**Straight cantilever beam**

The beam problem illustrated in Fig. 1 was modeled using varying number of two-node elements. This can be considered as a convergence test. Four different types of loadings are employed discretely at the free end i.e. extension, in-plane shearing, out-of-plane shearing and twisting moment.

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Figure 1. Straight cantilever beam 1

Length L = 6.0; height h = 0.2; thickness t = 0.1; E = 1.0 x 107;

ν = 0.3. Loading P = unit forces at free end.

The exact displacement for extension, in-plane shear, out-of-plane shear and torsion in the direction of load for the above beam is given below for comparison purpose.

(a) Extension:  (1.1)

(b) In-plane shear:  (1.2)

(c) Out-of-plane shear:  (1.3)

(d) Torsion: **  (1.4)

The results obtained from **XFRAME** are compared with the above analytical solution in table 1.

|  |  |  |  |
| --- | --- | --- | --- |
| Problem | Tip load  direction | Displacement in direction of load | |
| Exact | **XFRAME** |
| Straight- beam 1 | Extension | 0.00003 | 0.00003 |
| In-plane shear | 0.10800 | 0.1081 |
| Out-of-plane  shear | 0.43200 | 0.4321 |
| Torsion | 0.034243 | 0.03334 |

Table 1. Theoretical and FEM solutions for beam problems