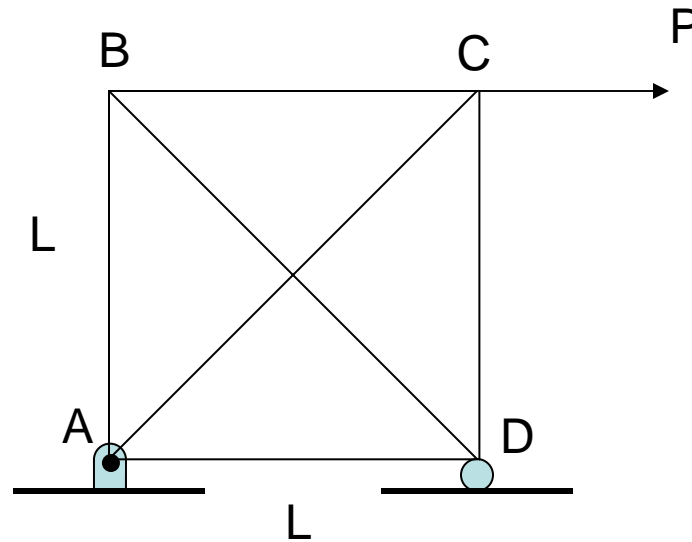
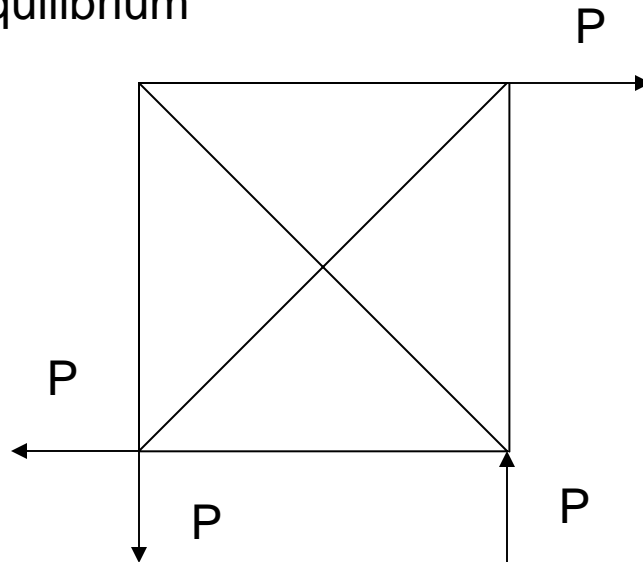


Statically Indeterminant Truss

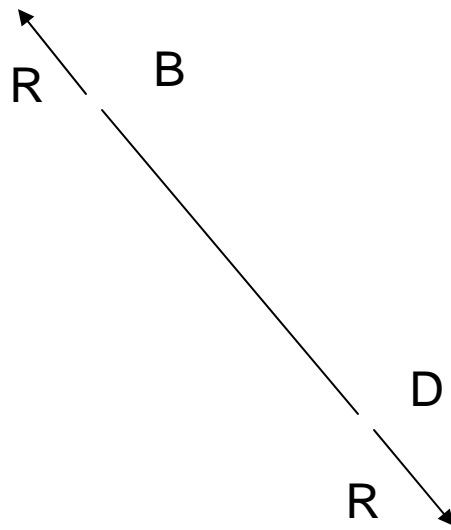
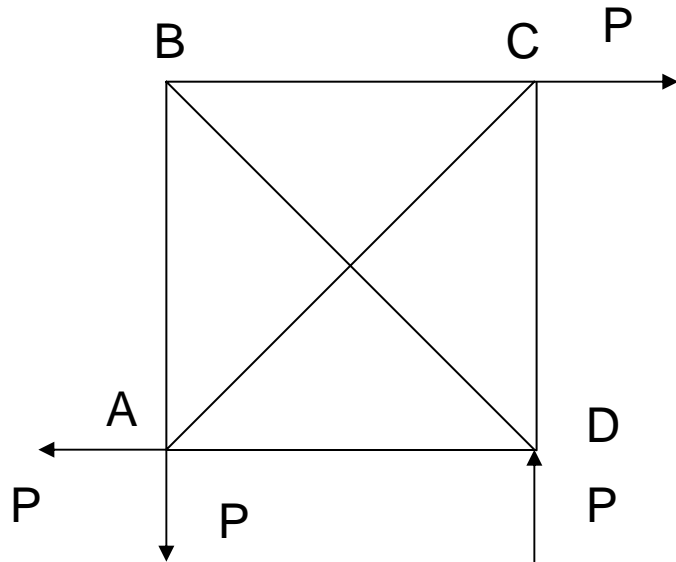


Overall Equilibrium

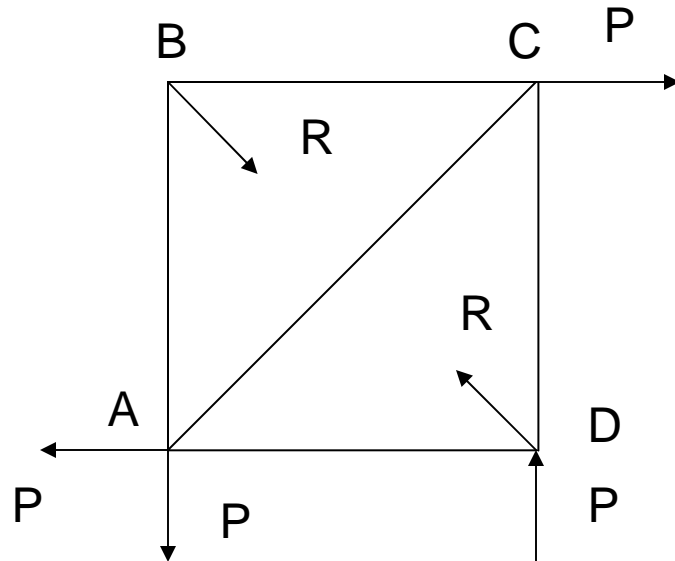


We can find all the external reactions but the truss is still statically indeterminant since there are too many members to solve for all the forces

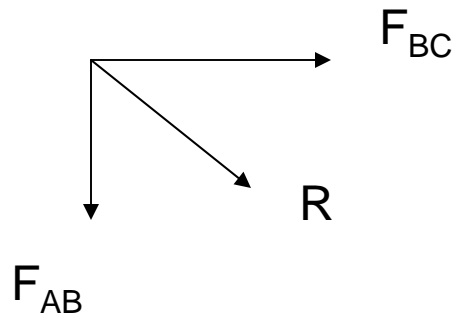
Take out, for example, BD



Then for the remaining truss we can solve for all the forces in terms of P and R . R is our redundant force



For example, at B



$$\sum F_x = 0$$

$$F_{BC} = -\frac{R\sqrt{2}}{2}$$

$$\sum F_y = 0$$

$$F_{AB} = -\frac{R\sqrt{2}}{2}$$

Now, for the entire truss

$$U = \sum_{i=1}^6 \frac{F_i^2 L_i}{2A_i E_i} \quad \text{where we will take} \quad \begin{aligned} A_i &= A \\ E_i &= E \end{aligned}$$

From the Principle of Least Work

$$\frac{\partial U}{\partial R} = \sum_{i=1}^6 \frac{F_i L_i}{AE} \frac{\partial F_i}{\partial R} = 0$$

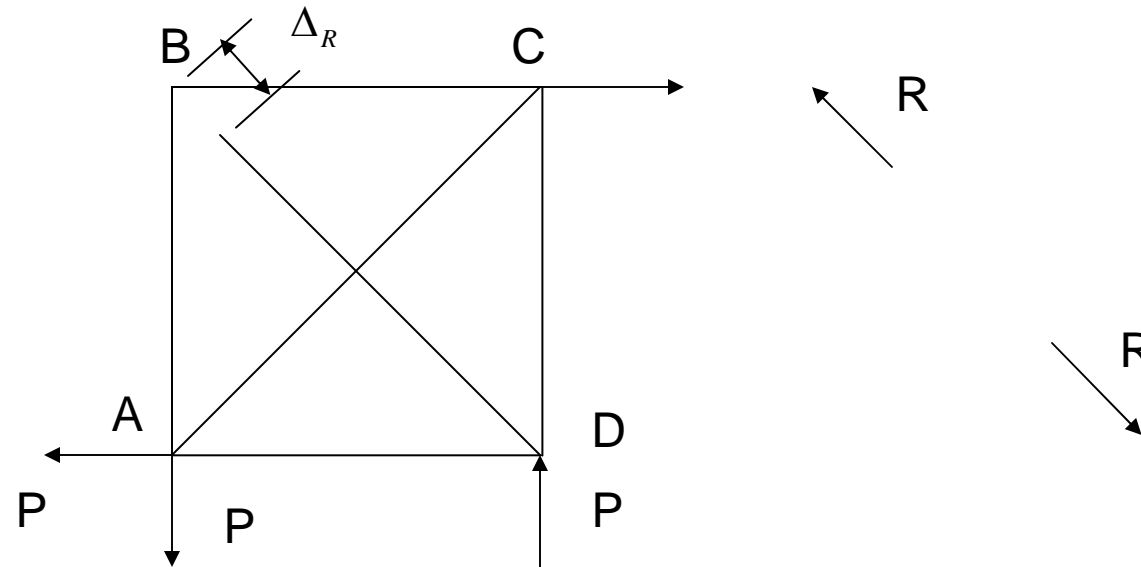
$$\frac{\partial U}{\partial R} = \sum_{i=1}^6 \frac{F_i L_i}{AE} \frac{\partial F_i}{\partial R} = 0$$

member	L_i	F_i	$\partial F_i / \partial R$	$F_i L_i \partial F_i / \partial R$
AB	L	$-R\sqrt{2}/2$	$-\sqrt{2}/2$	$RL/2$
BC	L	$-R\sqrt{2}/2$	$-\sqrt{2}/2$	$RL/2$
CD	L	$-(P + R\sqrt{2}/2)$	$-\sqrt{2}/2$	$L(P\sqrt{2}/2 + R/2)$
DA	L	$-R\sqrt{2}/2$	$-\sqrt{2}/2$	$RL/2$
AC	$\sqrt{2}L$	$P\sqrt{2} + R$	1	$L\sqrt{2}(R + P\sqrt{2})$
BD	$\sqrt{2}L$	R	1	$RL\sqrt{2}$

$$\sum_{i=1}^6 \frac{F_i L_i}{AE} \frac{\partial F_i}{\partial R} = \frac{(4.83RL + 2.707PL)}{AE} = 0$$

$$\Rightarrow R = -0.56P$$

Now, suppose that in assembling the truss, member BD was slightly short so that there was a lack of fit



In this case R does complimentary virtual work and we have

$$\delta U = \frac{\partial U}{\partial R} \delta R = \sum_{i=1}^6 \frac{F_i L_i}{AE} \frac{\partial F_i}{\partial R} \delta R = \delta R \Delta_R$$

which must be satisfied for all δR so

$$\sum_{i=1}^6 \frac{F_i L_i}{AE} \frac{\partial F_i}{\partial R} = \Delta_R$$

$$\frac{(4.83RL + 2.707PL)}{AE} = \Delta_R$$

$$R = -0.56P + \frac{AE}{4.83L} \Delta_R$$

so the force in BD is less compressive, which is what we expect since we have to pre-tension BD to get it to fit.