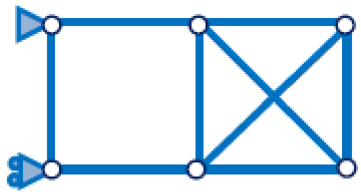
$\mathrm{DSI} = \mathrm{EDSI} + \mathrm{IDSI} = -1$

Alternatively:

$\mathrm{DSI} = \mathrm{r} + \mathrm{m} - 2\mathrm{j} = 3 + 10 - 2.7 = -1$

Then the structure is **partially linked** (mechanism).

Truss (III)



$\mathrm{EDSI} = \mathrm{R} - \mathrm{EDOF} = 3 - 3 = 0$

$\mathrm{IL} = 2.[2(2-1) + 2(3-1) + 2(4-1)]$

$\mathrm{IL} = 24$

$\mathrm{IDOF} = 3.(9-1) = 24$

$\mathrm{IDSI} = \mathrm{IL} - \mathrm{IDOF} = 0$

$\mathrm{DSI} = \mathrm{EDSI} + \mathrm{IDSI} = 0$

Alternatively:

$\mathrm{DSI} = \mathrm{r} + \mathrm{m} - 2\mathrm{j} = 3 + 9 - 2.6 = 0$

The DSI is equal to zero, **however the structure is partially linked** because it cannot withstand all system of forces because of the limitation of the truss when fulfilling its equation of equilibrium (for more information look for more information of trusses).