SPACE TRUSS DESIGN

CDR FOR TRUSS DESIGN LAB:

ASEN 2001, STATICS AND STRUCTURES, FALL 2018.

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OVERVIEW

Outline and Overview

- Overview of Matlab Code.
- Showcase of designs
- Monte Carlo simulations
- The final designs
- Free body diagrams for both designs
- Assumptions (and self-weight)
- Sleeves and connections

Designing by Trial and Error → GUI

Input for Code

Matlab *Magic*

Output
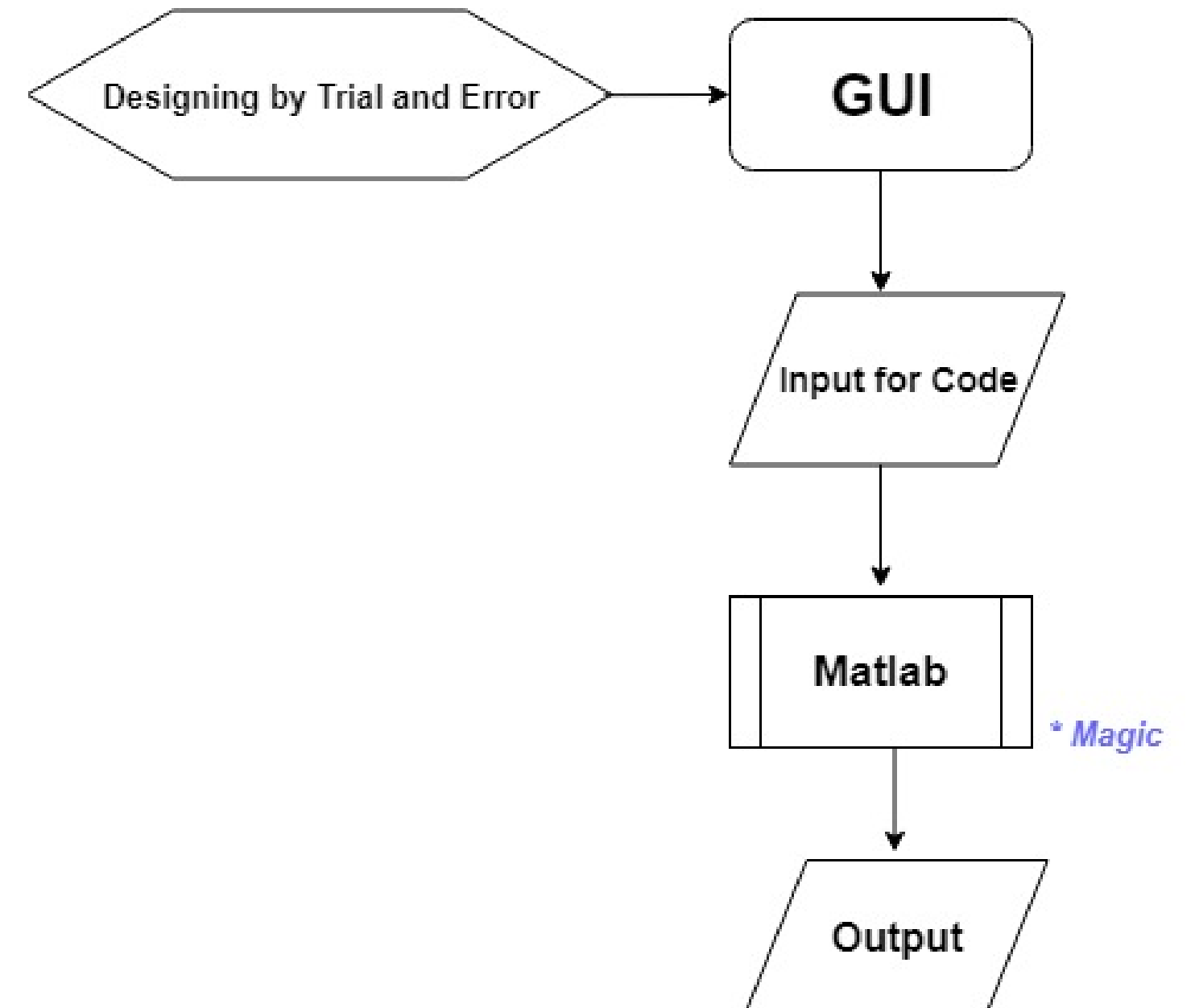
MATLAB CODE

VERIFICATION:

```
1   BOBBY 3-D Truss analysis
2   ------------------
3
4   Date: 08-Oct-2018 11:40:52
5
6   Input file: test3d_1.inp
7
8   Joints:        Joint-id  x-coordinate  y-coordinate
9                  1         6.00          0.00          0.00
10                 2         3.00          4.50          0.00
11                 3         0.00          0.00          0.00
12                 4         3.00          2.00          6.00
13
14
15  External loads: Joint-id  Force-x       Force-y
16                  4         0.00          0.00          -8.00
17
18  Bars:          Bar-id    Joint-i       Joint-j       Force     (T,C)
19                 1         1             2             0.890     (T)
20                 2         2             3             0.890     (T)
21                 3         3             1             0.617     (T)
22                 4         1             4             2.593     (C)
23                 5         2             4             3.852     (C)
24                 6         3             4             2.593     (C)
25
26  Reactions:     Joint-id  Uvec-x        Uvec-y        Uvec-z    Force
27                 1         1.00          0.00          0.000     -0.000
28                 1         0.00          1.00          0.000     -0.000
29                 1         0.00          0.00          1.000     2.222
30                 2         0.00          0.00          1.000     3.556
31                 3         0.00          1.00          0.000     0.000
32                 3         0.00          0.00          1.000     2.222
33
```

```
1   3-D Truss analysis
2   ------------------
3
4   Date: 21-Oct-2018 20:28:55
5
6   Input file: test3d_1.inp
7
8   Joints:        Joint-id  x-coordinate  y-coordinate  z-coordinate
9                  1         6.00          0.00          0.00
10                 2         3.00          4.50          0.00
11                 3         0.00          0.00          0.00
12                 4         3.00          2.00          6.00
13
14
15  External loads: Joint-id  Force-x       Force-y       Force-z
16                  4         0.00          0.00          -8.00
17
18  Bars:          Bar-id    Joint-i       Joint-j       Force     (T,C)
19                 1         1             2             0.890     (T)
20                 2         2             3             0.890     (T)
21                 3         3             1             0.617     (T)
22                 4         1             4             2.593     (C)
23                 5         2             4             3.852     (C)
24                 6         3             4             2.593     (C)
25
26  Reactions:     Joint-id  Uvec-x        Uvec-y        Uvec-z    Force
27                 1         1.00          0.00          0.00      -0.000
28                 1         0.00          1.00          0.00      -0.000
29                 1         0.00          0.00          1.00      2.222
30                 2         0.00          0.00          1.00      3.556
31                 3         0.00          1.00          0.00      0.000
32                 3         0.00          0.00          1.00      2.222
33
```
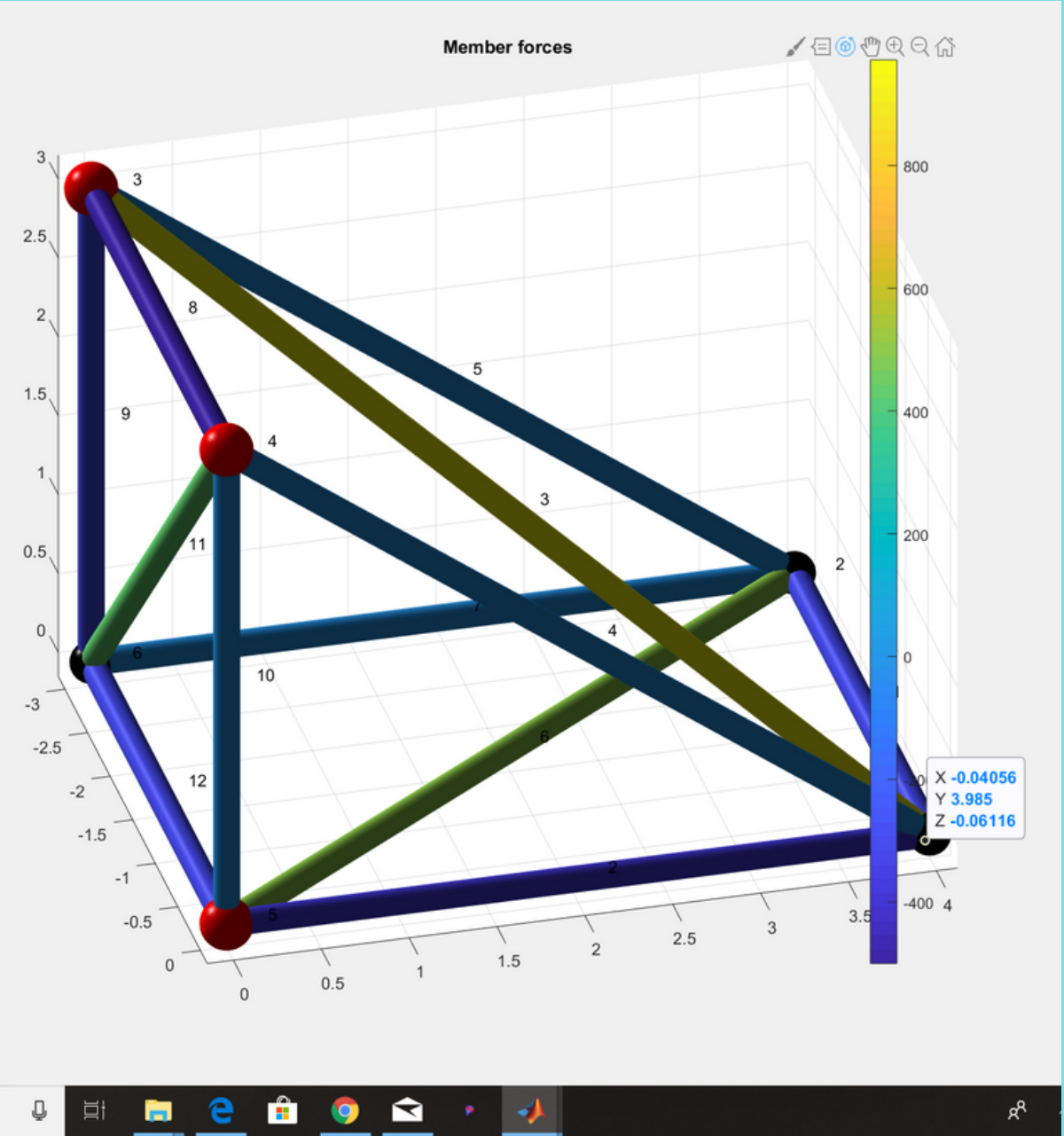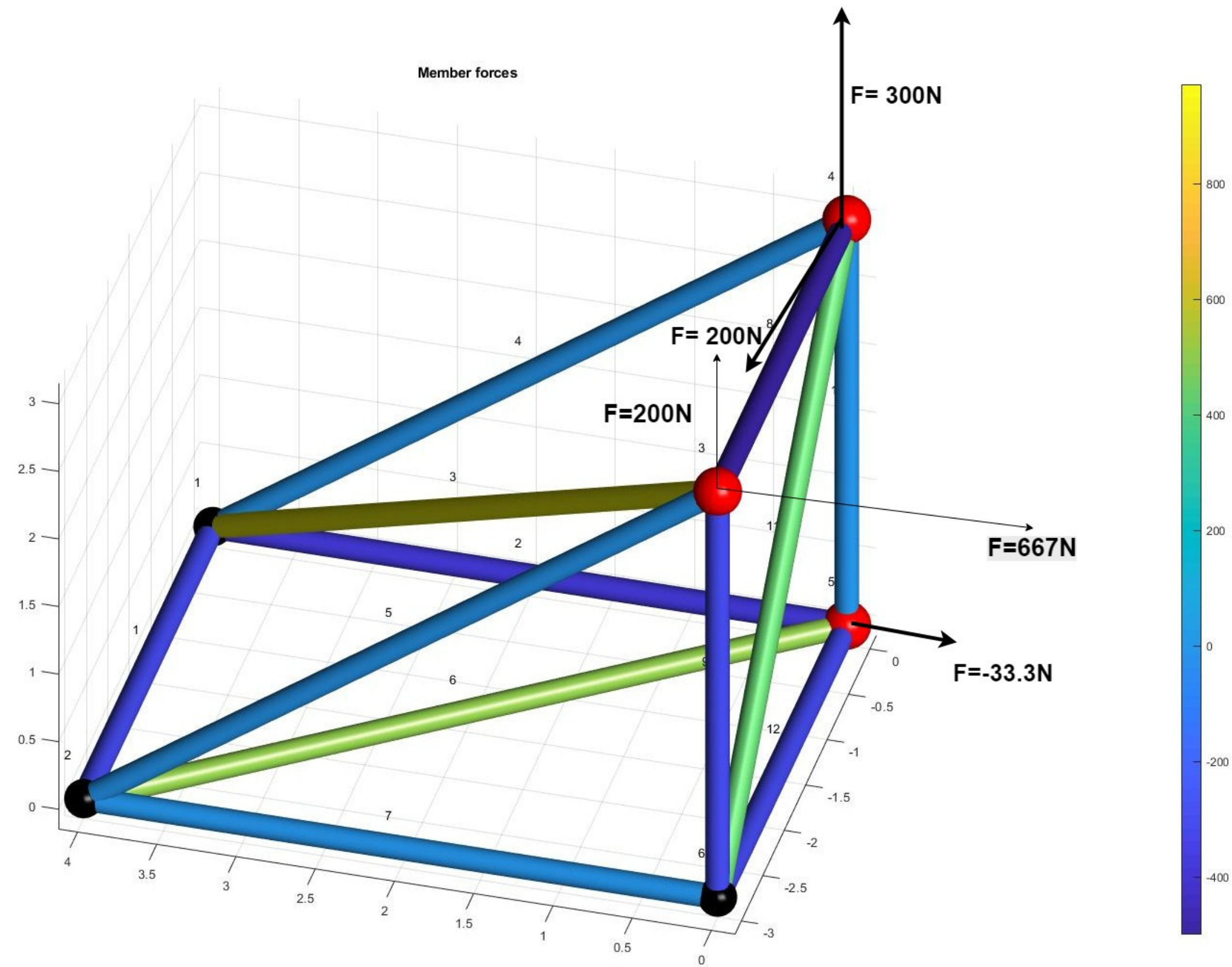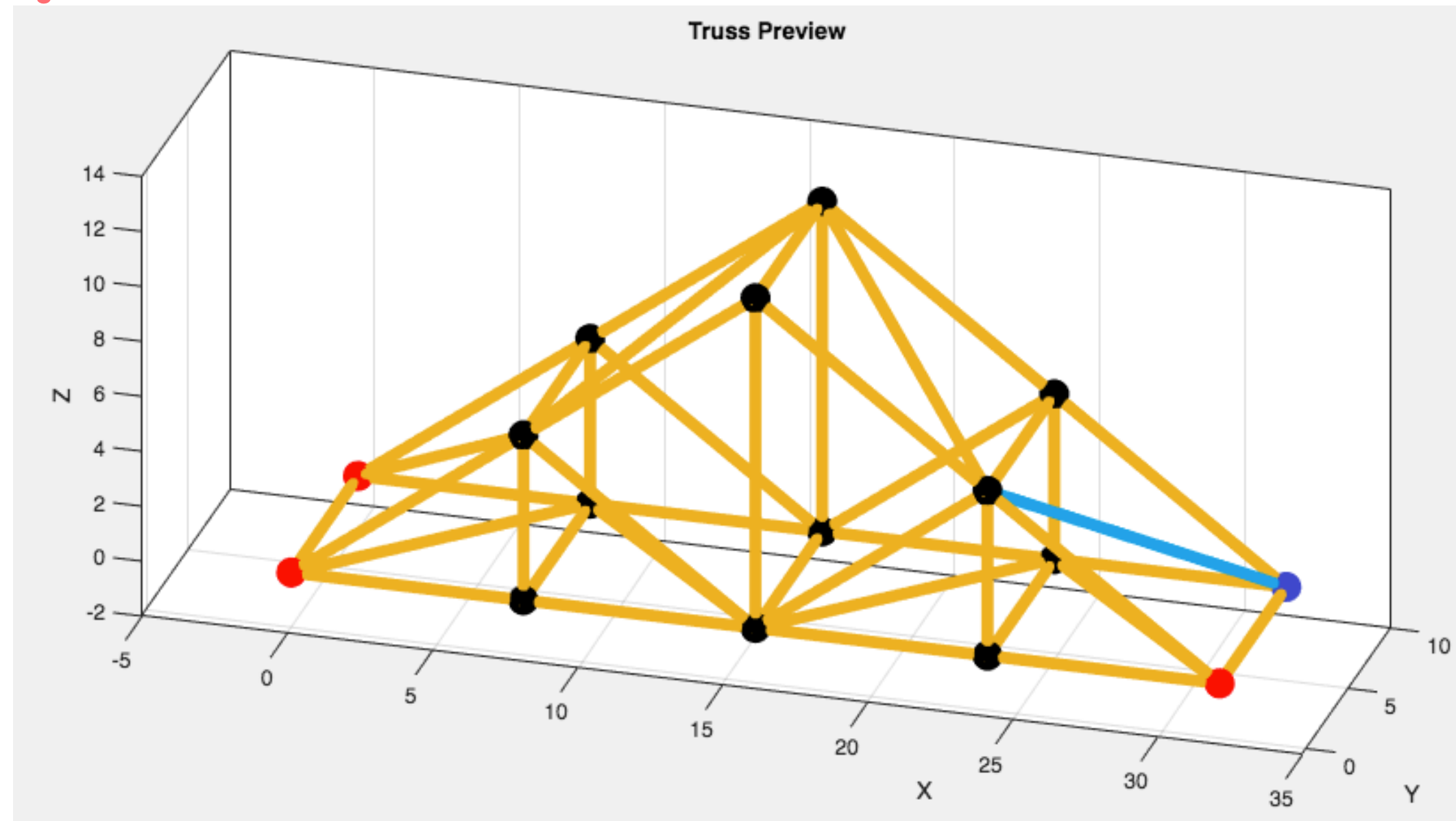
Member forces
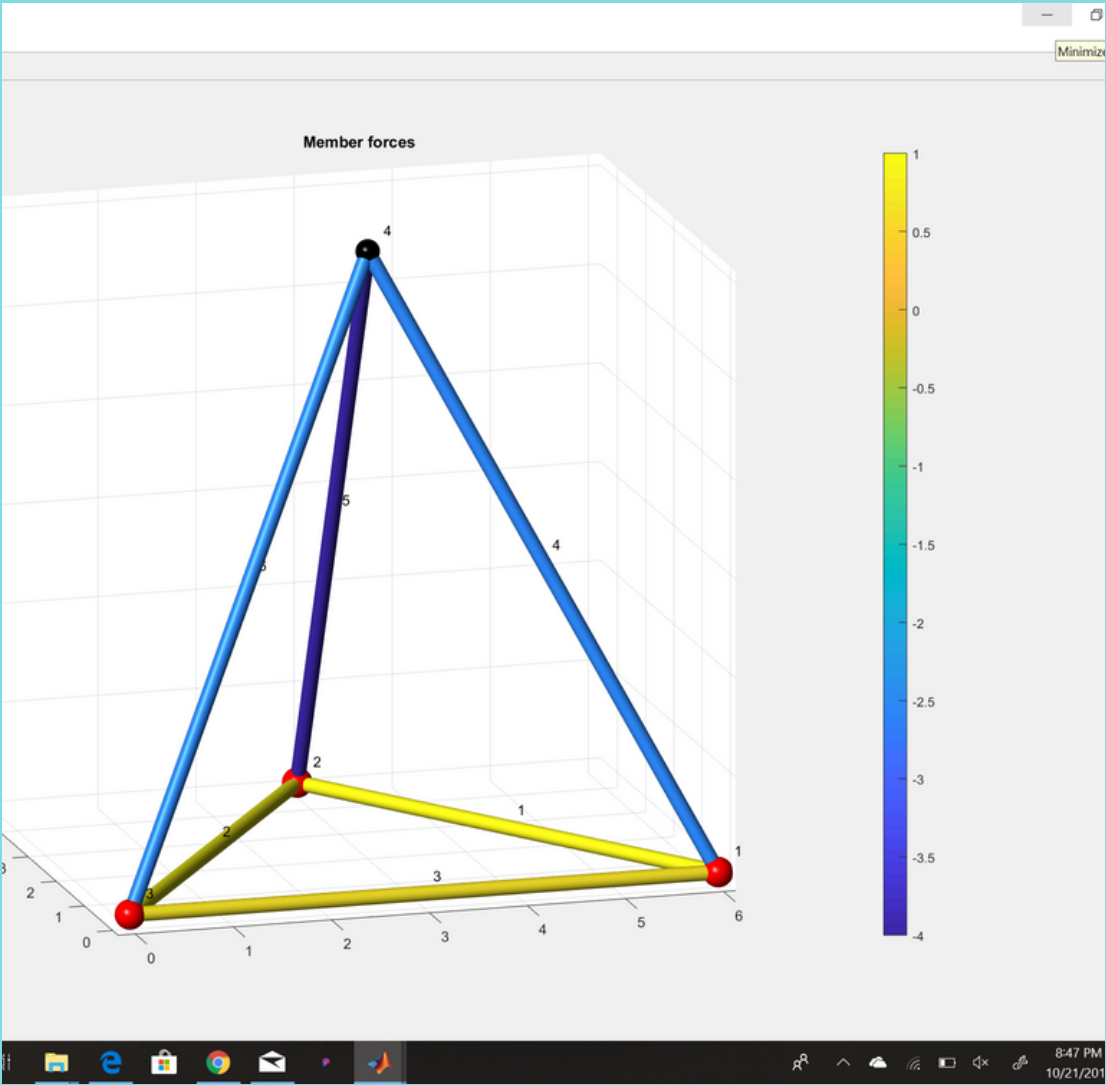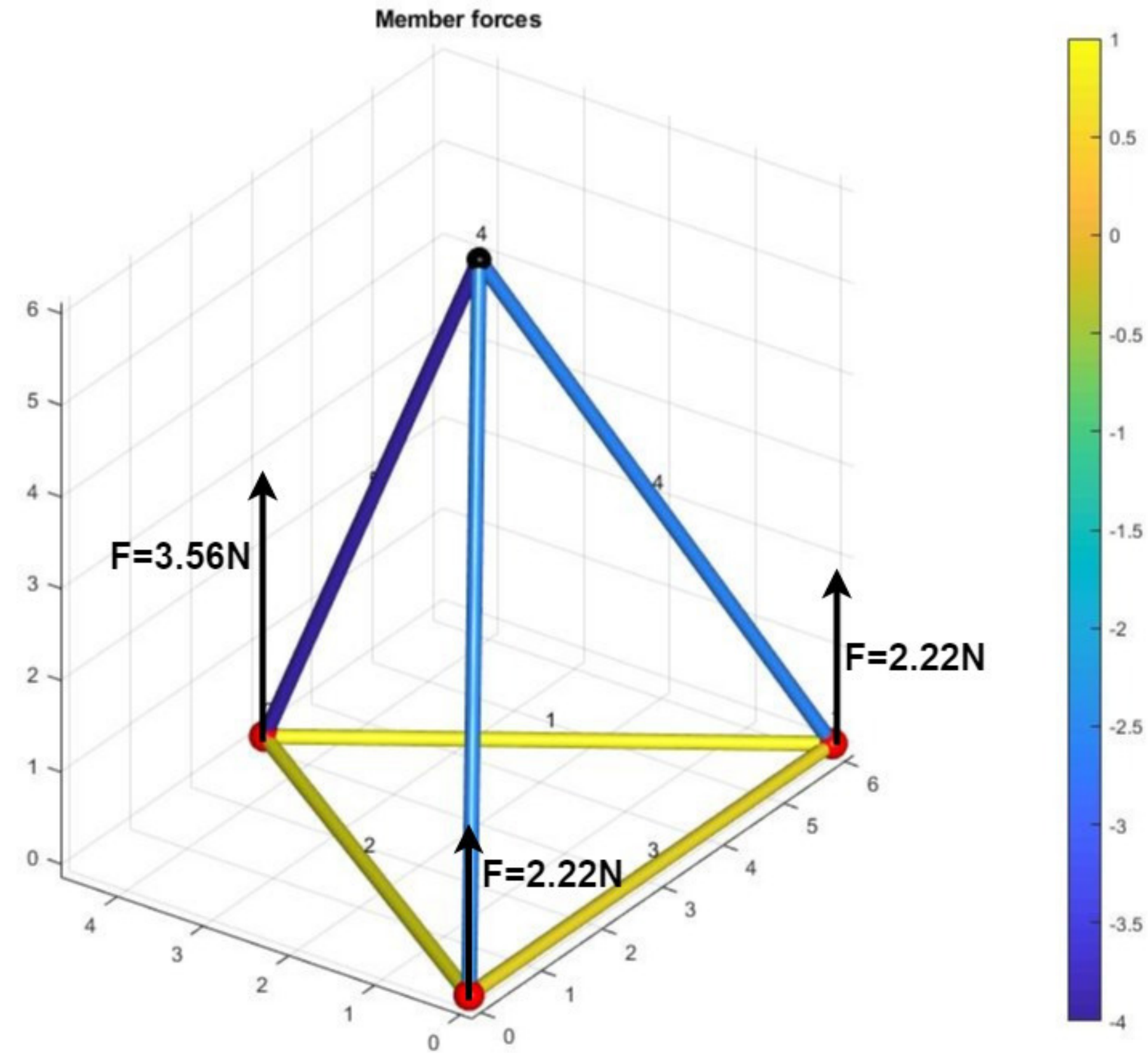
MATLAB CODE

VERIFICATION:


```
 1  BOBBY 3-D Truss analysis
 2  -------------------
 3
 4  Date: 08-Oct-2018 11:43:03
 5
 6  Input file: test3d_2.inp
 7
 8  Joints:        Joint-id  x-coordinate  y-coordinate
 9                 1         0.00          4.00          0.00
10                 2        -3.00          4.00          0.00
11                 3        -3.00          0.00          3.00
12                 4         0.00          0.00          3.00
13                 5         0.00          0.00          0.00
14                 6        -3.00          0.00          0.00
15
16
17  External loads: Joint-id  Force-x       Force-y
18                 1         200.00        300.00       -500.00
19                 2         0.00          400.00        0.00
20
21  Bars:          Bar-id    Joint-i   Joint-j     Force    (T,C)
22                 1         1         2         300.000     (C)
23                 2         1         5         366.667     (C)
24                 3         1         3         971.825     (T)
25                 4         1         4           0.000     (C)
26                 5         2         3           0.000     (C)
27                 6         2         5         500.000     (T)
28                 7         2         6           0.000     (C)
29                 8         3         4         500.000     (C)
30                 9         3         6         300.000     (C)
31                 10        4         5           0.000     (C)
32                 11        4         6         424.264     (T)
33                 12        5         6         300.000     (C)
34
35  Reactions:     Joint-id  Uvec-x    Uvec-y      Uvec-z       Force
36                 3         0.00      1.00        0.000     -666.667
37                 3         0.00      0.00        1.000      200.000
38                 4         1.00      0.00        0.000     -200.000
39                 4         0.00      1.00        0.000        0.000
40                 4         0.00      0.00        1.000      300.000
41                 5         0.00      1.00        0.000      -33.333
42
```

```
 1  3-D Truss analysis
 2  -------------------
 3
 4  Date: 21-Oct-2018 20:47:37
 5
 6  Input file: test3d_2.inp
 7
 8  Joints:        Joint-id  x-coordinate  y-coordinate  z-coordinate
 9                 1         0.00          4.00          0.00
10                 2        -3.00          4.00          0.00
11                 3        -3.00          0.00          3.00
12                 4         0.00          0.00          3.00
13                 5         0.00          0.00          0.00
14                 6        -3.00          0.00          0.00
15
16
17  External loads: Joint-id  Force-x       Force-y       Force-z
18                 1         200.00        300.00       -500.00
19                 2         0.00          400.00        0.00
20
21  Bars:          Bar-id    Joint-i   Joint-j     Force    (T,C)
22                 1         1         2         300.000     (C)
23                 2         1         5         366.667     (C)
24                 3         1         3         971.825     (T)
25                 4         1         4           0.000     (C)
26                 5         2         3           0.000     (C)
27                 6         2         5         500.000     (T)
28                 7         2         6           0.000     (C)
29                 8         3         4         500.000     (C)
30                 9         3         6         300.000     (C)
31                 10        4         5           0.000     (C)
32                 11        4         6         424.264     (T)
33                 12        5         6         300.000     (C)
34
35  Reactions:     Joint-id  Uvec-x    Uvec-y      Uvec-z       Force
36                 3         0.00      1.00        0.00      -666.667
37                 3         0.00      0.00        1.00       200.000
38                 4         1.00      0.00        0.00      -200.000
39                 4         0.00      1.00        0.00         0.000
40                 4         0.00      0.00        1.00       300.000
41                 5         0.00      1.00        0.00       -33.333
42
```
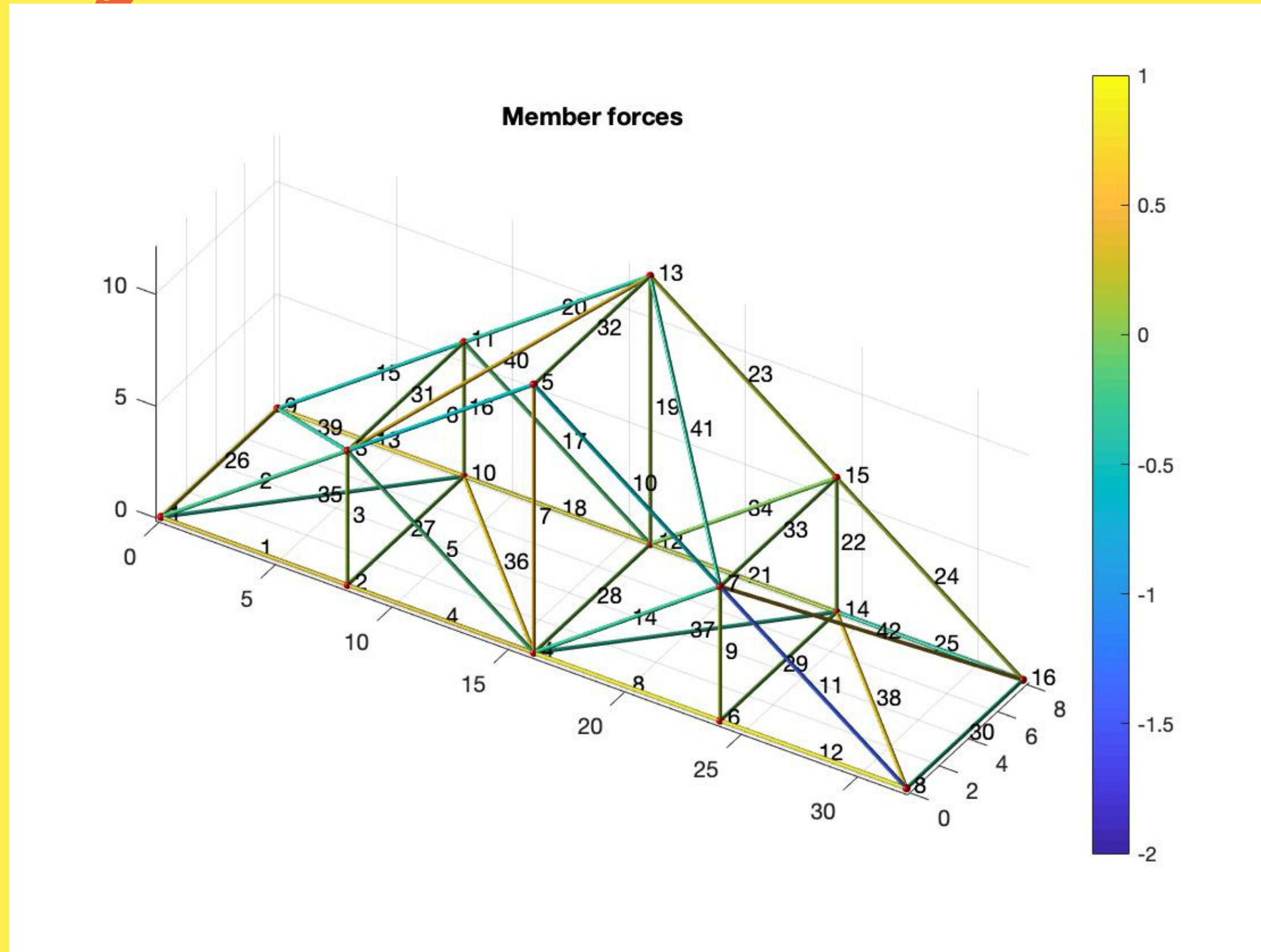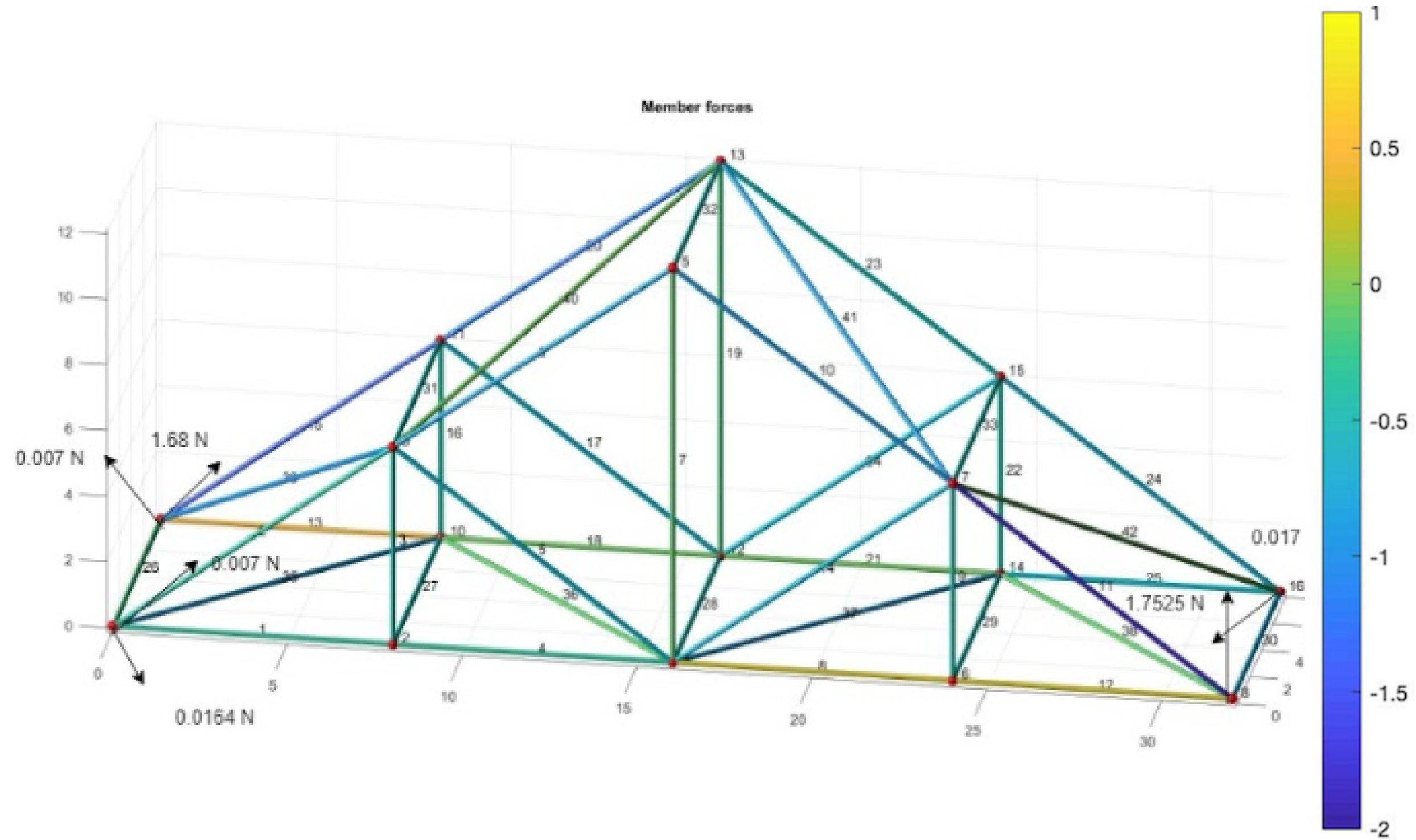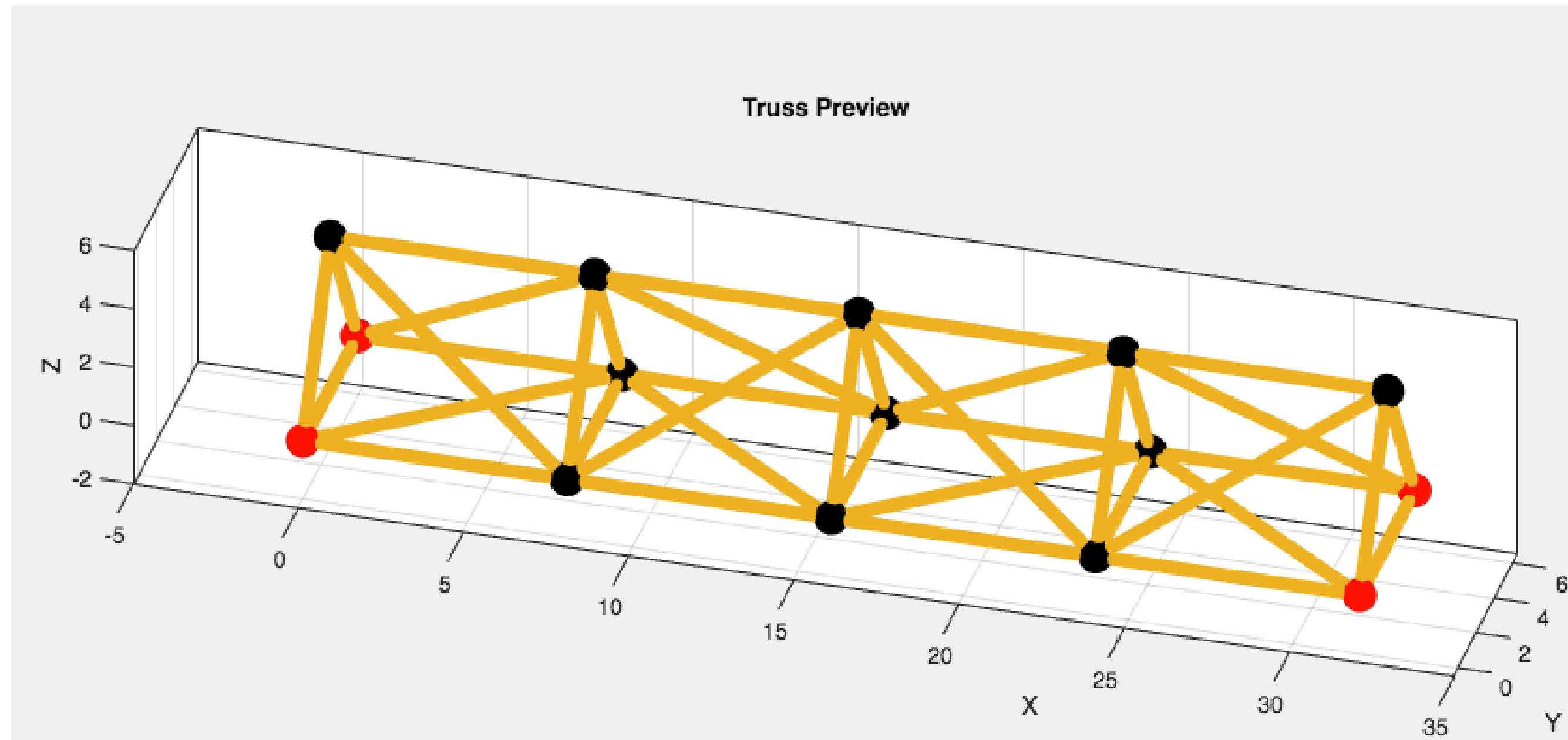
Member forces

DESIGN 1

Truss Preview

Final Design 1

FBD FOR DESIGN 1

Member forces

DESIGN 2

Truss Preview

Final Design 2
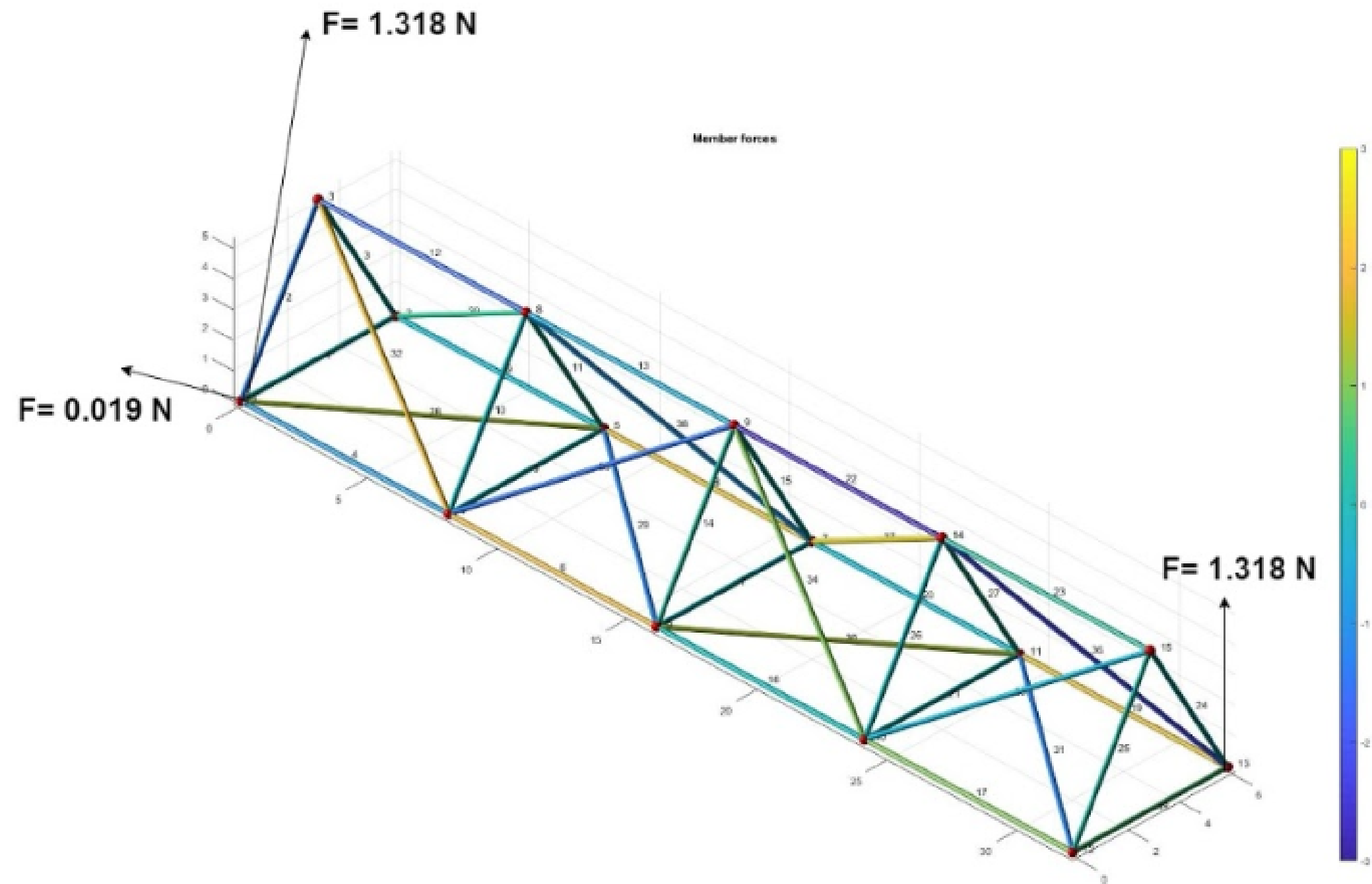

Member forces

FBD FOR DESIGN 2

F= 1.318 N

F= 0.019 N

F= 1.318 N

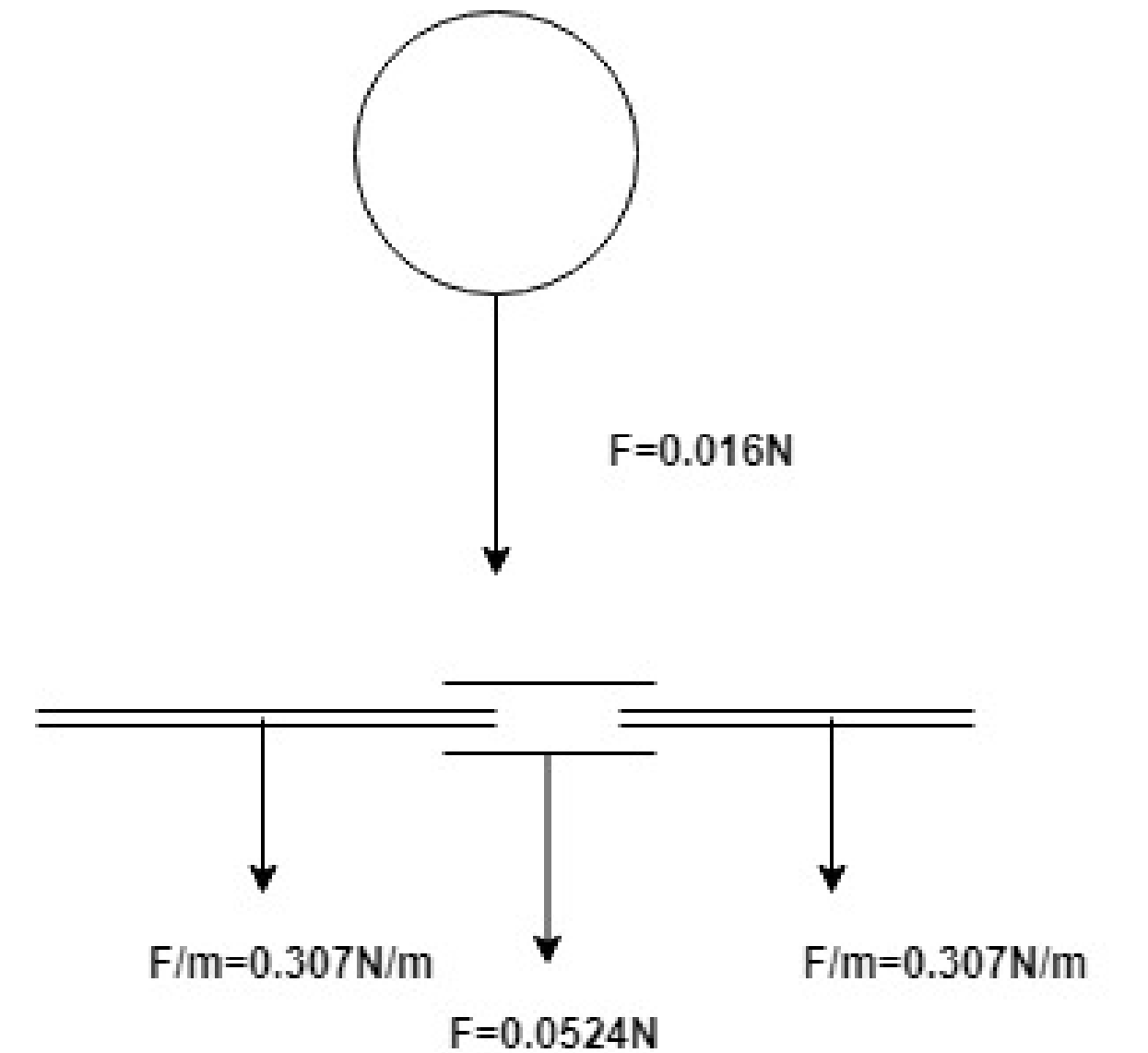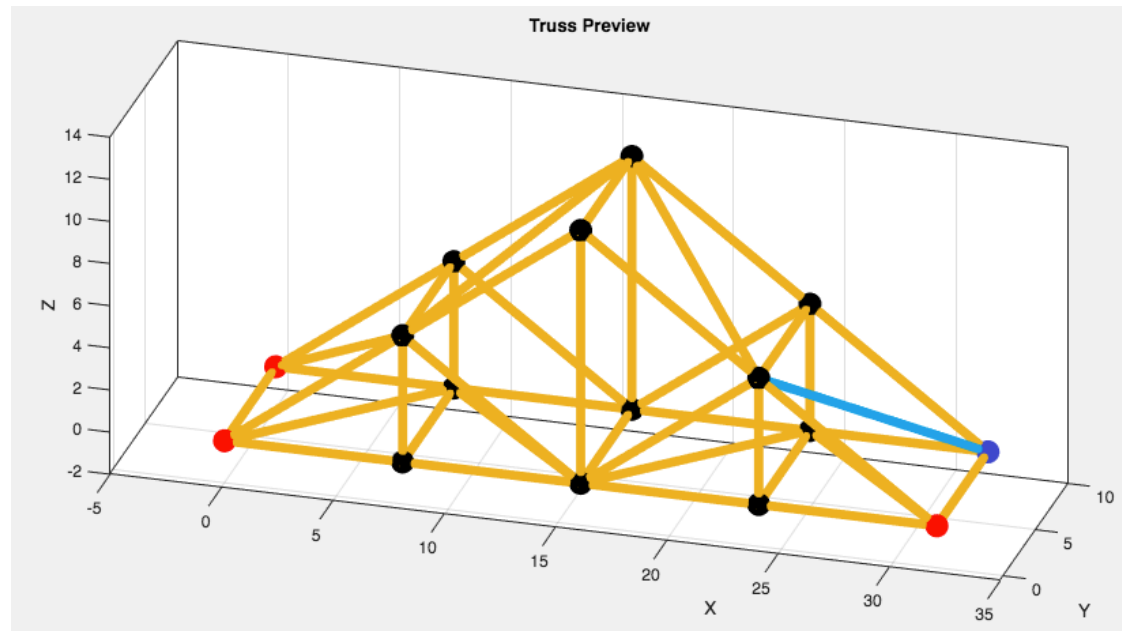Member forces
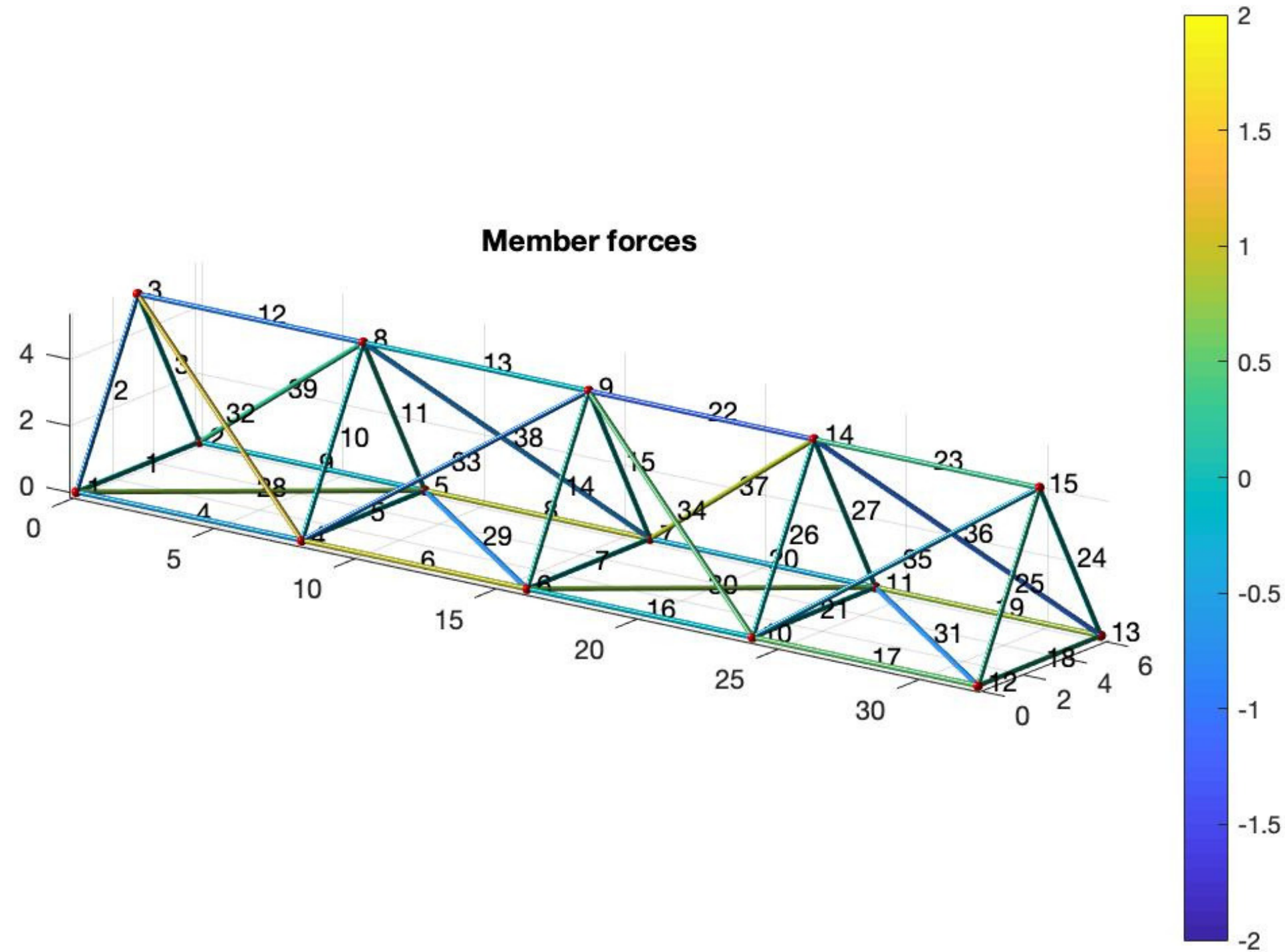
EXTERNAL LOAD ASSUMPTIONS

We are assuming that the only external load acting on our truss is the weights of the items used to make it. In addition, we assume that the bars have uniform linear density. The weight of the bars and sleeves act equally on both joints that it is connected to.
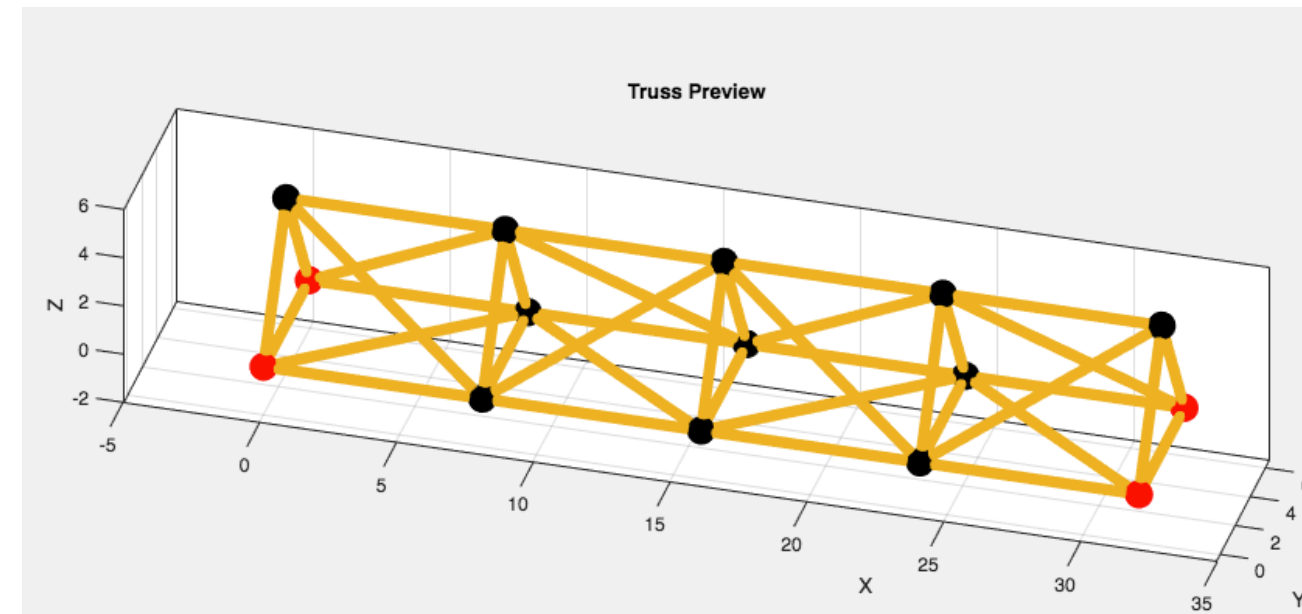
F=0.016N

F/m=0.307N/m

F/m=0.307N/m

F=0.0524N

SAFETY FACTOR RATIONAL

Design 1: 1.5

Less forces in the bars, more room for safety.

Design 2: 1.8

more internal forces, a bigger safety factor.

FINAL DESIGN CHOICE

We chose to pick the first design, since the FBD shows how the amount of stress on each member of the truss is more spread out than the second design. The type of bars is more diverse than the second design as well. There is a higher chance of breakage with the second design, and although it is simpler, it's not worth the risk.
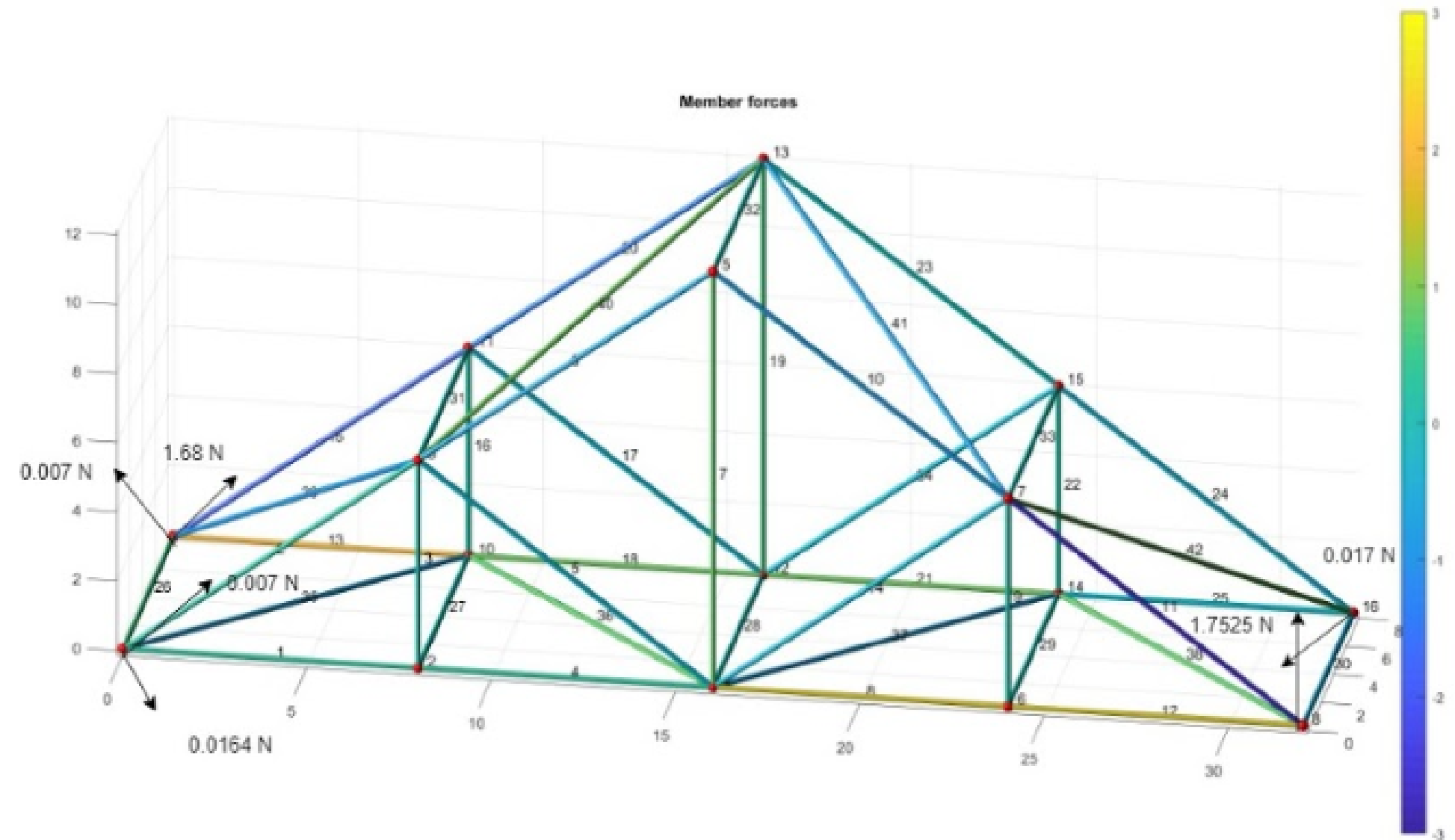
BUILD PLAN

YES!

Both our designs can be made with the truss bars and sleeves given to us.

All the lengths of our bars were checked by looking at the data from our Matlab code and found that every bar complies with the lengths of the bars which will be given to us. In addition, we don't exceed the amount of each bar given to us.

Build Plan Cont.

Bar Lengths / Item	Design 1 Number used	Design 2 Number used
12"	2	0
10"	12	12
8"	18	12
6"	18	15
Sleeves	8	0