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. ملخص للمادة Pdf للمذكرة والمراجعة
. محاضرات مباشرة علي برنامج زووم
لمناقشة الأجزاء الغير مفهومة
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ONLINE COURSES

Structure Analysis 2

Principle of Virtual work
Method of Virtual Work (Trusses)

Lecture 2

Method of Virtual Work: Trusses

EXTERNAL LOADING

- To compute the vertical displacement Δ of joint B of the truss caused by external loadings $\mathbf{P_1}$ and $\mathbf{P_2}$:

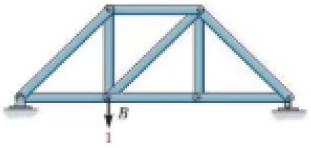
$$1 \cdot \Delta = \sum u \cdot dL$$

where $dL = \frac{NL}{AE}$

$$1 \cdot \Delta = \sum \frac{nNL}{AE}$$

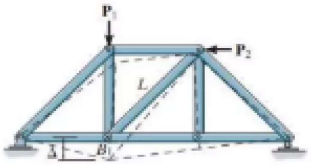
where

1 = external virtual unit load acting on the truss joint in the stated direction of Δ



Apply virtual unit load to B

(a)



Apply real loads $\mathbf{P}_1$, $\mathbf{P}_2$

(b)

n = internal normal force in a truss member caused by the external virtual unit load

Δ = external join displacement caused by the real loads on the truss

N = internal normal force in a truss member caused by the real loads

L = length of the member

A = cross-sectional area of a member

E = modulus of elasticity of a member

TEMPERATURE

- In some cases, truss members may change their length due to temperature
- If α is the coefficient of thermal expansion for a member and ΔT is the change in its temperature, the change in length of a member is

$$\Delta L = \sum n\alpha\, \Delta T\, L$$

- To compute the displacement of a selected truss joint due to this temperature change

$$1 \cdot \Delta = \sum n\alpha\, \Delta T\, L$$

where

1 = external virtual unit load acting on the truss joint in the stated direction of Δ

α = coefficient of thermal expansion of a member

ΔT = change in temperature of member

FABRICATION ERRORS AND CAMBERS

- Occasionally, errors in fabricating the lengths of the members of a truss may occur
- Also, in some cases truss members must be made slightly longer or shorter in order to give the truss a camber
- To compute the displacement of a truss joint from its expected position

$$1 \cdot \Delta = \sum n \, \Delta L$$

where

1 = external virtual unit load acting on the truss joint in the stated direction of Δ

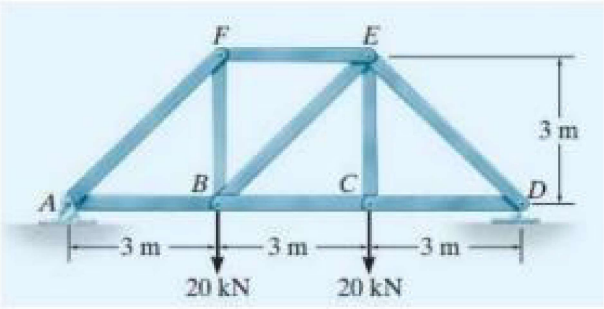
ΔL = difference in length of the member from its intended size as caused by a fabrication error

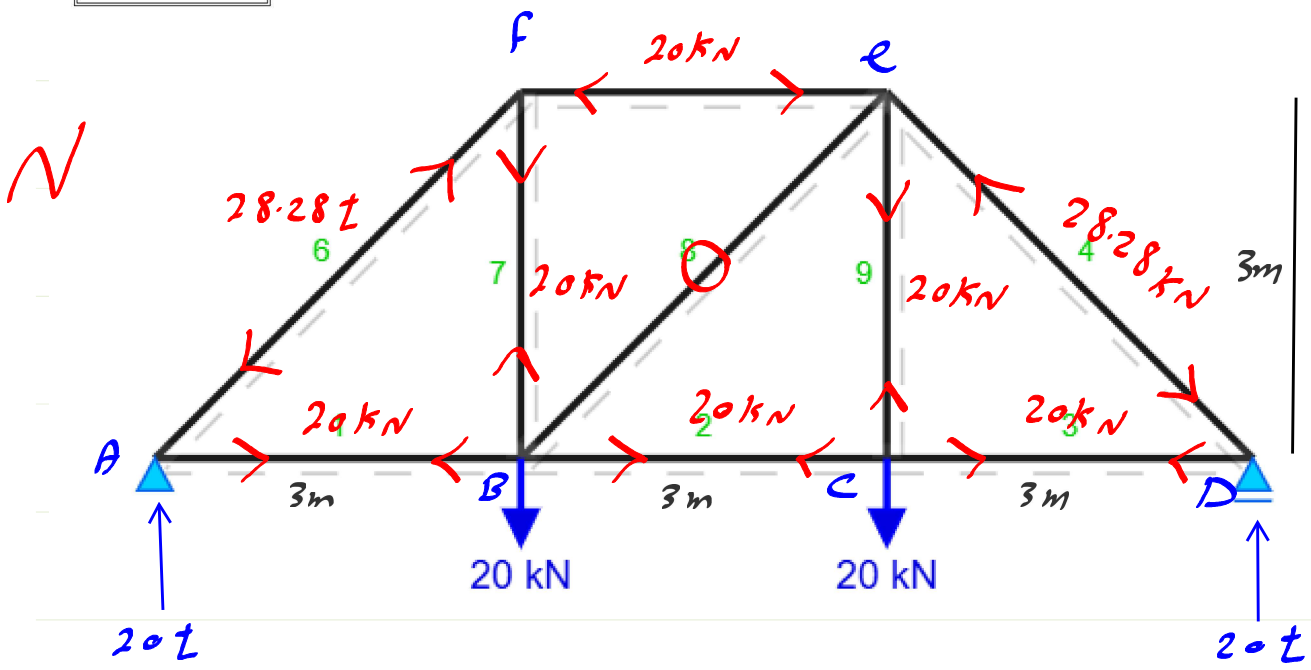
EXAMPLE 1

Problem:

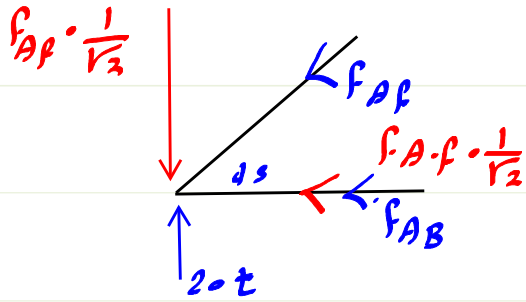
Determine the vertical displacement if joint C of the steel truss shown. The cross-sectional area of each member is A = 300 mm^2 and E = 200 Gpa.

$$\Delta = \sum \frac{nNL}{AE}$$





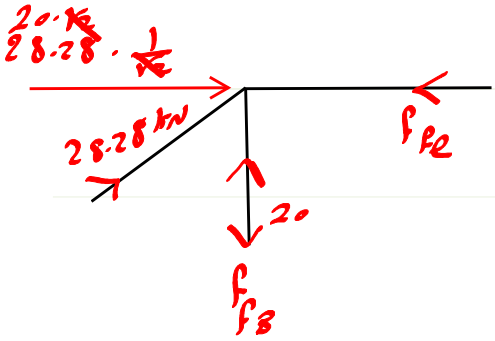
at joint A

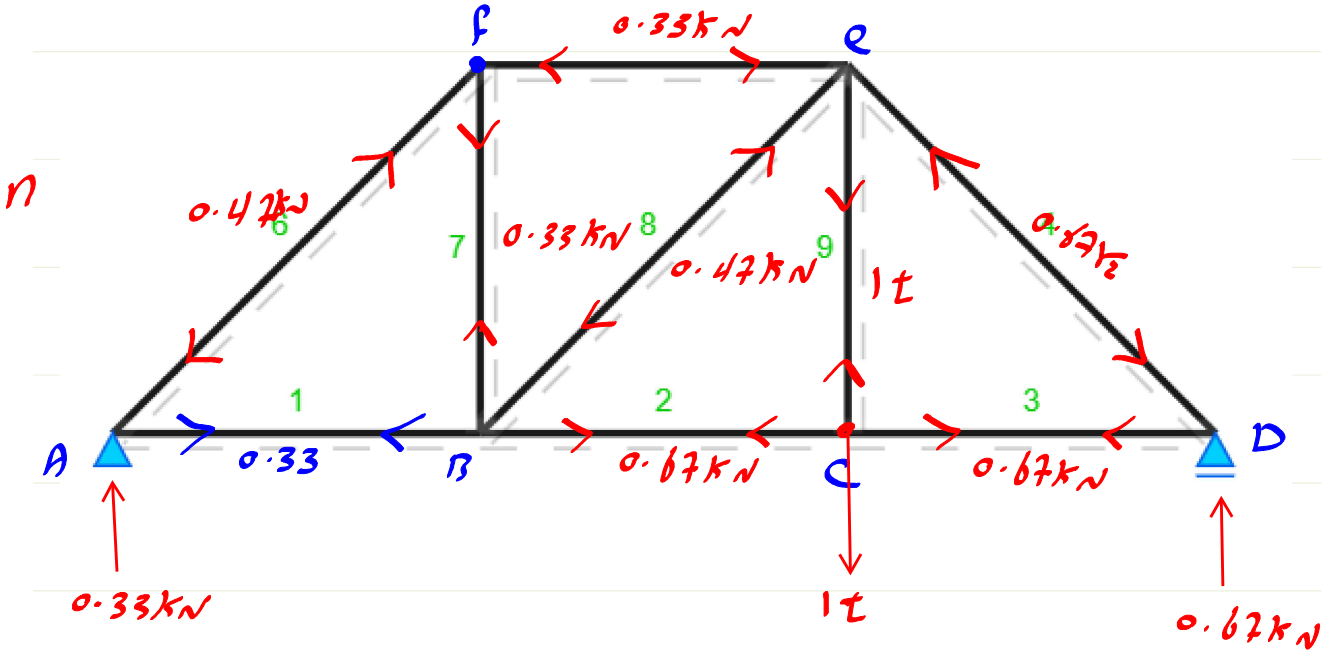


$$\Sigma f_y = 20 - f_{Af} \cdot \frac{1}{\sqrt{2}} = 0 \Rightarrow f_{Af} = 20\sqrt{2} = 28.28\ t$$

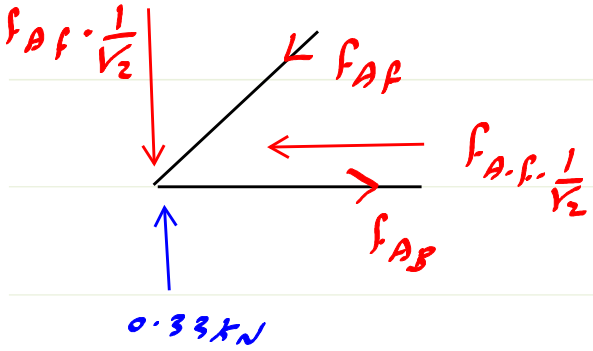
$$\Sigma f_x = -f_{AB} - f_{Af} \cdot \frac{1}{\sqrt{2}} = 0 \Rightarrow f_{AB} = -20\ t$$

at joint f



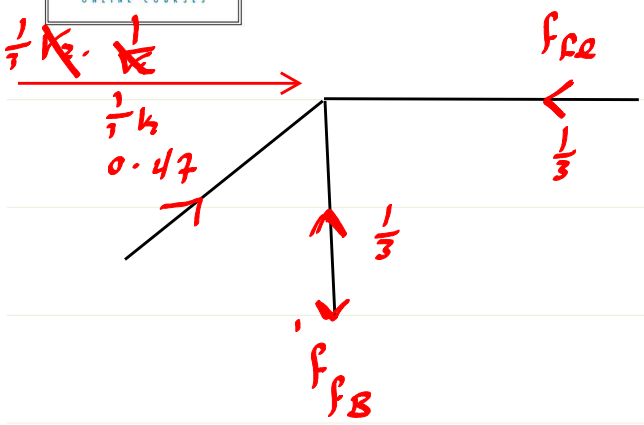


at joint A

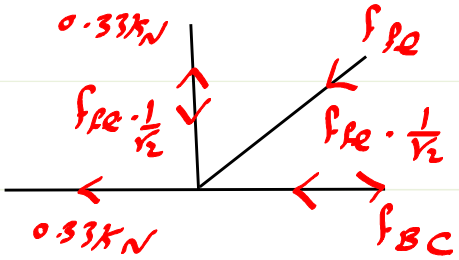


$$\Sigma F_y = 0.33 - F_{AF}\cdot\frac{1}{\sqrt{2}} = 0 \Rightarrow F_{AF} = 0.47kN$$

$$\Sigma F_x = F_{AB} - 0.47\cdot\frac{1}{\sqrt{2}} = 0 \Rightarrow F_{AB} = 0.33kN$$



at joint B



$$\Sigma f_y = 0.33 - f_{FE} \cdot \frac{1}{\sqrt{2}} = 0 \Rightarrow f_{FE} = 0.47\,kN$$

$$\Sigma f_x = -0.33 - 0.47 \cdot \frac{1}{\sqrt{2}} + f_{BC} = 0$$

H . V . D

member	n(KN)	N(KN)	L(m)	nNL(KN².m)
AB	0.33	20	3	20
BC	0.67	20	3	40
CD	0.67	20	3	40
Ef	-0.33	-20	3	20
FB	0.33	20	3	20
EC	1	20	3	60
AF	-0.47	-28.28	4.24	56.56
BE	-0.47	0	4.24	0
ED	-0.947	-28.28	4.24	119.55

ΣnNl 369.91

$A = 300mm^2 = 300 * (10^{-3})^2 \ m^2$

$E = 200GPa = 200 * 10^9 \ Pa$

$$\Delta = \Sigma \frac{nNl}{AE} = \frac{369.91 * 10^3}{300 * 10^{-6} * 200 * 10^9} = 6.16 * 10^{-3} m$$

$= 6.16mm$