Report on the two established system

1 Answer the Question

1.1 Is this structure potentially inconsistent? What does that mean?

Answer: For system 1, the Michell Truss of Order 4, the A_{se} is not potential inconsistent, and the system 2, the nonminimal tensegrity prism with 4 bars, the A_{se} is potential inconsistent.

Potential inconsistent means that number of the rows of A_{se} m is bigger that the rank(A_{se}), which indicates that there more equations than actually needed to solve the x, will have only 0 or 1 solution. Or put it another way, will have soft modes or just be instability.

1.2 Is this structure undetermined? What does that mean? If it is underdetermined, is it pretensionable, or only tensionable under load?

Answer: For system 1, it is not undetermined, thus system 1 is neither potentially inconsistent nor undetermined, this means that the rank(A_{se}) equals to both the rows number m and the columns number n. under this circumstance, the equation will have a unique solution.

For system 2, it is undetermined with three DOFs, which means that the rank(A_{se})is smaller than the column number n, thus the system 2 is both potentially inconsistent and undetermined. So the system will have 0 or inf solutions determined by u. It is pretensionable with zero applied loads and under specified forces, all the strings are under tension.

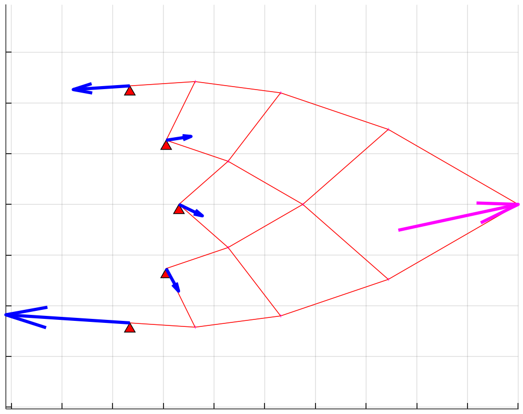
2 Some Other Works and Thinking

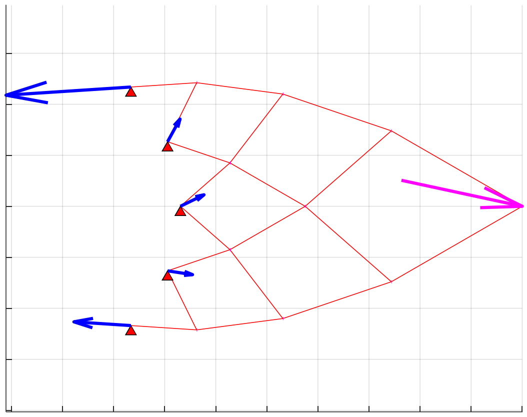
2.1 Show the results

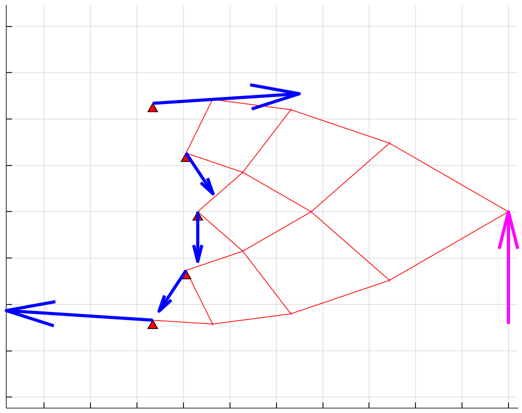
For system 1, I compute three force circumstance as demonstrated in Bob's book, which is :

$$\begin{cases} \beta \le \theta \le \pi - \beta \\ \beta - \pi \le \theta \le -\beta \\ \theta = \dfrac{\pi}{2} \end{cases}$$

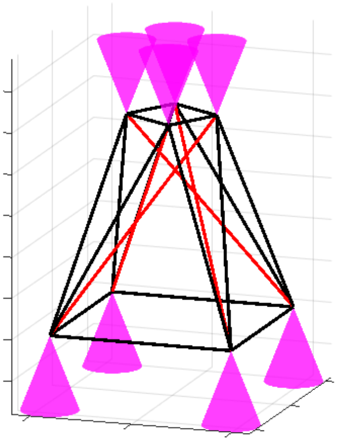
The results are ordered as follows:







For system 2, I use the rotation matrix to establish a relatively general codes to establish the structure, the results are as follows:



2.2 Some extra works

For system 1, I carefully read Bob's books, the tensegrity system, and write the code in a complex manner, that is using the exponential of complex number to describe the space configuration of the Michell Topology, by using this notation, I extend the 4 orders situation to a general q circumstance. In my code, one can change the parameter q to establish an arbitrary Michell Topology Structure. As you can see in my code, all the calculation involved with q, which make it easier for others to use this as a black box.

And to use Professor Bewley's toolbox, I must write the members vectors as $M = NC^T$, Professor Bewley's function utilize this matrix C to calculate matrix M. However, I can also skip this step, and just as the Bob's book writes, express the members vectors easily just along my manner:

$$m_{ik} = p_{i+k} e^{j(\beta+(i-k)\varphi)}$$

Where p_{i+k} denotes the length of the member, and can be easily calculated from the radius of the ring. Using this algorithm, we can easily establish an arbitrary order Michell Truss Structure and do calculations on that.

As for the system 2, all the nodes are free nodes, so once I gives the force uncarefully, the system will fail, so we must give the force vectors so that the sum of the force and the principle moment must be zero. Or it will have 0 solutions. System 2 has soft modes, which makes it easy to deform with a small disturbance in u. So whenever I give a small change in some column of the giving force u, u will be out of the column space of A_{se}, thus need great deformation to give a solution.