HW 1 report

Introduction

The main task of Homework 1 is to write two test code by MATLAB. The first test code, MitchelTruss4.m, is to build a Michell Topology of Order 4. The second test code, NonminimalPrism4.m, is to build a non minimal prism with four bars. The constructed function, tensegrity statics, and plot function, tensegrity_plot, are given. Also, from the figures, the number of different kinds of nodes and members are known. Therefore, the main task is to define the location of the nodes and a connectivity matrix. After all input variables of the function " tensegrity statics" are known, the function can determine whether the structure is determined and inconsistent.

Produce

Michell Topology of Order four

In the Figure 4.6 of Bob's book, the number of fixed nodes is five and the number of free nodes is ten. The degree of Φ is $\pi/16$ and the degree of β is $\pi/6$. From the color of the figure, there are at least ten bars, which can endure compression. Therefore, we assume there are ten bars and ten strings. Also, the equation, which calculates the relation between radius of different orders, is given. Therefore, the radius of each order is known. We define the initial radius, which is also the longest, as 1 in the case. The next step is to find the location of each node and store the locations in a location matrix. We know the radius and angle of each node, we can get the coordinates of each point through the trigonometric function. Now, we have two location matrices, P(2*5), and Q(2*10). The next step is to define the connectivity matrix C. For each bar and string, we set one entry as 1 and the other entry as -1. Finally, the functions, " tensegrity statics" and "tensegrity_plot" are used to plot the structure.

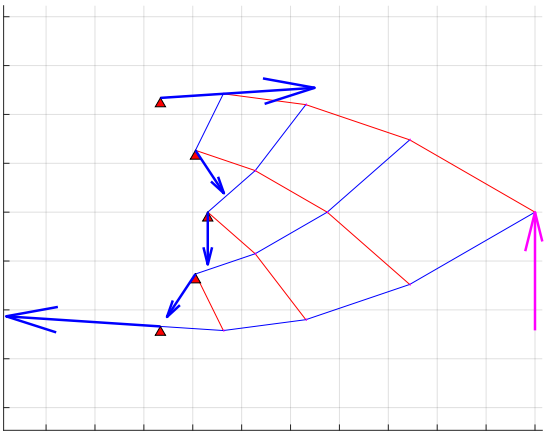

Figure 1. The plot of Michell Topology of Order 4

Non minimal prism with four bars

There are four bars, so the number of free nodes is eight. The number of strings can be calculated by number of bars. The number of strings is 16(3*4+4). The construction of the prism has two squares on the top and bottom. In order to define the location of nodes, we should define the height of prism, the length of square and the twist angle. The twist angle is 45 degrees. In the case, we assume length as 6 and height as 12. The next step is to calculate the location of each node. After we define the location of an arbitrary node, other nodes can get if the length and height are known. Now, we have the location matrix of free nodes Q. Then, we define the connectivity matrix C. The method mentioned in the previous case. Finally, the functions, " tensegrity statics" and "tensegrity_plot" are used to plot the structure.

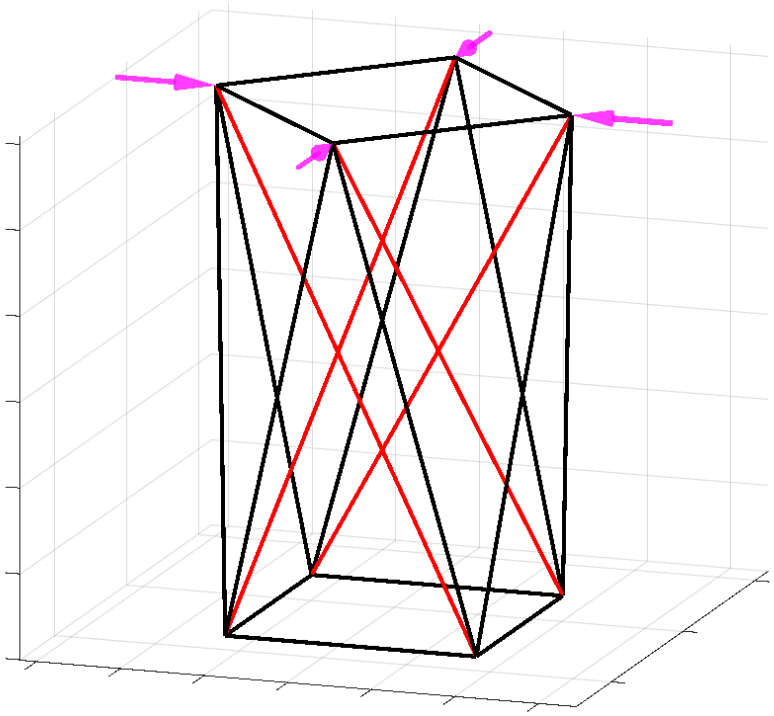

Figure 2. The plot of Non minimal prism with four bars

Result and Discussion

Michell Topology of Order four

In Figure 1, there is a up force acted on the end free node. The result of the function " tensegrity statics" shows that the structure is not potentially inconsistent. It means the rank of matrix is bigger than the product of dimension and number of free nodes.

Therefore, there is only one unique solution and there is no soft mode. The structure is stable and reliable under certain loading. The structure is also determined. It means that there is no degree of freedom. The structure only has one solution. Also, it is not undetermined, so it is not tensionable.

Non minimal prism with four bars

In Figure 2, there are four external forces, which acted on corners of top square. The result of the function " tensegrity statics" shows that the structure is potentially inconsistent. The rank of matrix is 17. The product of dimension and number of free nodes is 24 and the product of dimension and number of members is 20. The rank is smaller than 24 and 20. Therefore, the structure is unstable or has soft mode. Unstable structure lead to a failure with some small cracks. The soft mode indicates that the structure may has big deflection under some small force. The result also shows that the structure is underdetermined and is not pretensionable. The underdetermined structure indicates there are more unknowns. In this case, the degree of freedom is 3. Also, this indicates that some strings may endure large tension, which may lead to failure. In the case, the structure is tensionable under load.