okAgenda	
	Subject: TEST PROBLEMS – JOINT OFFSETS, TRANSFORM STIFFNESS
	Subtask:
	Prepared by: ok Date: 10/29/2008
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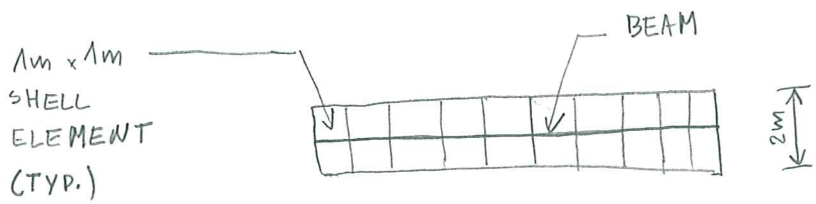
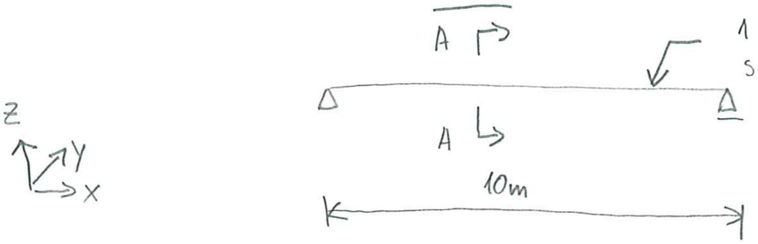
OBJECTIVE: DEMONSTRATE THE END OFFSETS AND TRANSFORM STIFFNESS FEATURES OF SAP2000

MODEL SKETCH:



PLAN



1 BEAM 0.1m DEEP, 2m WIDE
SHELL ELEMENTS 0.1m THICK

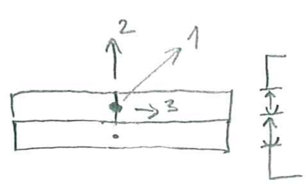
} BOTH DRAWN AT THE MIDHEIGHT OF THE SHELL ELEMENTS

AVAILABLE DOFS:
UX, UZ, RY

ELEVATION

$\rho = 2500\ kg/m^3$

$E = 30 \times 10^9$ MPa



SHELLS 0.1m

BEAM 0.1m – INSERTION POINT = CENTROID
END OFFSET = −0.1m IN 2 direction

SECTION A-A
(ACTUAL STRUCTURE)

Analyze the following 2 cases:

case A : Transform stiffness for frame element

case B : Do not transform stiffness for frame element

check deflection at the mid span

Theoretical Solution

$$\Delta = \frac{5}{384} \frac{wL^4}{EI}$$

CASE A

$$w = A_S\, g = (0.2\text{ m DEEP})(2\text{ m WIDE})(2500\text{ kg/m}^3)(9.81\text{ m/s}^2) =$$

$$= 9810\text{ N/m}$$

$$I = \frac{1}{12}(2\text{m})(0.2\text{m})^3 = \frac{4}{3}\times 10^{-3}\text{ m}^4$$

$$\Delta = \frac{5}{384}\frac{wL^4}{EI} = \frac{5}{384}\frac{9810\text{ N/m}\ (10\text{m})^4}{(30\times 10^9\text{ Pa})(\frac{4}{3}\times 10^{-3}\text{ m}^4)} = 0.031934\text{ m}$$

CASE B

w same as for case A, but $I = 2\times\frac{1}{12}(2)(0.1)^3 = \frac{4}{3}\times 10^{-4}\text{ m}^4$

$$\Delta = \frac{5}{384}\frac{9810\text{ N/m}\ (10\text{m})^4}{(30\times 10^9\text{ Pa})(\frac{10}{3}\times 10^{-4}\text{m}^4)} = 0.127734\text{ m}$$

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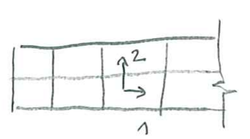
SAP2000 Results

	beam insertion point	end offsets in 2 direction	transform stiffness	midspan deflection
case A	10 (centroid)	-0.075m	YES	-0.0326m
case B	10 (centroid)	-0.075	NO	-0.12468m

check the following forces:

P, M3 in frame elements

F11, M11 in shell elements ...



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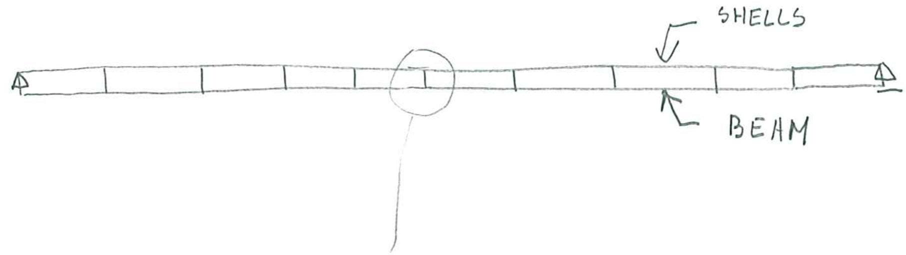
$$M_{max} = \frac{wL^2}{8} = \frac{(9810\ N/m)(10\ m)^2}{8} = 122.625\ kNm$$

CASE A:



(shell forces are similar to beam forces)

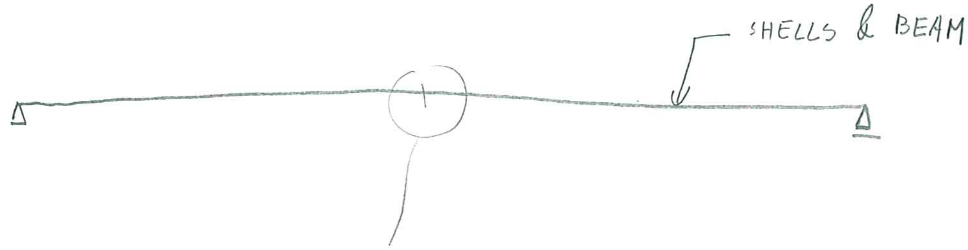
899 kN (axial force carried by beam)

15.8 kN-m (moment carried by beam)

Total moment:

$$M = \underbrace{15.8\ kN\text{-}m}_{Beam} + \underbrace{15.8\ kN\text{-}m}_{shell} + \underbrace{(899\ kN)(0.1m)}_{moment\ arm} = \underline{\underline{121.5\ kN\text{-}m}}$$

CASE B:



→ ϕ ... no axial force in shell or beam

59.86 kN-m ... moment carried by the beam (shell moment similar)

Total moment:

$$M = \underbrace{59.86\ kN\text{-}m}_{beam} + \underbrace{59.86\ kN\text{-}m}_{shell} = \underline{\underline{119.72\ kN\text{-}m}}$$