Computational Structural Mechanics and Dynamics (Assignment-6 (Beams))

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(a) In first part of the question, we are required to modify the K_s^e to implement reduced integration case. Given below is the modified part of the code.

```
const = D_mats/len;

K_s = [   1    ,   len/2 ,   -1    ,   len/2 ;
        len/2 , len^2/4 , -len/2 , len^2/4 ;
         -1    ,  -len/2 ,    1    ,  -len/2 ;
        len/2 , len^2/4 , -len/2 , len^2/4 ];

K_s = K_s * const;
```

Figure 1: Matlab program for timoshenko reduced integration element

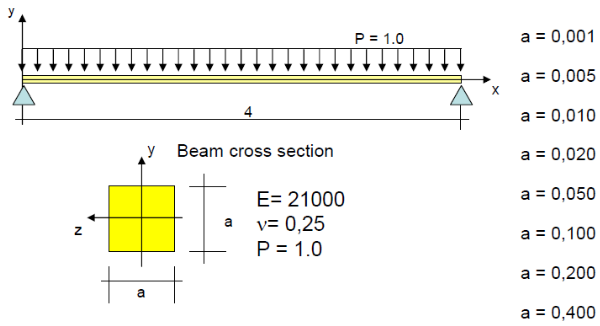

Figure 2: Displacement(3-noded tri element)

(b) In second part, firstly, the beam geometry, properties, loads and constraints are specified for 8 different cross-section, as per the question, in the GiD- MatFem Interface and an input file is generated which act as an input for Euler, Timoshenko full and reduced integration elements Matlab program. Finally, the max. displacement, max. shear and max. moment values are identified among 65 nodes (64-element mesh as per the question) and "Max. disp. Vs a/L", "Max. moment Vs a/L", "Max. shear force Vs a/L" graphs are plotted for comparison of Euler Bernoulli, timoshenko full and reduced integration elements.

		Timoshenko Full-Int.			Timoshenko Reduced Integration			Euler Bernoulli		
	a/L	Displacement	Shear	Moment	Displacement	Shear	Moment	Displacement	Shear	Moment
1.	0.001	2.92E+05	1.97E+00	9.76E-04	3.81E+08	1.97E+00	1.27E+00	3.81E+08	2.00E+00	1.31E+00
2.	0.005	8.48E+03	1.97E+00	2.40E-02	6.09E+05	1.97E+00	1.27E+00	6.10E+05	2.00E+00	1.31E+00
3.	0.01	2.72E+03	1.97E+00	9.07E-02	3.81E+04	1.97E+00	1.27E+00	3.81E+04	2.00E+00	1.31E+00
4.	0.02	5.60E+02	1.97E+00	2.99E-01	2.38E+03	1.97E+00	1.27E+00	2.38E+03	2.00E+00	1.31E+00
5.	0.05	4.02E+01	1.97E+00	8.36E-01	6.10E+01	1.97E+00	1.27E+00	6.10E+01	2.00E+00	1.31E+00
6.	0.1	3.396e+00	1.97E+00	1.13E+00	3.83E+00	1.97E+00	1.27E+00	3.81E+00	2.00E+00	1.31E+00
7.	0.2	2.38E-01	1.97E+00	1.23E+00	2.45E-01	1.97E+00	1.27E+00	2.38E-01	2.00E+00	1.31E+00
8.	0.4	1.65E-02	1.97E+00	1.26122	1.67E-02	1.97E+00	1.27E+00	1.49E-02	2.00E+00	1.31E+00

Figure 3: Maximum displacement Vs a/L Plot

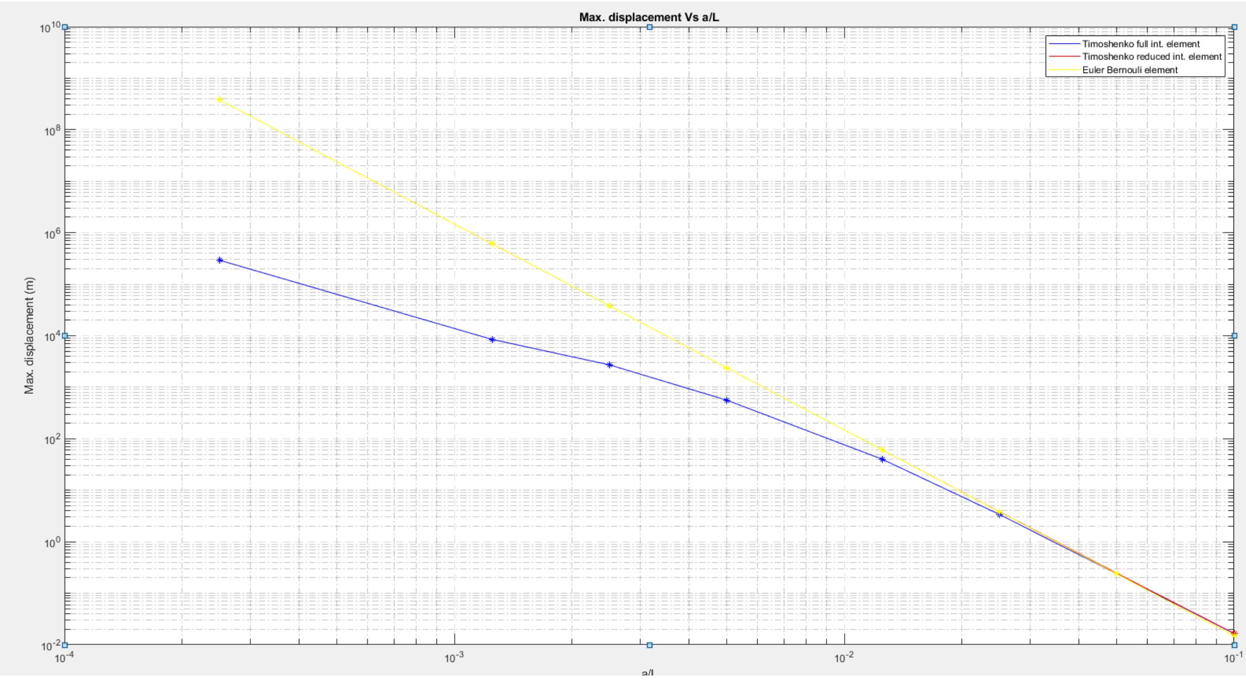

Figure 4: Maximum displacement Vs a/L Plot

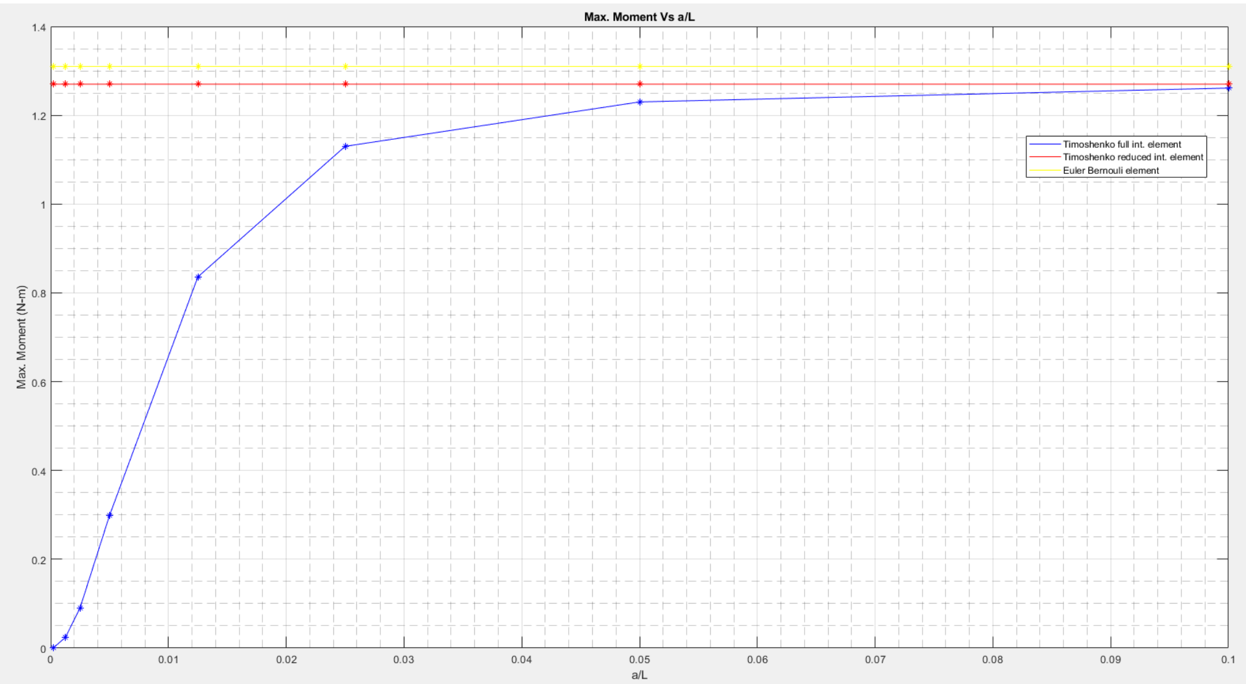

Figure 5: Maximum moment Vs a/L Plot

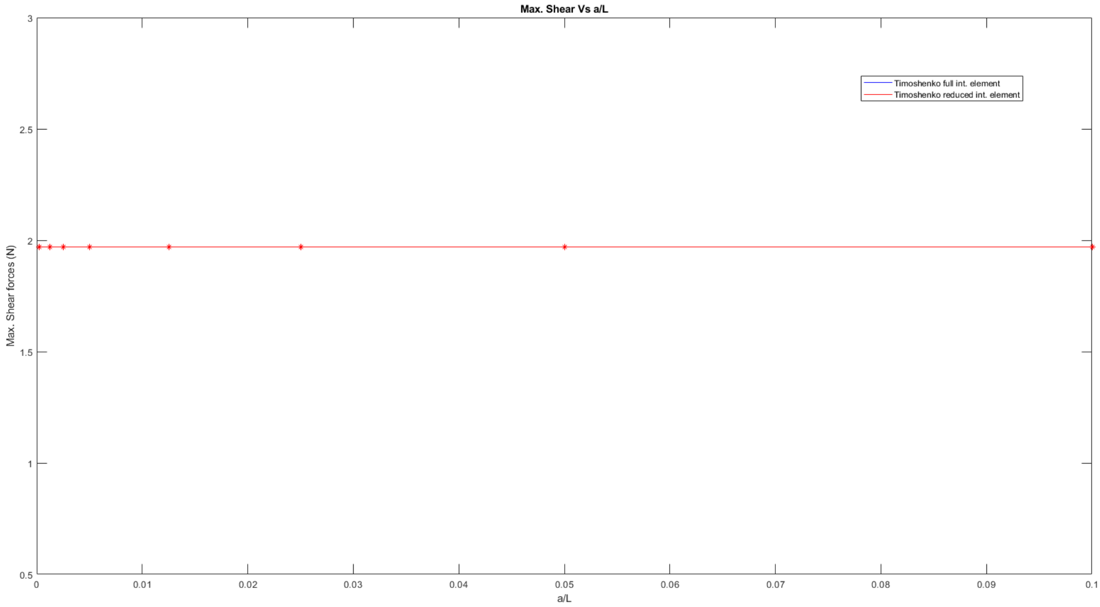

Figure 6: Maximum Shear Vs a/L Plot

Conclusions:
1) It can be interpreted from max. displacement Vs a/L that timoshenko full integration model gives accurate results for thick beams, while for thin beams, the accuracy decreases gradually. On contrast, Timoshenko reduced integration element produces accurate results and it's max. disp. Vs a/L plot coincides with that of Euler-Bernoulli elements.
2) Similarly, for thin beams the Timoshenko full integration model produces inaccurate results for moment Vs a/L plot. Therefore, Timoshenko reduced integration model is preferred which produces max. moment values approximate to euler beam elements.
3) Euler-Bernoulli Beams does not takes into account the deformations due transverse shear forces. In this condition, Timoshenko theory is considered. Both timoshenko full and reduced integration model produces same results.