1. Figure 3.2.1 shows the pin-ended cross model. The model is modeled with 4 elements per arm.

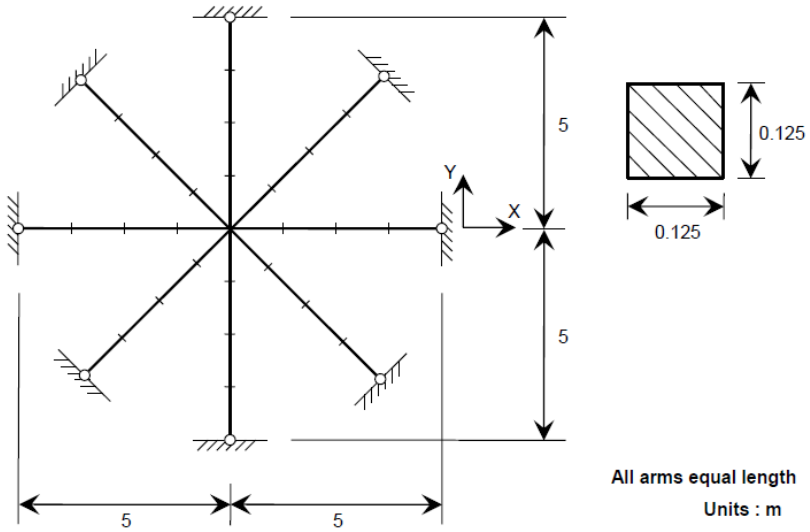


Figure 3.2.1 Pin-ended double cross model

Material data	Young's modulus Density	*E = 200 GPa* $\rho = 8000\ kg/m^3$
Section property	Square cross-section	*0.125 m × 0.125m*

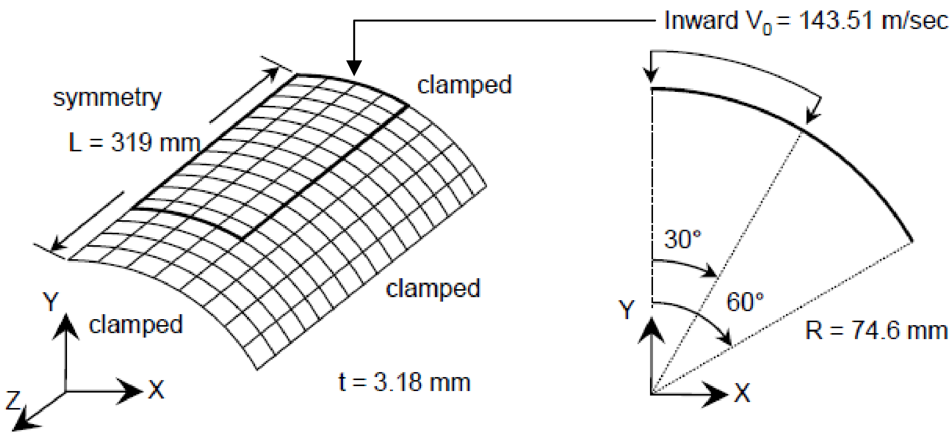
(1) Create the finite element model and find the natural frequencies and mode shapes (1st ~ 5th).

① 4 beam elements (10 pts)

② 4 solid elements (10 pts)

(2) Increase the number of divisions twice and three times, and repeat the problem (1). Graph the natural frequencies (1st ~ 5th) versus the number of elements and make a discussion. (5 pts each)

2. A clamped cylindrical shell panel is exposed to sudden velocity condition to simulate explosive load by detonation. Half of the panel is discretized by quadrilateral shell elements with symmetric condition imposed on one end. A von Mises elastic, perfectly plastic material model is used.



Material data	Young's modulus	$E = 72.4 \times 10^3\ N/mm^2$
	Poisson's ratio	$\nu = 0.33$
	Density	$\rho = 2.672 \times 10^{-6}\ kg/mm^3$
	Perfect plasticity	$\sigma_Y = 303\ N/mm^2$
Section property	Thickness	$t = 3.18\ mm$

(1) Create finite element model as follows and find the maximum deflection (y-direction).

① 8 by 16 shell elements (15 pts)

② 16 by 32 shell elements (15 pts)

③ 32 by 64 shell elements (15 pts)

(2) Graph the result and make a discussion. (15 pts)

(Hint: Using the initial velocity menu. The direction of the velocity is -x direction)