Applied Mechanics

Chapter 7

Analysis of Plane Trusses

Lecture 13 (week 13)

Calculation of Member Forces of Truss by method of sections: Examples

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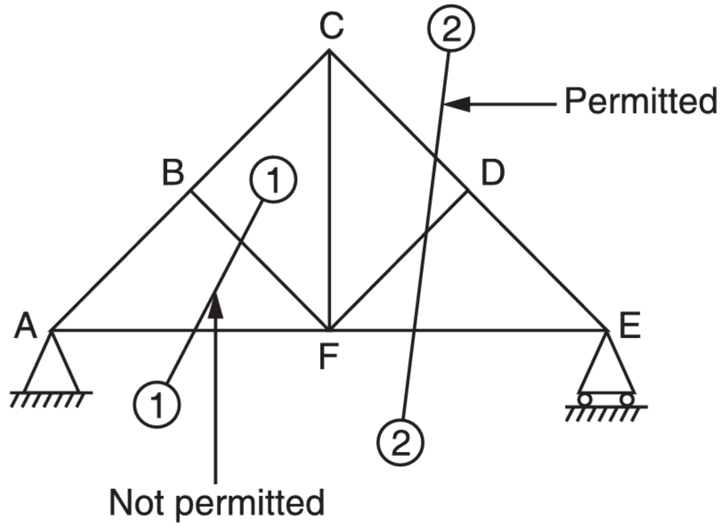
Learning Objectives:

- Learn and understand the assumptions made in the method of sections.
- Refresh knowledge on the equilibrium equations (sum of forces and moments being zero).
- Analyze worked examples to see the method of sections in practice.
- Identify common challenges and mistakes in the analysis process.
- Recognize the limitations and applicability of the method of sections.

7.3 **Calculation of Member Forces of Truss by method of sections**

In this method, we will cut the truss into two sections by passing a cutting plane through the members whose internal forces we wish to determine. This method permits us to solve directly any member by analyzing the left or the right section of the cutting plane.



We can use 3 equilibrium equations as

$\Sigma Fx=0$, $\Sigma F_V=0$ and $\Sigma M_{\text{at any joint}}=0$

Because we can only solve up to three unknowns, it is important that not to cut more than three unknown members of the truss.

Depending on the type of truss and which members to solve, one may have to repeat Method of Sections more than once to determine all the desired forces.

Method of section is the method in which a section line has to be passed through the members in which the internal forces need to be calculated.

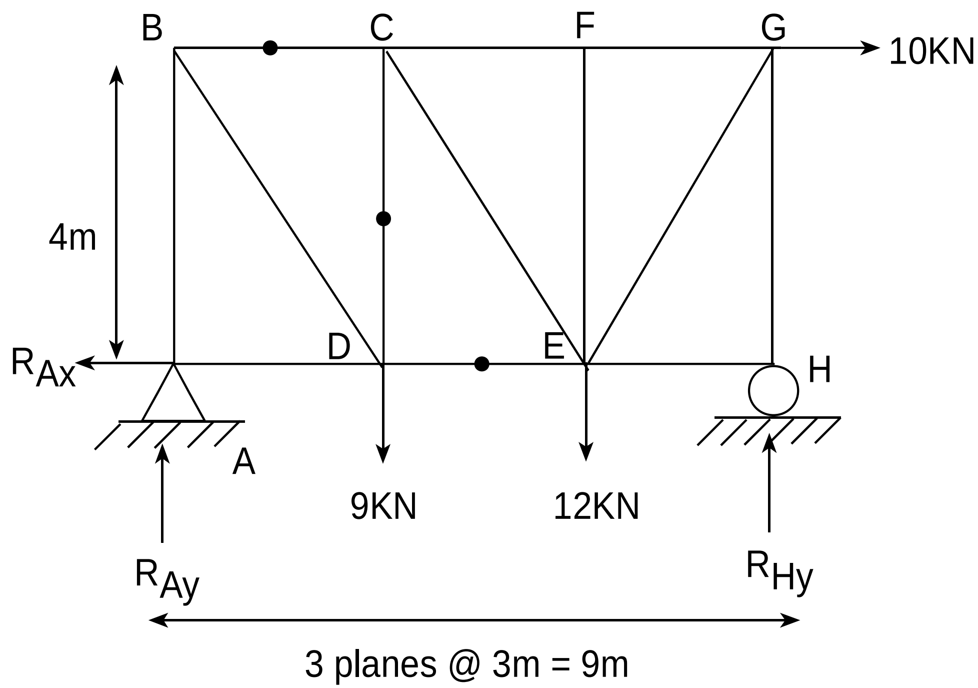
This method is suitable when it is necessary to find the forces induced in a few or selected members of a truss.

Some of the points to be recalled in using the method of section are as follows:

- The section line should be a complete.
- The section line should pass through the members, but not through the joints.
- The section line can pass through maximum of three members because only three conditions of equilibrium are available.

- The section line can pass through the four members in a situation where three members are meeting at a common point.
- The moment equation of equilibrium can be applied about a point may be beyond the portion under consideration.
- Consider either left portion or right portion whichever is easy for the analysis, as both portions are under equilibrium.[1]

Q. Find the reactions at supports and forces in the members BC, CD and DE of the truss.



Solution: For support reaction

(↻+) $\sum M_A = 0$

$-R_{Hy} \times 9 + 9 \times 3 + 12 \times 6 + 10 \times 4 = 0$

$[R_{Hy} = 15.44KN\ (\uparrow)]$

(+↑) $\sum Fy = 0$

$R_{Ay} - 9 - 12 + R_{Hy} = 0$

$R_{Ay} - 21 + 15.44 = 0$

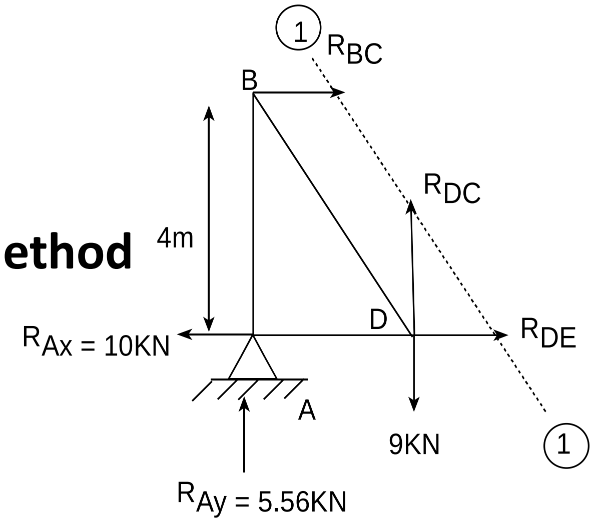
$[R_{Ay} = 5.56\ KN\ (\uparrow)]$

$\sum Fx \overset{+}{\rightarrow} = 0$, $-RAx + 10 = 0$

$[RAx = 10\ KN\ (\leftarrow)$

(Here, only one section is enough to Cutting 3 members to calculate the member) force developed in that members.

Here, taking section (i)-(i) and considering left part of the truss under equilibrium we get that figure.



3 equations of equilibrium can be applied in section method

Here, if we taking moment about point D, R_{BC} is found out in one step so,

(↻+) $\sum M_D = 0$

$5.56 \times 3 + R_{BC} \times 4 = 0$

[∴ $R_{BC} = -4.17$ KN = 4.17KN (C)]

(+↑) $\sum Fy = 0$

$5.56 - 9 + R_{CD} = 0$, [$R_{CD} = 3.44$KN (T)]

$\sum F_X \overset{+}{\rightarrow} = 0$

$-10 + R_{DE} + R_{BC} = 0$

$-10 + R_{DE} + (-4.17) = 0$ [the assumption of BC is tension so take (-ve) in tension)

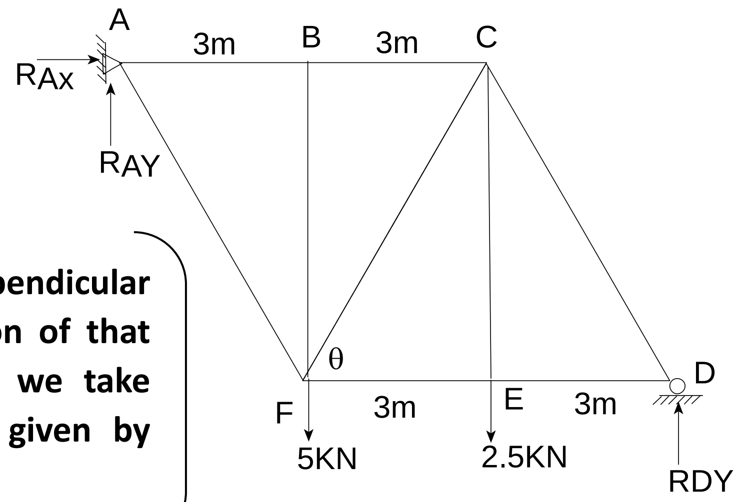
$\therefore$ [R_{DE} = 14.17KN (T)]

Hence

member	Member force and nature (T or C)
BC	4.17KN (C)
CD	3.44KN (T)
DE	14.17 KN (T)

(Note: *Results will be some if taking right portion of the sections.)*

Q. Determine the force developed in the members BC, BF, EF and FC of the given truss.



solution: At first, Calculation of support reaction

$R_{Ax} = 0$ [no horizontal forces]

(↻) $\sum MA = 0$

$5 \times 3 + 2.5 \times 6 - R_{Dy} \times 9 = 0$

[R_{Dy} = 3.33KN (↑)]

Moment = force × perpendicular distance from line of action of that force to the point where we take moment and direction is given by force.

(+↑) $\sum Fy = 0$

$R_{Ay} - 5 - 2.5 + R_{Dy} = 0$

[R_{Ay} = 4.17 KN (↑)] $\left[q = \tan\text{-}1 \left(\frac{4}{3}\right) = 53.13^{\circ} \right]$

Here, section method is easy and time reducing method so, apply these

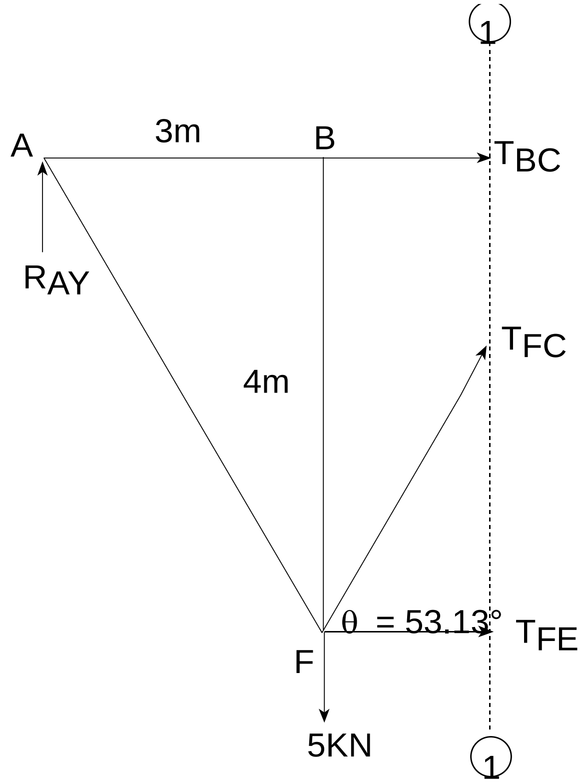
Taking a section (i)– (i) and considering left part only.

(↻+) $\sum M_F = 0$

$4.17 \times 3 + T_{BC} \times 4 = 0$

$T_{BC} = -3.13$ KN

$T_{BC} = 3.13$KN (C)



(+↑) $\sum Fy = 0$

$-5 + 4.17 + T_{FC} \sin\theta = 0$

$$T_{FC} = \frac{0.83}{\sin 53.13^{\circ}}$$

$[T_{FC} = 1.037 \text{ KN (T)}]$

$\sum F_X \overset{+}{\rightarrow} = 0$

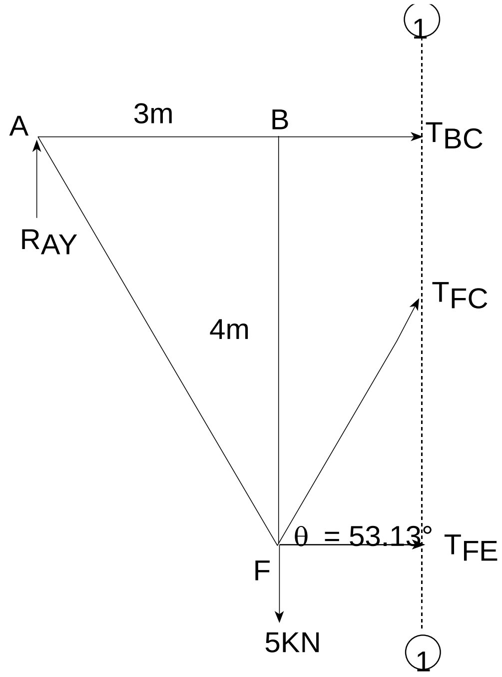
$T_{BC} + T_{FC} \cos \theta + T_{FE} = 0$

$(-3.13) + 1.037 \cos 53.13° + T_{FE} = 0$

$[T_{FE} = 2.51 KN\ (T)]$

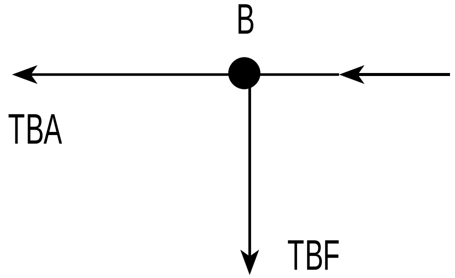
And for member force BF

$[T_{BF} = 0$ [by eye judgment]



i.e. At joint B

applying $\sum Fy = 0$ gives $T_{BF} = 0$



References

[1] M.N. SHESHA PRAKASH, G. B. (August, 2014). *ELEMENTS OF CIVIL ENGINEERING AND ENGINEERING MECHANICS.* Rimjhim House, 111, Patparganj, Delhi: PHI Learning Private Limited.

Thank You!!!!