Computational Structural Mechanics and Dynamics

Beams HomeWork

GiD + MATLab

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MS-Computational Mechanics

Assignment (Problem Data-a)

Assignment

a) Program In Mat Lab the Timoshenko 2 Nodes Beam element with reduce integration for the shear stiffness matrix

$$\mathbf{K}_b^{(e)} = \left(\frac{EI}{l}\right)^{(e)} \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 \end{bmatrix} \text{(The point interpolation is exact for } \mathbf{K}_b^{(e)}\text{)}$$

$$\mathbf{K}_s^{(e)} = \left(\frac{GA^*}{l}\right)^{(e)} \begin{bmatrix} 1 & \frac{l^{(e)}}{2} & -1 & \frac{l^{(e)}}{2} \\ \cdots & \frac{(l^{(e)})^2}{4} & \frac{l^{(e)}}{2} & \frac{(l^{(e)})^2}{4} \\ & \cdots & 1 & -\frac{l^{(e)}}{2} \\ \text{Simetr.} & & \cdots & \frac{(l^{(e)})^2}{4} \end{bmatrix} \text{(Reduced integration)}$$

Hint: For stress evaluation make gaus1 = gaus2 = 0.0

Simulation Results

Instead of 2 guas points, the results are obtained with single guas point. The simulation are carried out for varying geometry of beam (from a = 0.001 to a = 0.4) with three different types of mesh

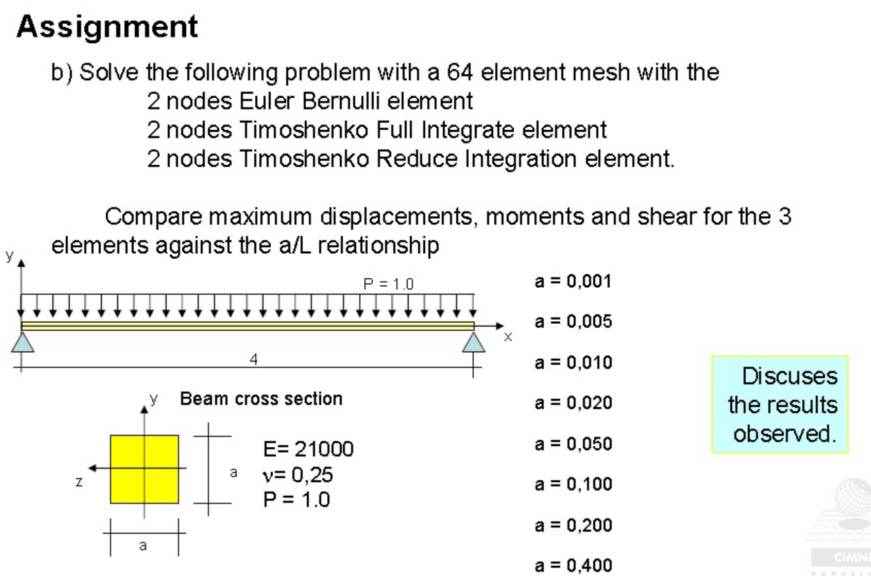
1. 2 nodes Euler Bernoulli Elements
2. 2 nodes Timoshenko Full Integrated Elements
3. 2 nodes Timoshenko Reduced Integrations Elements

The maximum values of displacement and bending moment in each of the 3 cases are presented at 2 extreme values of geometry. The results are presented in the table below.

Geometry	Simulation Scheme	Maximum Displacement	Maximum Bending Moment
a = 0.001	Euler Bernoulli Elements	-1907.4	2.0019
	Timoshenko Full Integrated Elements	-828.34	0.86903
	Timoshenko Reduced Integrations Elements	-1907	2.001
a = 0.4	Euler Bernoulli Elements	-0.016667	2.7999
	Timoshenko Full Integrated Elements	-0.017606	2.7896
	Timoshenko Reduced Integrations Elements	-0.01766	2.7986

This can be seen that when beam is think at a = 0.001, the Full Integrated Timoshenko scheme does not predict accurate value of deflection (it shows very less than the actual displacement value) while Reduced scheme gives accurate results.

Assignment (Problem Data-b)



Simulation Results

The problem data given above is used to modify the code accordingly and simulation results are compared for all 3 cases and comparison are drawn by the help of graphs, presented below.

a) Max Displacement vs. a/L

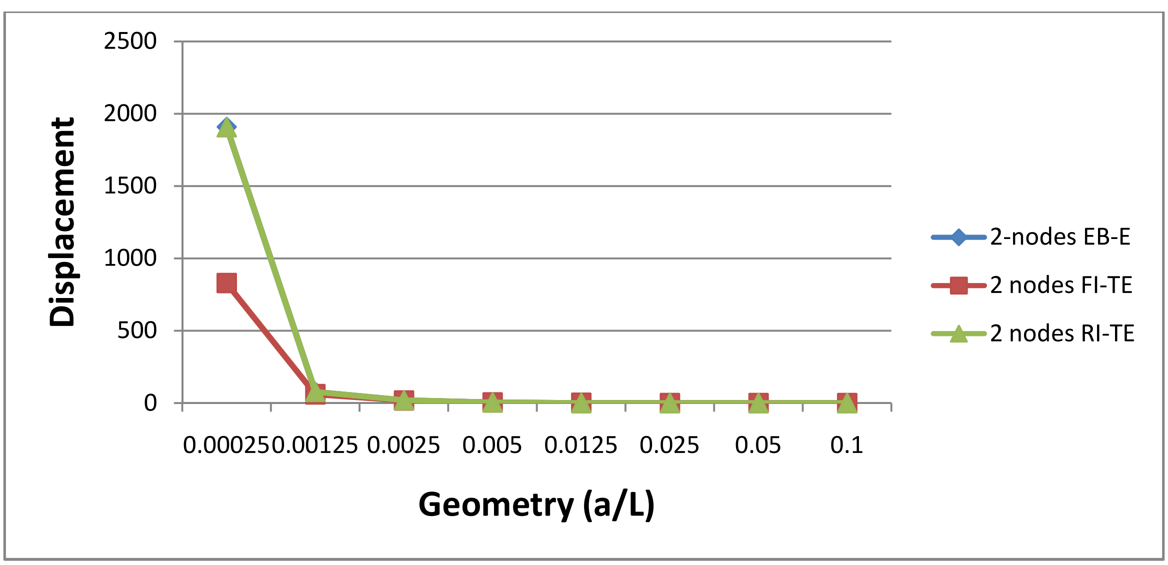


Figure 1 Comparison of displacement

When beam is thin, fully integrated Timoshenko elements cannot predict the displacement accurately as compared to the other schemes. And this inaccuracy decreases as the beam cross section changes from thin to thick beam. When beam is thick, all schemes behave the same way. This can be seen in figure-1.

b) Max Bending Moment vs. a/L

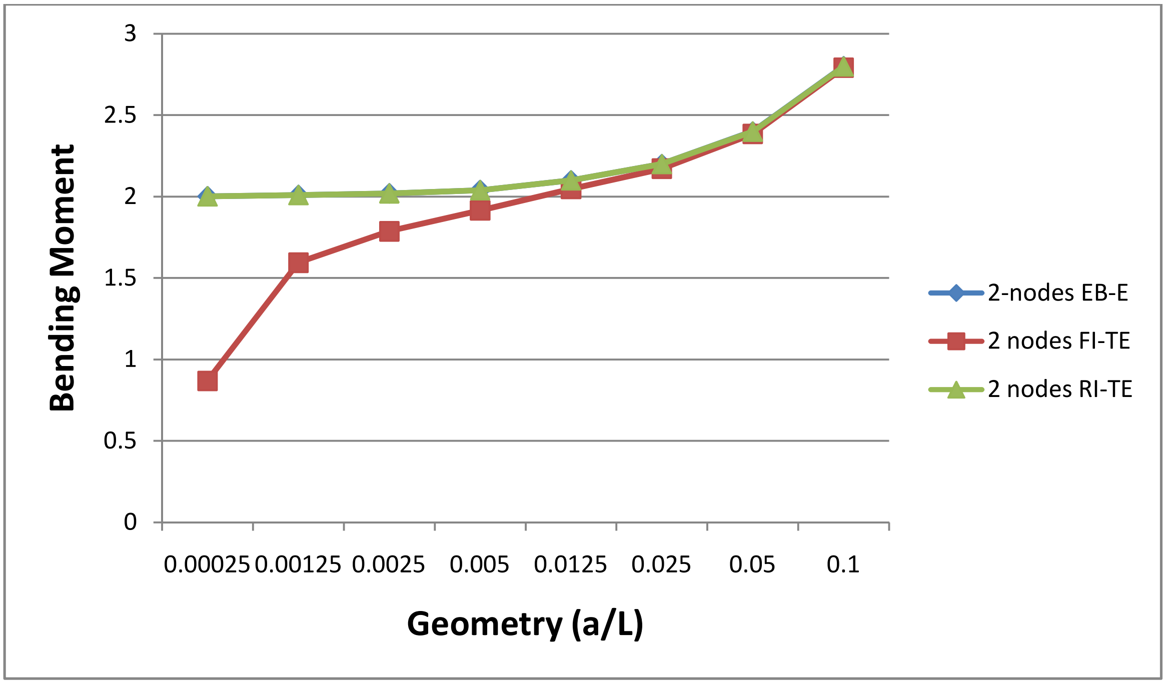


Figure 2 Comparison of bending moment

Same as the displacement, fully integrated Timoshenko element does not provide accurate results when beam is thin. It shows less bending moment than the actual value whiles the other 2 schemes provides accurate results. This is due shear locking effect which should be kept in consideration for thin beams. As the beam becomes thicker all the schemes behave similar.

c) Max Shear Stress vs. a/L

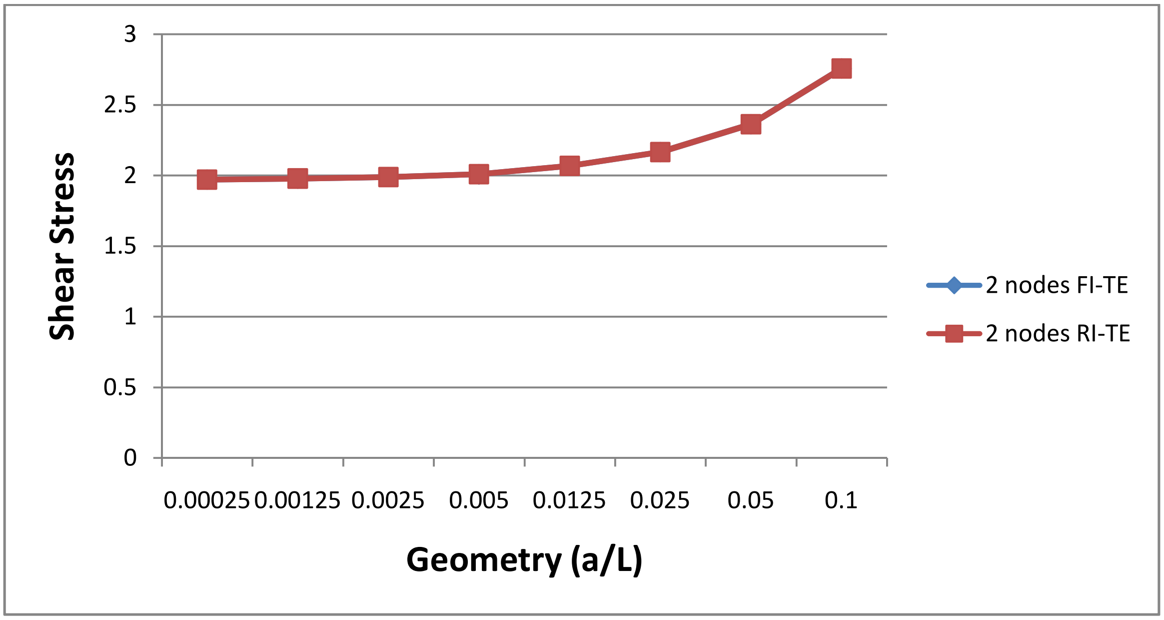


Figure 3 Comparison of shear stress

Shear stress is compared for both Timoshenko elements only because Euler Bernoulli cannot predict shear stress in beams. Both fully integrated and reduced integrated Timoshenko elements behave exactly the same.