Michell Truss of order 4

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The structure is as Figure 1 shown. We are only giving forces on the node N00 on the very right side to test the structure. After trying forces from different directions, we can notice that the structure is always not potentially inconsistent and not underdetermined as well. Which means that no matter with what kind of loading profile, there will only be a unique solution to the system. In other words, the structure is stable.

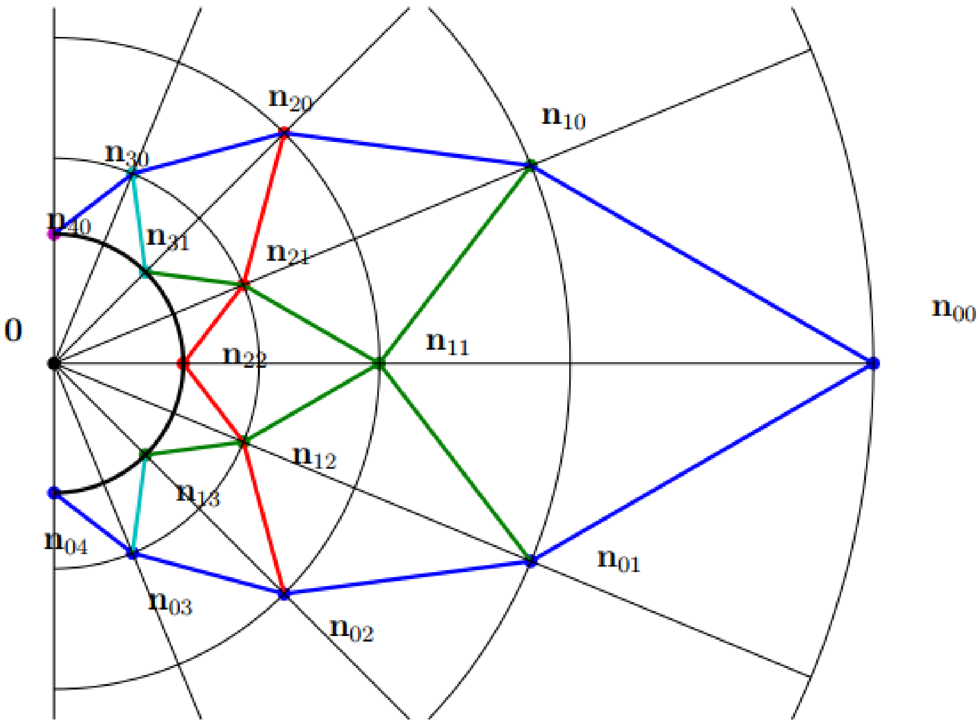
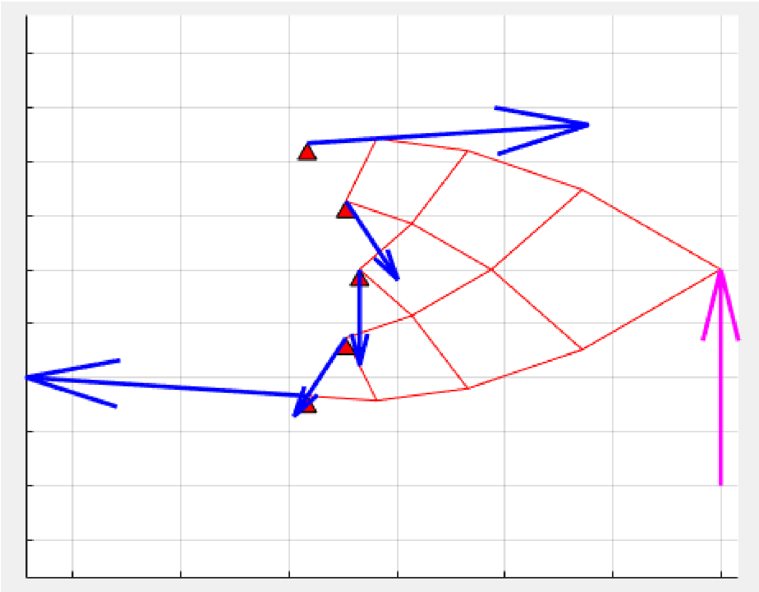


Figure 1:Michell Topology of Order 4 ($\varphi = \pi/16$, $\beta = \pi/6$)

Bob mentioned in his book that the force configuration will vary with the direction of external force, so I tried several conditions. Here θ is the direction of force. The bars are lined up from down to up, from right to left, for example, the bar (n01 to n00) is bar1 and the bar (n02 to n01) is bar3.

1. $\beta < |\theta| < \pi - \beta$

Following is a plot at θ = π/2 .



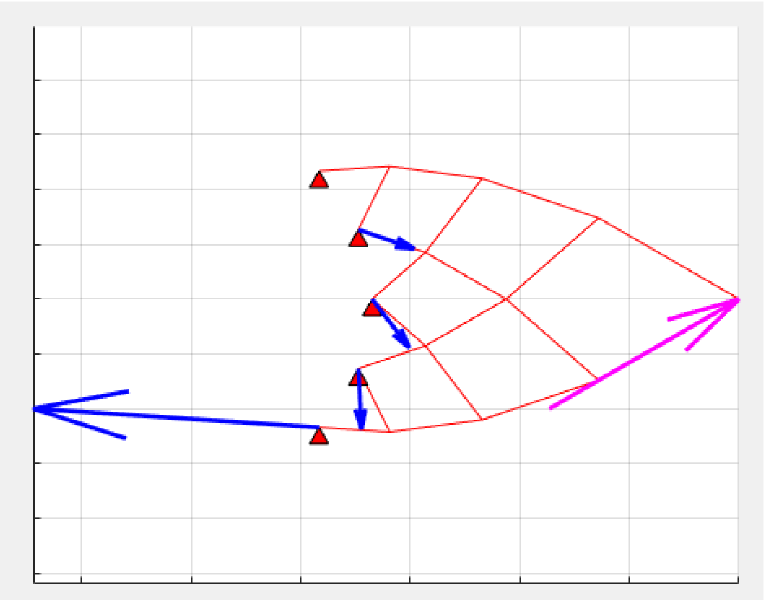
All the bars in a direction over horizonal line is under compression and others are under tension. Also, the magnitude of the force on bars are Symmetrical with respect to the middle line.

When we choose θ = -π/2, all bars under compression exchange with bars under tension, magnitude doesn't change.

When we try other θ in this range, the direction of member forces don't change. If the single external force of any magnitude lies in this region of direction, then force direction in all bars is the same, as the case of pure bending in the direction of |θ| = π/2

Then we tried the two conditions not discussed in the book.

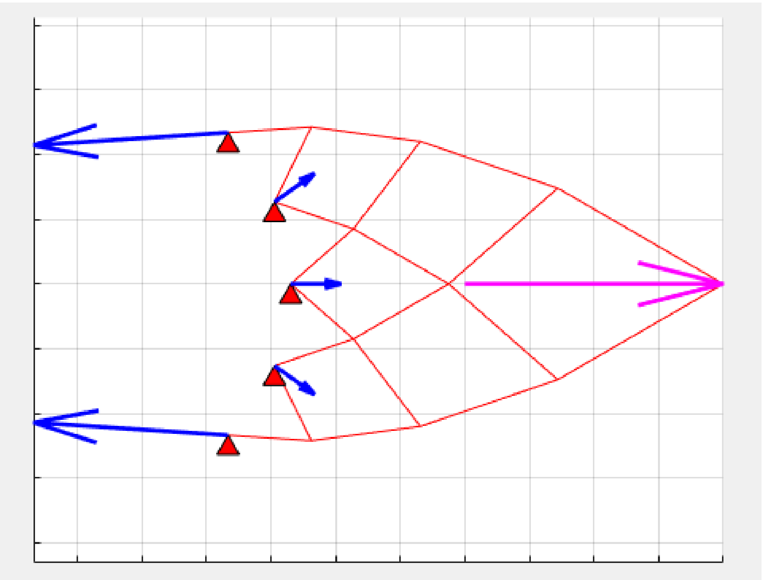
2. $\beta = |\theta|$



The four bars at the top are no longer under force.

3. $\beta < |\theta|$

Then it's the case that $\theta = 0$.

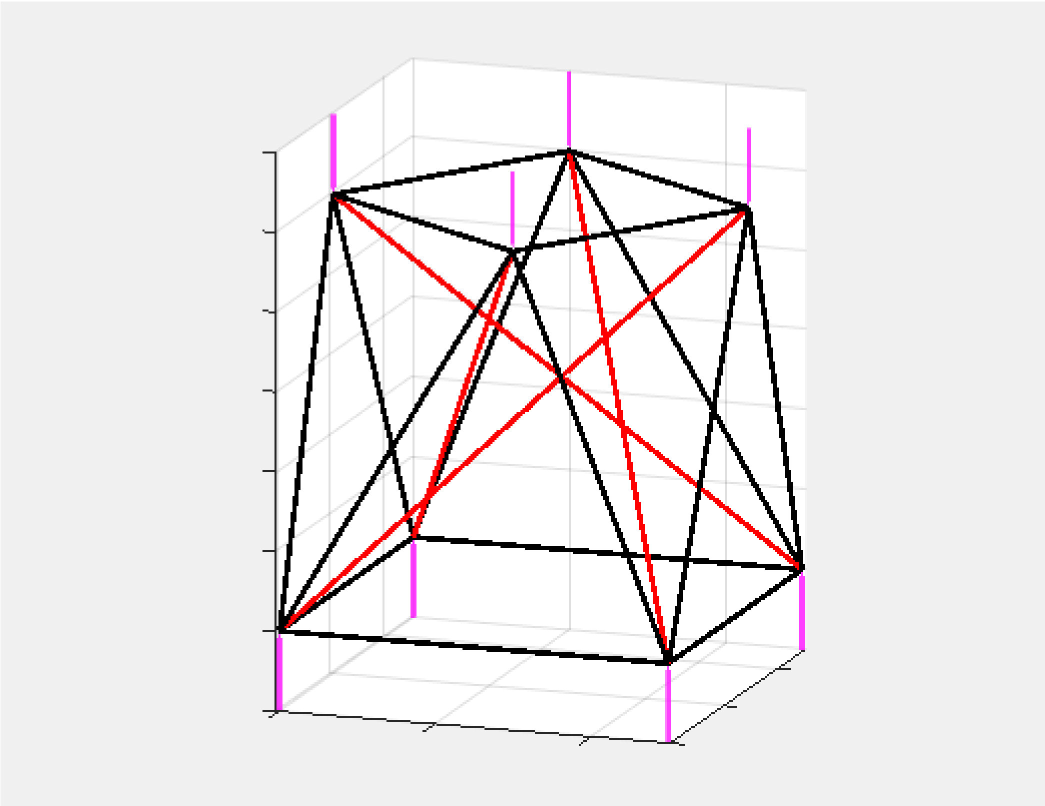


All the marginal bars are under tension and those in the middle are under compression. And again, the magnitude of force are symmetric, like the first case.

In all, the tensegrity structure is highly symmetrical and stable. Configuration of force is regular with external force.

Non minimal tensegrity prism with 4 bars

First, a corresponding tensegrity configuration of force cannot be worked out when the direction of external forces is not totally in z direction. Then we get a plot by setting downwards forces at the top and upwards forces at the bottom, as



The structure is both potentially inconsistent and underdetermined, which means that it’s very unstable and either have no solution of configuration or have unlimited solutions. Also, it’s pretensionable, means that with zero external load, all strings can be under tension. So we can solve it with a given tau_min while minimizing the L1 norm of the tensions.