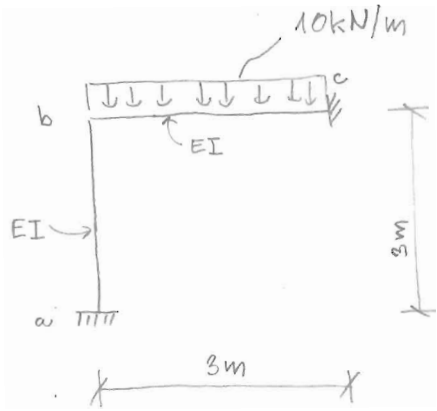
okAgenda

Subject: FRAME FULL/PARTIAL RELEASES, PANEL ZONES, SUPPORT SPRINGS

Subtask:

Prepared by: ok Date: 4/22/2011

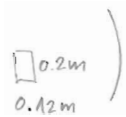
Sheet No. 1 of



$EI = 2400\ kNm^2$

$E = 30\ GPa$

$I = \frac{1}{12}(0.12m)(0.2m)^3 = 8\times10^{-5}\ m^4$

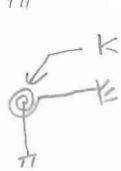


(rotation at joint b) ✓

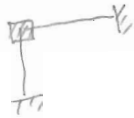
Goal: Determine the response of the above structure for different types of frame releases.

Model 1 - fully fixed 

Model 2 - beam fully released at column 

Model 3 - beam partially released at column 

Model 4 - rotational spring at right support 

Model 5 - panel zone at beam column intersection 

okAgenda

Subject:

Subtask:

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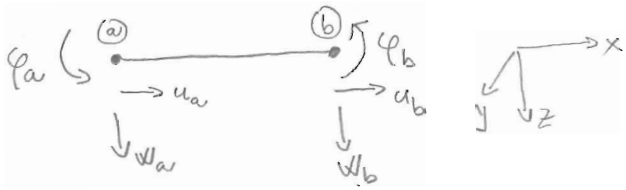
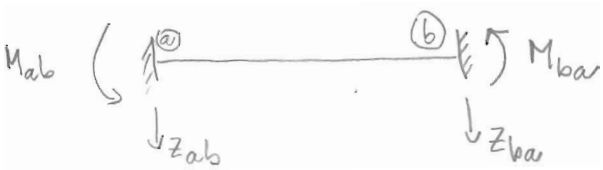
Sheet No. 2 of

Conventions and Formulas for stiffness method



Fixed End Moments



$$M_{ab} = \overline{M_{ab}} + \frac{2EI}{L}\left(2\varphi_a + \varphi_b + 3\frac{w_b - w_a}{L}\right)$$

$$M_{ba} = \overline{M_{ba}} + \frac{2EI}{L}\left(2\varphi_b + \varphi_a + 3\frac{w_b - w_a}{L}\right)$$

okAgenda

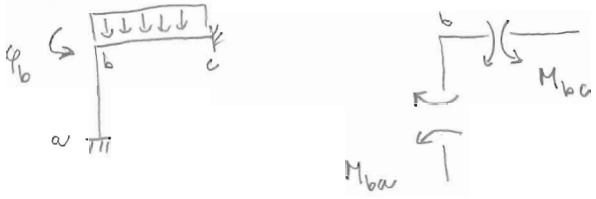
Subject:

Subtask:

Prepared by: ok Date: 4|22|2011

Sheet No. 3 of

Model 1



$$M_{ba} + M_{bc} = 0$$

$$M_{ba} = \overline{M}_{ba} + \frac{2EI}{L} 2\varphi_b = 0 + \frac{4EI}{L}\varphi_b = 3200\,\varphi_b \quad [kN\text{-}m]$$

$$M_{bc} = \overline{M}_{bc} + \frac{2EI}{L} 2\varphi_b = \frac{fL^2}{12} + \frac{4EI}{L}\varphi_b = 7.5 + 3200\,\varphi_b \quad [kN\text{-}m]$$

$$3200\,\varphi_b + 7.5 + 3200\,\varphi_b = 0$$

$$\varphi_b = -0.001172 \text{ rad}$$

(matches SAP2000)

okAgenda

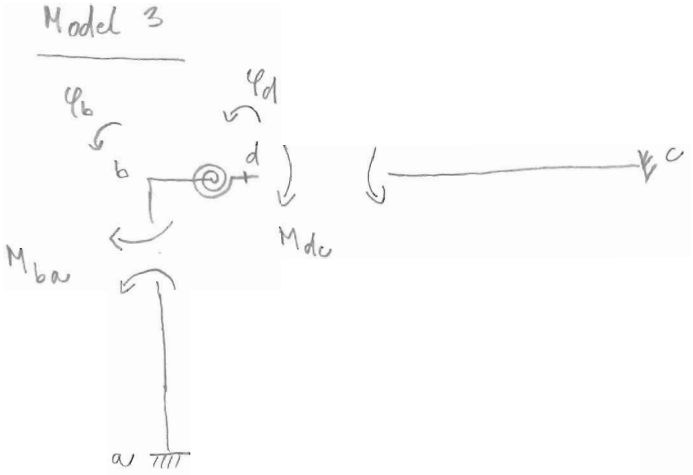
Subject:

Subtask:

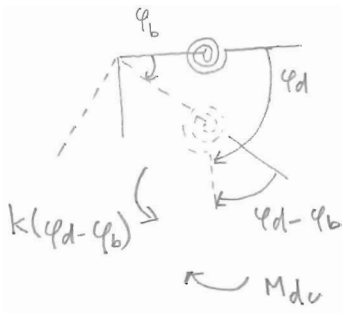
Prepared by: ok Date: 4/22/2011

Sheet No. 4 of

Model 3



$M_{dc} + M_{ba} = 0$



$k(\varphi_d - \varphi_b) + M_{dc} = 0$

$M_{ba} = 3200\ \varphi_b$ [kN-m]

$M_{dc} = 7.5 + 3200\ \varphi_d$ [kN-m] } from model 1

$M_{ba} + M_{dc} = 0$

$k(\varphi_d - \varphi_b) + M_{dc} = 0$

$3200\varphi_b + 7.5 + 3200\varphi_d = 0$

$200(\varphi_d - \varphi_b) + 7.5 + 3200\varphi_d = 0$

① $3200\varphi_b - 3200\varphi_d = -7.5$ | + 16 × ②

② $-200\varphi_b + 3400\varphi_d = -7.5$

$\varphi_d = \frac{-127.5}{57600} = -0.002213$ rad

from ①: $\varphi_b = \frac{-7.5 - (3200)(-0.002213)}{3200} =$

$= -0.0001308$ rad

(matches SAP2000)

okAgenda

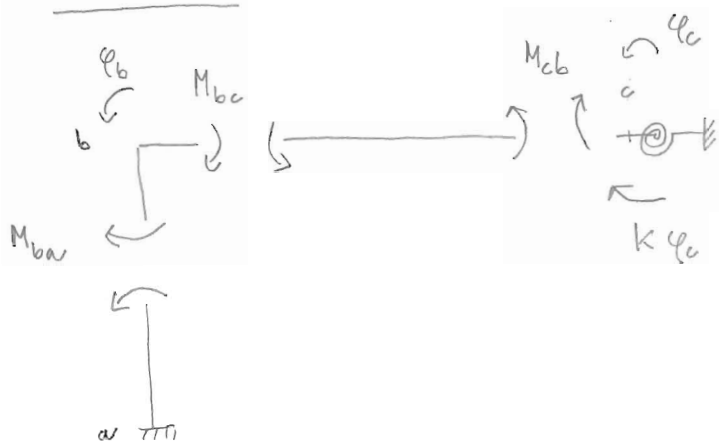
Subject:

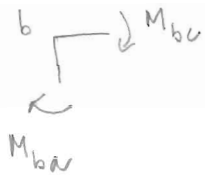
Subtask:

Prepared by: ok Date: 4/22/2011

Sheet No. 5 of

Model 4





$$M_{ba} = \cancel{\bar{M}_{ba}} + \frac{2EI}{L}(2\varphi_b + \cancel{\varphi_a}) = 3200\,\varphi_b \quad [kN\text{-}m]$$

$$M_{bc} = \bar{M}_{bc} + \frac{2EI}{L}(2\varphi_b + \varphi_c) = 7.5 + 3200\,\varphi_b + 1600\,\varphi_c \quad [kN\text{-}m]$$

$$M_{cb} = \bar{M}_{cb} + \frac{2EI}{L}(2\varphi_c + \varphi_b) = -7.5 + 3200\,\varphi_c + 1600\,\varphi_b \quad [kN\text{-}m]$$

$$3200\,\varphi_b + 7.5 + 3200\,\varphi_b + 1600\,\varphi_c = 0$$

$$-7.5 + 3200\,\varphi_c + 1600\,\varphi_b + 200\,\varphi_c = 0$$

(1) $6400\,\varphi_b + 1600\,\varphi_c = -7.5$ $\quad | - 4\times(2) \rightarrow -12000\,\varphi_c = -37.5$

(2) $1600\,\varphi_b + 3400\,\varphi_c = 7.5$

$\varphi_c = 0.003125$ rad

from (2): $\varphi_b = \dfrac{7.5 - (3400)(0.003125)}{1600} =$

$= -0.001953$ rad

(matches SAP2000)