1.4 TENSION COEFFICIENT METHOD

Tension Coefficient is defined as the ratio between pull and length of member

$$T = P/L$$

Where, T = Tension Coefficient

P = pull

L = Length

Example 1.4.1 A truss of 8m span consisting of seven members each 4m length supported at its ends and loaded as shown in Fig.5.7. Determine the forces on the members by tension coefficient method.

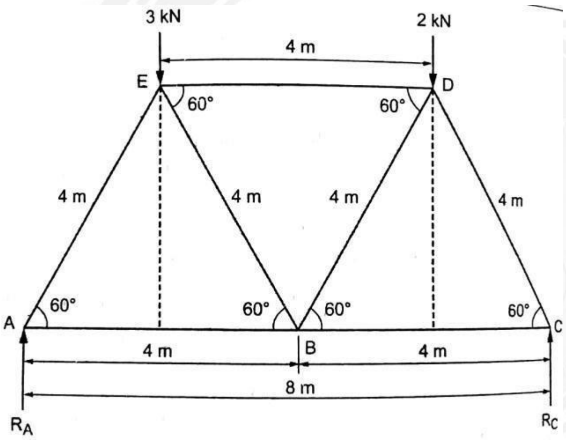


Fig.1.7.a

Solution:

Taking moment about A,

R_E X 2 +R_D X 6 = R_C X 8

Or 3 X 2 + 2 X 6 = R_C X 8

∴ R_C = 2.25 kN

R_A + RC = 3+2

R_A +2.25 = 5

R_A =5-2.25 =2.75 kN Consider a joint A.

In X direction (Take 'A' as a reference point)

At joint A, F_{AB} and F_{AE} forces are acting, so tension coefficient equation is

$$T_{AB}(X_B – x_A) + T_{AE}(X_E – X_A) =0 \qquad …(1)$$

Where,

T_{AB} = Tension coefficient at joint A and B

T_{AE} = Tension Coefficient at joint A and E

X_B = Horizontal distance between point A and B = 4m

X_A = Horizontal distance between point A and A = 0m

X_E = Horizontal distance between point A and E = Ap

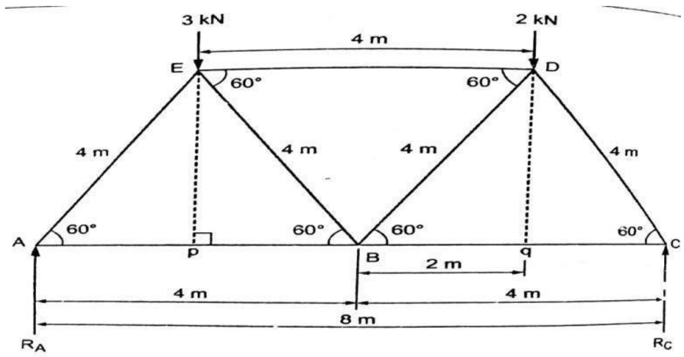


Fig.1.7.b

(1) → T_{AB} (4-0) + T_{AE} (Ap – 0) = 0

Or T_{AB} X 4 + T_{AE} X 2 = 0 …(2)

Similarly,

In Y direction (Take A as a reference point)

T_{AB} (Y_B – Y_A) + T_{AE} (Y_E – Y_A) + R_A = 0 …(3)

Where,

Y_B = Vertical distance between points A and B = 0

Y_A = Vertical distance between points A and A = 0

Y_E = Vertical distance between points A and E = Ep

(3) → T_{AB} (0-0) + T_{AE} (Ep – 0) + 2.75 = 0

Or 0+ T_{AE} (Ep – 0) = -2.75

From Δ APE,

$$\text{Sin}60^\circ = \frac{Ep}{AE} = \frac{Ep}{4}$$

∴ Ep = 3.46m T_{AE}

X 3.56 = -2.75

∴ T_{AE} = -0.79

Substituting T_{AE} value in equation (2),

T_{AB} X 4 - 0.79 X 2 = 0

4 T_{AB} = 1.58

∴ T_{AB} =0.39

Consider joint C.

In x direction (Take A as a reference point)

T_{CB}(X_B – X_C) + T_{CD}(X_D – X_C) = 0

Where,

X_B = Horizontal distance between points A and B = 4m

X_C = Horizontal distance between points A and C = 8m

X_D = Horizontal distance between points A and D = Aq

T_{CB}(4 – 8) + T_{CD}(6 – 8) = 0

Or T_{CB} X -4 + T_{CD} X -2 = 0 …(4)

Similarly,

In Y direction (Take 'A' as a reference point)

$$T_{CB}(Y_B - Y_C) + T_{CD}(Y_D - Y_C) + R_C = 0$$

Where,

Y_B = Vertical distance between A and B = 0

Y_C = Vertical distance between A and C = 0

Y_D = Vertical distance between A and D = Dq = Eq

Then, $T_{CB}(0 - 0) + T_{CD}(Ep - 0) + R_C = 0$

T_{CD} X 3.46 + 2.25 = 0

$\therefore$ T_{CD} = -0.65

Substituting, T_{CD} value in equation (4).

$$T_{CB} \text{ X } (-4) + (-0.65)\text{X } (-2) = 0$$

$$-4\ T_{CB} = -1.3$$

$$\therefore\ T_{CB} = 0.325$$

Consider the joint D.

In X direction (Take 'A' as a reference point)

$T_{DC}\ (X_C - X_D) + T_{DE}(X_E - X_D) + T_{DB}(X_B - X_D) = 0$

Where,

X_C = Horizontal distance between points A and C = 8m

X_D = Horizontal distance between points A and D = 6m

X_E = Horizontal distance between points A and E = 2m

X_B = Horizontal distance between points A and B = 4m

$T_{DC}\ (8 - 6) + T_{DE}(2 - 6) + T_{DB}(4 - 6) = 0$

or $2T_{DC} - 4\ T_{DE} - 2T_{DB} = 0$ …..(5)

Similarly,

In Y direction (Take 'A' as a reference point)

$$T_{DC}\ (Y_C - Y_D) + T_{DE}(Y_E - Y_D) + T_{DB}(Y_B - Y_D) - 2kN = 0$$

Where,

Y_C = Vertical distance between points A and C = 0m

Y_D = Vertical distance between points A and D = Dq = Ep = 3.46m

Y_E = Vertical distance between points A and E = Ep = 3.46m

Y_B = Vertical distance between points A and E = 0m

$$T_{DC}\ (0 - 3.46) + T_{DE}(3.46 - 3.46) + T_{DB}(0 - 3.46) - 2 = 0$$

$- 3.46\ T_{DC} + 0 - 3.46\ T_{DB} = 2$

$- 3.46\ (-0.65) - 3.46\ T_{DB} = 2$

(we know that, T_{DC} = -0.65)

T_{DB} = 0.07

Substituting, T_{DC} value in equation (5),

$2T_{DC} - 4\,T_{DE} - 2(0.07)$

$= 0$ $\quad 2(-0.65) - 4$

$T_{DE} - 2(0.07) = 0$

$\mathbf{T_{DE} = -0.36}$

Consider joint E.

In X direction (Take 'A' as a reference point)

$$T_{ED}\,(X_D - X_E) + T_{EA}(X_A - X_E) + T_{EB}(X_B - X_E) = 0$$

Where,

X_D = Horizontal distance between points A and D = 6m

X_E = Horizontal distance between points A and E = 2m

X_A = Horizontal distance between points A and A = 0

X_B = Horizontal distance between points A and B = 4m

$$T_{ED}\,(6 - 2) + T_{EA}(0 - 2) + T_{EB}(4 - 2) = 0$$

$4\,T_{ED} - 2\,T_{EA} + 2T_{EB}) = 0$

$4(-0.36) - 2(-0.79) + 2T_{EB} = 0$

$\mathbf{T_{EB} = -0.07}$

Result

Sl.No.	Member	Tension coefficient	Length (m)	Force(kN) = Tension Coefficient X Length	Nature
1	AE	-0.79	4	-3.16	Compression
2	AB	0.39	4	1.57	Tension
3	CD	-0.65	4	-2.6	Compression
4	CB	0.325	4	1.3	Tension
5	DB	0.07	4	0.28	Tension
6	DE	-0.36	4	-1.44	Compression
7	EB	-0.07	4	-0.28	Compression

TWO MARK QUESTIONS AND ANSWERS

1. What is meant by frame?

A structure made up of several bars (or members) riveted or welded together is known as frame.

2. What are the different types of frames? The different types of frame are :

(i). Perfect frame and (ii). Impefect frame.
Imperfect frame may be a deficient frame or redundant frame.

3. what is meant by Perfect frame?

The frame which is composed of such members, which are just sufficient to keep the frame in equilibrium, when the frame is supporting an external load, is known as perfect frame.

The simplest perfect frame is a triangle as shown in Fig.5.1

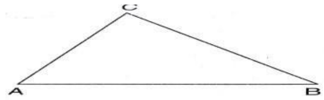


Fig.1.1

It consists of three members AB, BC and AC whereas the three joints are A,B and C. This frame can be easily analysed by the condition of equilibrium given below.

$n = 2j - 3$

Where n = Number of members and j = Number of joints.

4. What is meant by Imperfect frame?

A frame in which the number of members and number of joints are not given by $n = 2j - 3$ is known as imperfect frame.

5. Define Deficient frame and Redundant Frame

If the number of members in an imperfect frame are less than $2j – 3$, then the frame is known as deficient frame. and If the number of members in an imperfect frame are more than $2j – 3$, then the frame is known as redundant frame

6. What are the assumptions made in finding the forces in a truss? (Apr/May 05)

(a) All the members are pin – jointed
(b) The frame is loaded only at the joints
(c) The frame is a perfect frame
(d) The self – weight of the members is neglected

7. What are the methods to analyse the forces in the members of the frame?

a) Analytical method and
b) Graphical method

8. What is meant by method of Joints?

In this method, after determining the reactions at the supports, the equilibrium of every joint is considered. This means the sum of all the vertical forces as well as the horizontal forces acting on a joint is equated to zero. The joint should be selected in such a way that at any time there are only two members, in which the forces are unknown. The force in the member will be compressive if the member pushes the joint to which it is connected whereas the force in the member will be tensile if the member pulls the joint to which it is connected.

9. What is maeant by Method of Sections?

When the forces in a few members of a truss are to be determined, then the method of section is mostly used. This method is very quick as it does not involve the solution of other joints of the truss.

In this method, a section line is passed through the members, in which the forces are to be determined. The section line should be drawn in such a way that it does not cut more than three members in which the forces are unknown. The part of the truss on any one side of the section line is treated as free body in equilibrium under the action of external forces on that part and forces in the members cut by the section line. The unknown forces in the members are then determined by using equations of equilibrium as $\Sigma Fx = 0$, $\Sigma Fy = 0$ and $\Sigma M = 0$,

10. What is meant by Tension Coefficient method?

Tension Coefficient is defined as the ratio between pull and length of member

$$T = P/L$$

Where, T = Tension Coefficient

P = pull

L = Length

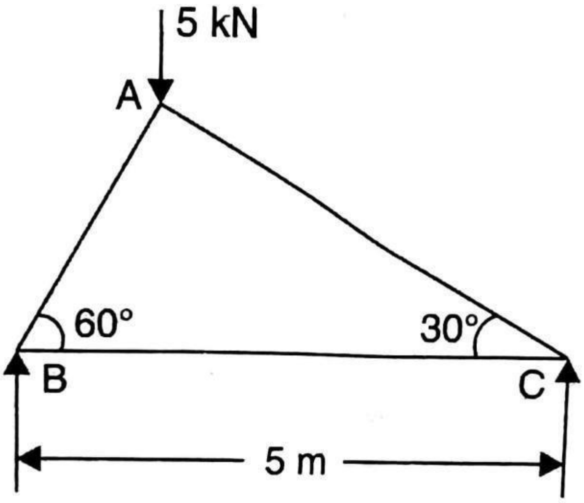
REVIEW QUESTIONS (PART –A)

1. What is mean by perfect frame?
2. What are the different types of frames?
3. What is mean by Imperfect frame?
4. What is mean by deficient frame?
5. What is mean by redundant frame?
6. What are the assumptions made in finding out the forces in a frame?
7. What are the reactions of supports of a frame?
8. How will you Analysis of a frame?

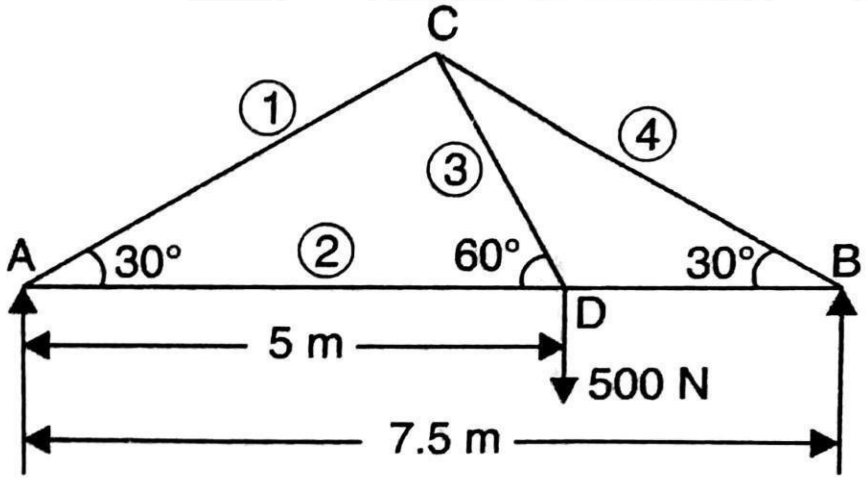
10. What are the methods for Analysis the frame?
11. How method of joints applied to Trusses carrying Horizontal loads.
12. How method of joints applied to Trusses carrying inclined loads.
13. How will you determine the forces in a member by method of joints?

REVIEW QUESTIONS (PART – B)

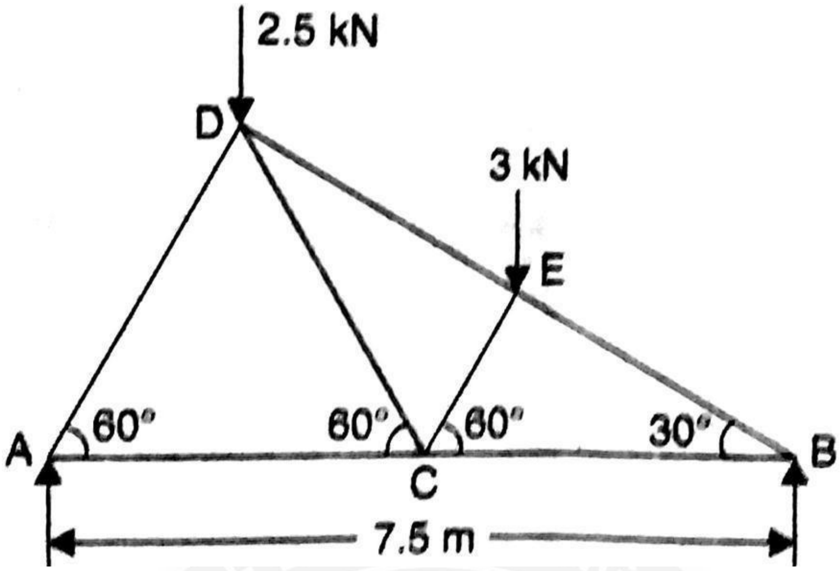
1. Determine the forces in the following figure by method of joints.



2. Determine the forces in the members by method of joints as given below.



3. Determine the forces in the members by method of joints as given below.



4. Determine the forces in the members by method of joints as given below.