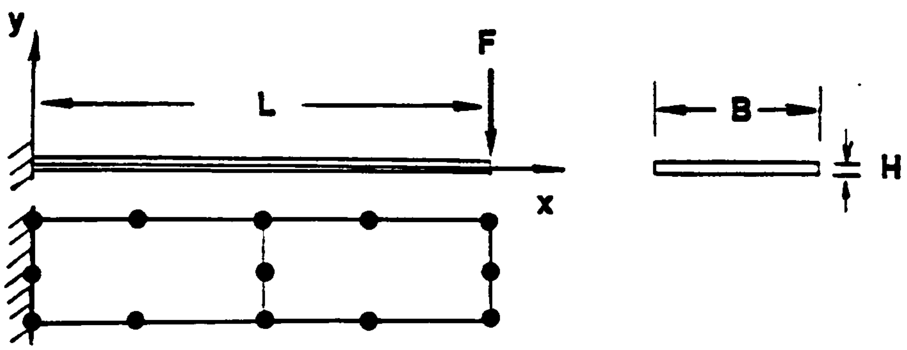
6.2 *PROBLEM 1: CANTILEVER PLATE*

One of the major goals of this work is to obtain reasonable distribution of shear stress through the plate/shell thickness. Another major goal of this work is to prove and to obtain the transverse normal stress. To demonstrate the achievements of these two goals, several example problems are presented here.

A. Isotropic cantilever plate with concentrated load at free end

The geometry, material property and loading condition of an isotropic cantilever plate are shown in the figure below.



L=4″ H=0.1″ B=1.0″ E=1.0x10⁷ psi ν =0.0 F=-30.0lb

The analytical solution from [61], and the results of the first-order shear deformation theory (FSDT) and current theory are plotted in Figure 6.1. From this plot it is clear that current solution yields compatible analytical shear stress, which is a great improvement over the FSDT solution. The excellent agreement between current work and analytical solution (see Table 6.1) verifies the formulation of the linear stiffness matrix derived in this work.

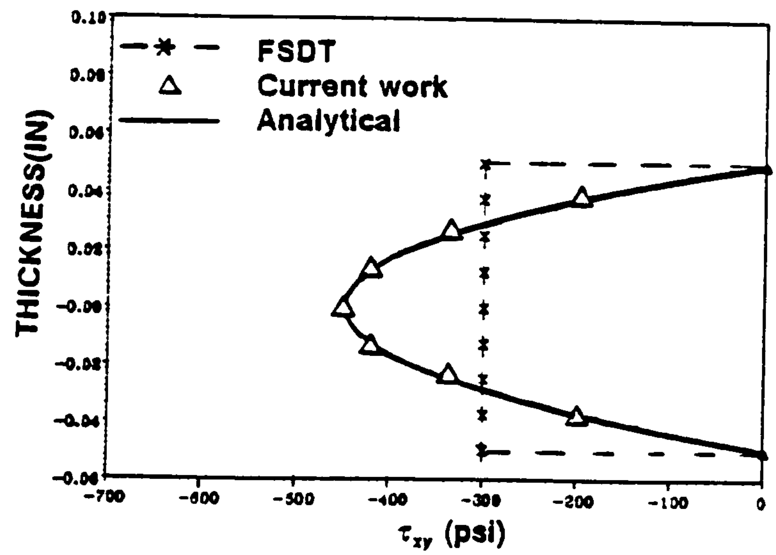


Figure 6.1 Shear stress distribution

Table 6.1 Stresses of a Cantilever Plate

x	y	σ_x (psi)		τ_{xy} (psi)	
		Exact	FEM	Exact	FEM
0.0	0.050	72000.00	72001.75	0.00	0.00
	0.025	36000.00	36000.87	-337.50	-337.51
	0.000	0.00	0.00	-450.00	-450.01
	-0.025	-36000.00	-36000.87	-337.50	-337.51
	-0.050	-72000.00	-72001.75	0.00	0.00
2.0	0.050	36000.00	36000.39	0.00	0.00
	0.025	18000.00	18000.19	-337.50	-337.50
	0.000	0.00	0.00	-450.00	-450.01
	-0.025	-18000.00	-18000.19	-337.50	-337.50
	-0.050	-36000.00	-36000.39	0.00	0.00

X	Y	STRESS XX [Psi]					
		Exact [61]	FEM [1]	Ccx STATIC "LAMINATED"	Ccx STATIC ISOTROPIC	Ccx NonLinear Quasi-static "LAMINATED"	Ccx NonLinear Quasi-static ISOTROPIC
	0,05	72.000	72.002	71.998	71.999	70.865	70.525
	0,025	36.000	36.001	35.998		35.247	
0	0,0	-	-	- 1	2	- 370	-0.1
	-0,025	- 36.000	- 36.001	- 36.001		- 35.249	
	-0,05	- 72.000	- 72.002	- 72.002	- 71.999	- 70.131	- 70.525
	0,05	36.000	36.000	35.999	35.999	33.270	33.208
	0,025	18.000	18.000	17.999		16.562	
2	0	-	-	- 1	2	- 145	- 62
	-0,025	- 18.000	- 18.000	- 17.999		- 16.688	
	-0,05	- 36.000	- 36.000	- 35.999	- 35.999	- 33.232	- 33.332
Mesh		2x1 Q8		4x1*2L S8R	8x1 S8R	4x1*2L S8R	8x1 S8R

X	Y	SHEAR XY [Psi]					
		Exact [61]	FEM [1]	Ccx STATIC "LAMINATED"	Ccx STATIC ISOTROPIC	Ccx NonLinear Quasi-static "LAMINATED"	Ccx NonLinear Quasi-static ISOTROPIC
	0,05	0	0	-300	-300	-1.468	-644
	0,025	-338	-338	-300	-300	-882	
0	0,0	-450	-450	-300	-300	-297	-301
	-0,025	-338	-338	-300	-300	271	
	-0,05	0	0	-300	-300	840	41
	0,05	0	0	-300	-300	-7.602	-7.464
	0,025	-338	-338	-300	-300	-3.936	
2	0	-450	-450	-300	-300	-270	-288
	-0,025	-338	-338	-300	-300	3.358	
	-0,05	0	0	-300	-300	6.986	6.886
Mesh		2x1 Q8		4x1*2L S8R	8x1 S8R	4x1*2L S8R	8x1 S8R

[1] LARGE DEFORMATION ANALYSIS OF LAMINATED COMPOSITE STRUCTURES BY A CONTINUUM-BASED SHELL ELEMENT WITH TRANSVERSE DEFORMATION . Pey M. Wung

[61] Timoshenko S. and Young D.H., Elements of Strength of Materials, 5th editon,1968.