

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

MINOR I : CVL756

ADVANCED STRUCTURAL ANALYSIS (2023-24)

Time: 2 h

Venue: LH 310

Date: 15 Sep 2023

Max marks : 30

NOTE: (a) All questions are compulsory. (b) Draw neat and clear sketches wherever required. (c) Assume suitable data if necessary. (d) Assume members as extensible unless otherwise stated. (e) All answers must be supported by calculations/ justification to secure assigned marks.

Q1.

Determine the sizes of K_{pp} , K_{xx} and K_{px} for the structure shown in Figure 1 for the case of (a) no slab present, (b) rigid slab present, at the level of joints 1, 2, 3...6. Please note that joint numbers are marked bound in circles and member numbers in squares/ rectangles.

36X36 (no slab), 21X21 (slab present)

36X36 (both cases)

(2.5x2 = 5 marks)

Q2.

For the 3D structure shown in Figure 1, assuming no slab present, which members shall contribute towards following elements of K_{TS} : (a) $K_{29,20}$ (b) $K_{29,29}$

36X36 (no slab)
21X36 (slab present)

(4x2 = 8 marks)

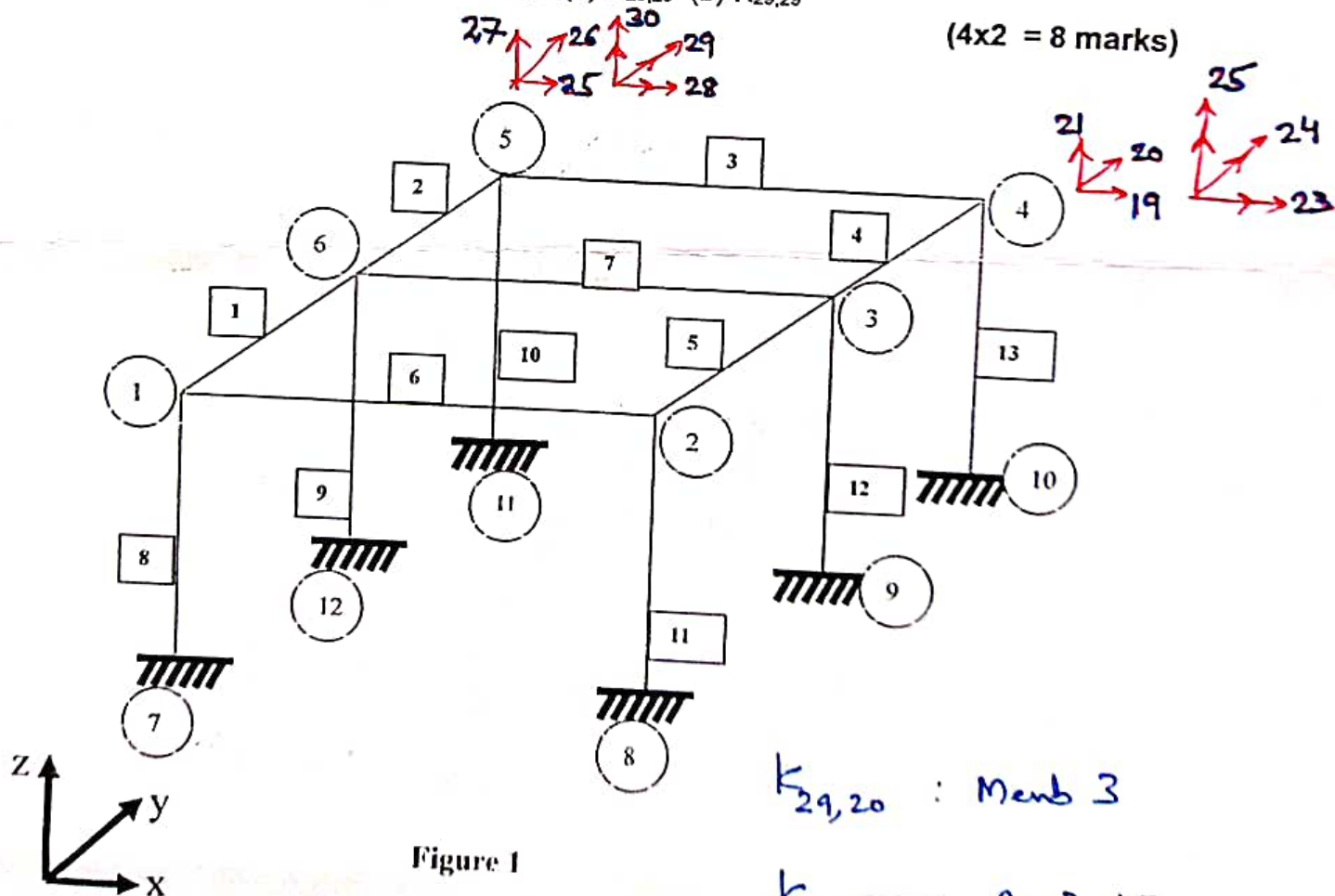
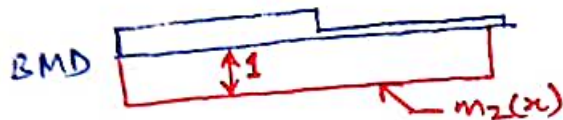
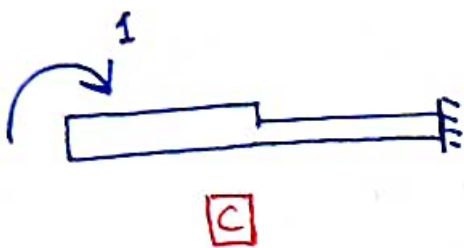
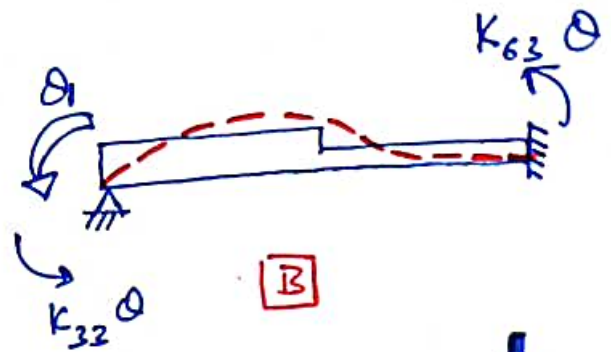
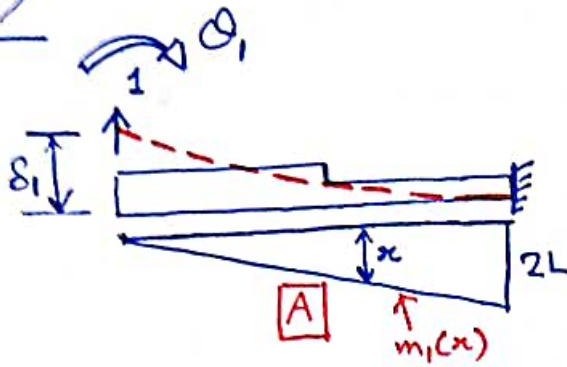


Figure 1

$K_{29,20}$: Memb 3

$K_{29,29}$: 2, 3, 10

Q(3)



Formulations

Final sol. = A + B.

$$S_1 = \int_0^{2L} \frac{m_1(x)^2}{EI} dx$$

$$= \int_0^L \frac{x^2}{2EI} dx + \int_L^{2L} \frac{x^2}{EI} dx$$

$$= \frac{5}{2} \frac{L^3}{EI}$$

$$\theta_1 = \int_0^{2L} \frac{m_1(x) m_2(x)}{EI} dx$$

$$= \int_0^L \frac{x}{2EI} dx + \int_L^{2L} \frac{x}{EI} dx$$

$$= \frac{7}{4} \frac{L^2}{EI}$$

Superimpose A & B -

$$F = \text{Total force} = 1 + \frac{(k_{22} + k_{62}) \theta}{2L}$$

$$= 1 + \left(\frac{8EI}{L^2} + \frac{12EI}{L^2} \right) \cdot \frac{7}{4} \frac{L^2}{EI}$$

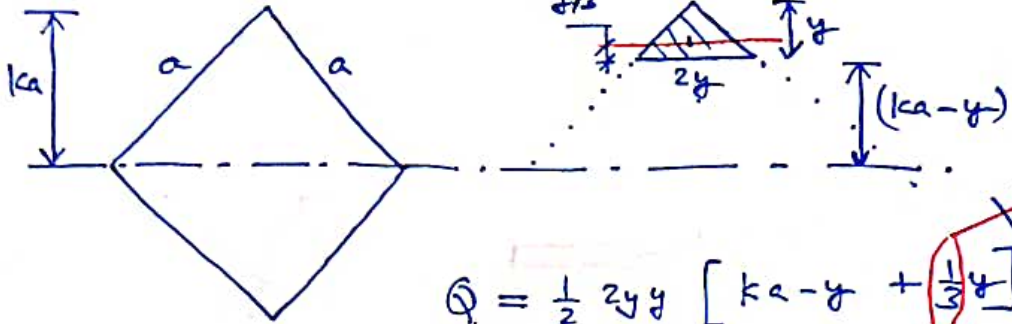
$$F = 18.5$$

By def:

$$k_{22} = \frac{F}{\delta_1} = \frac{36}{\frac{5}{2} \frac{L^3}{EI}} = \frac{37}{5} \left(\frac{EI}{L^3} \right)$$

Q(4)

$$k = \frac{1}{\sqrt{2}}$$



$$Q = \frac{1}{2} 2y y \left[ka - y + \frac{1}{3} y \right]$$

$$Q = y^2 \left[ka - \frac{2}{3} y \right]$$

$$= y^2 (ka - py)$$

Let $\frac{2}{3} = p$

$$\frac{Q}{b} = \frac{y^2 (ka - py)}{2y} = \frac{y}{2} [ka - py]$$

$$\frac{Q^2}{b^2} = \frac{y^2}{4} [k^2 a^2 + p^2 y^2 - 2kapy]$$

$$\int_A \frac{Q^2}{b^2} dA = 2 \int_{y=0}^{y=ka} \frac{y^2}{4} [k^2 a^2 + p^2 y^2 - 2kapy] (2y dy)$$

$$= \int_0^{ka} \left(\frac{k^2 a^2}{2} y^3 + \frac{p^2}{2} y^5 - kapy^4 \right) dy$$

$$= \left[\frac{k^2 a^2 y^4}{4} + \frac{p^2 y^6}{6} - \frac{2}{5} kapy^5 \right]_0^{ka}$$

$$= 0.00717125 a^6$$

$$\frac{A}{I^2} = \frac{a^2}{\frac{1}{12} a^4} = \frac{144}{a^6}$$

$$\therefore S = \frac{A}{I^2} \int \frac{Q^2}{b^2} dA = \underline{1.0326}$$