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Structural Design Examination Response

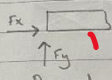
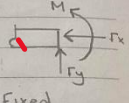
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Structural Design

Examination

a)  Pinned Support  Roller Support  Fixed Support

b)  Pinned  Roller  Fixed

c) Determinate structures are analysed by the use of basic equilibrium equations and include simply supported beams, cantilever etc. Indeterminate structures are not capable of being analysed by the use of basic equilibrium equations, extra conditions are required. Examples include 2 beams and arches.

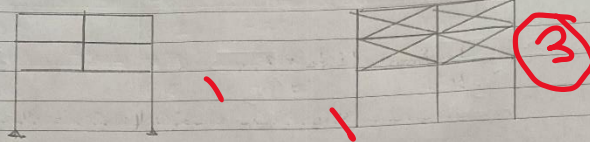
d) $\sum H = 0$ Summation of horizontal forces is equal to 0
 $\sum V = 0$ Summation of vertical forces is equal to 0
 $\sum M = 0$ Summation of moments is equal to 0

e) $r = 3n$ = Determinate n = total number of parts
 $r > 3n$ = Indeterminate r = total number of reactive force and moment components

f)

$F1 = r = 3$	$n = 1$	$= 3$	determinate
$F2 = r = 6$	$n = 2$	$= 3(2)$	determinate
$F3 = r = 5$	$n = 1$	$= 2$	Indeterminate to second degree
$F4 = r = 10$	$n = 3$	$= 1$	Indeterminate to first degree

g) Frame Structures have the combination of beam, column and slab to resist the lateral and gravity loads. Used to overcome large moments due to the applied load.



Rigid Frame Structure

Braced Frame Structure

h) a rigid truss is one which does not collapse and remains in equilibrium under the action of external forces at the joint.

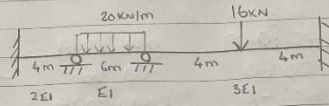
Non-rigid trusses do not satisfy the below equation - It has less numbers of members or a surplus member.

1) $m = 2j - 3$ $m = \text{number of members}$
 $j = \text{number of joints}$

- 2) I = Warren Truss II = Pratt Truss
 III = Howe Truss IV = K-truss
 V = Fink Truss

Q1 - 38

Section B



$$\text{Stiff coeff AB } (K_{AB}) = 2EI/L = 2/4$$

$$\text{Stiff coeff BC } (K_{BC}) = EI/L = 1/6$$

$$\text{Dist fact BA } (D_{FBA}) = K_{AB} / (K_{AB} + K_{BC}) = (2/4) / (2/4 + 1/6) = 0.75$$

$$\text{Dist fact BC } (D_{FBC}) = K_{BC} / (K_{AB} + K_{BC}) = (1/6) / (2/4 + 1/6) = 0.25$$

$$\text{Check } 0.75 + 0.25 = 1 \quad \checkmark$$

$$\text{Stiff coeff BC } (K_{BC}) = EI/L = 1/6$$

$$\text{Stiff coeff CD } (K_{CD}) = 3EI/L = 3/8$$

$$\text{Dist fact BA } (D_{FBA}) = K_{BC} / (K_{BC} + K_{CD}) = (1/6) / (1/6 + 3/8) = 0.31$$

$$\text{Dist fact BC } (D_{FBC}) = K_{CD} / (K_{BC} + K_{CD}) = (3/8) / (1/6 + 3/8) = 0.69$$

$$\text{Check } 0.31 + 0.69 = 1 \quad \checkmark$$

Fixed end moments

$$\text{Member AB } (FEM_{AB}) = WL^2/12$$

$$20 \times 6 \times 6 / 12 = 60 \text{ kN/m}$$

$$\text{Member BC } (FEM_{BC}) = PL/8 = 16 \times 8 / 8 = 16 \text{ kN/m}$$

Balance Moment at Joints

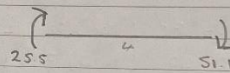
DE	1	0.75	0.25	0.31	0.69	0
FEM	0	0	60	-60	16	-16
BM		-45	-15	13.64	30.36	
COM	-22.5		6.82	-7.5	-0.4	15.185
BM		-5.12	-1.71	-2.33	5.18	
COM	-2.56		1.17	-0.86		2.59
BM		-0.88	-0.3	0.27	0.6	
COM	-0.44		0.14	-0.15		0.3
BM		-0.11	-0.04	0.05	0.1	
FEM	-25.5	-51.1	51.1	-52.2	-52.2	2.07

Span AB

$$(V_{AB} \times 4) + 25.5 + 51.1$$

$$4V_{AB} + 76.6$$

$$V_{AB} = 76.6/4 = 19.15 \text{ kN}$$



BA

$$(-V_{BA} \times 4) + 22.5 + 51.1$$

$$-V_{BA} \times 4 = 76.6$$

$$V_{BA} = 76.6/4 = 19.15 \text{ kN}$$

Span BC

$$(V_{BC} \times 6) - 51.1 - (20 \times 6 \times 3) + 52.2$$

$$6V_{BC} = -358.6$$

$$V_{BC} = -358.6/6$$

$$= -59.76 \text{ kN}$$

CB

$$(V_{CB} \times 6) + 52.2 + (20 \times 6 \times 3)$$

$$= 51.1$$

$$6V_{CB} = 36.1$$

$$36.1/6 = 6.02 \text{ kN}$$

Span CD

$$V_{CD} \times 8 - 52.2 - (16 \times 2) + 2.07$$

$$8V_{CD} = 177.93$$

$$V_{CD} = 177.93 / 8$$

$$= 22.24 \text{ KN}$$

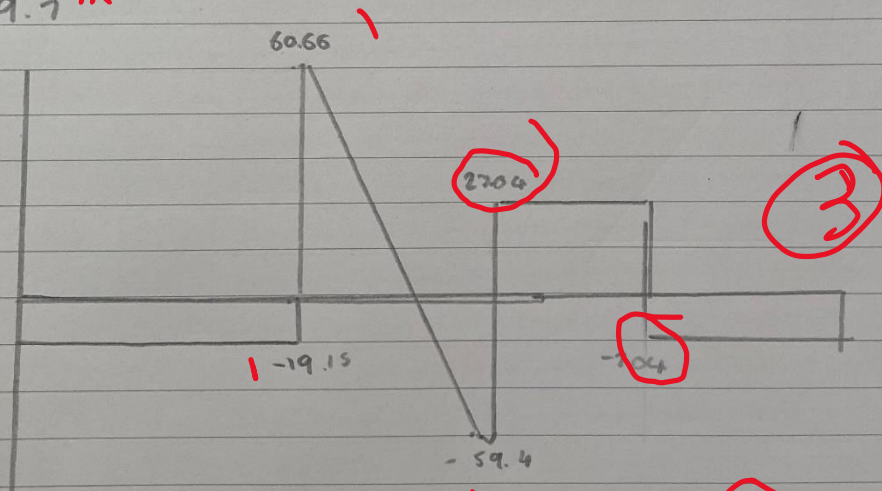
Span DC

$$-V_{DC} \times 8 + 7.07 + (16 \times 2) - 52.2$$

$$8V_{DC} = 77.87$$

$$V_{DC} = 77.87 / 8$$

$$= 9.7$$



22-20

Question 4

At A and B

$$\sum M_A = 0$$

$$RB \times (4+4) - 3 \times 2 - 8 \times 2 = 0$$

$$RB = -14 \text{ KN (C)}$$

$$VA = 8 - RB$$

$$8 - (-14) = 22$$

$$= 22 \text{ KN}$$

$$RA = \sqrt{VA^2 + NA^2} = \sqrt{(22)^2 + 3^2} = 22.2 \text{ KN}$$

Members AD and AC

$$\sum F = 0$$

$$FAD = \sin 45 + VA$$

$$0.707 FAD + 22$$

$$FAD = 22.707 \text{ (C)}$$

$$FAC + FAD \cos 45 - HA = 0$$

$$FAC - 22.7 \times 0.707 - 3$$

$$FAC = 19.04 \text{ KN (C)}$$

Members DE and DC

$$8 - FDE \sin 45 + FDC \sin 45 - FAD \sin 45 = 0$$

$$8 - 0.707 FDE + 0.707 FDC - 22.7 \times 0.707 = 0$$

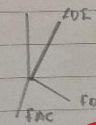
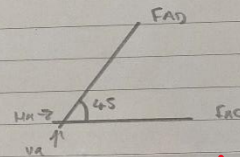
$$7.3 + 0.707 FDC + 0.707 FDE = 0$$

$$\sum F = 0$$

$$FAD \cos 45 + FDC \cos 45 + FDE \cos 45 = 0$$

$$22.7 \times 0.707 + 0.707 FDC + 0.707 FDE = 0$$

$$16.05 + 0.707 FDC + 0.707 FDE = 0$$



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