

Modeling Trusses

Read the handout on “Resourcefulness”

Notes: Be sure to use this exercise to get a physical feel for the magnitude of these forces:

$$1 \text{ lb}_f = 4.45 \text{ newtons}$$

Bridge Designer Simulator: Johns Hopkins University Bridge Designer:

<http://www.jhu.edu/virtlab/bridge/truss.htm>

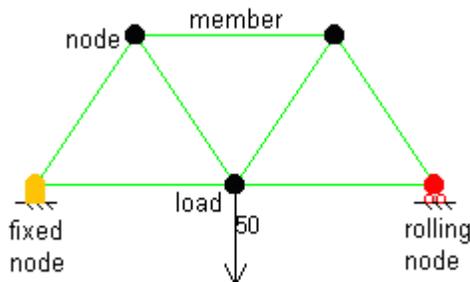
(Truss Simulator works on the Windows computers in the Computer Lab.)

UTube Tutorial: <http://www.youtube.com/watch?v=Xh6yjUrvq5o>

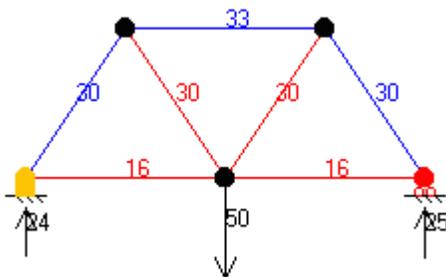
A good printed explanation: <http://shodor.org/succeed-1.0/curriculum/EIT/pages/strussdir/strussp2.html`1>

Introduction to Bridge Designer (from web site)

Trusses are composed of straight members connected at their ends by hinged connections to form a stable configuration. When loads are applied to a truss only at the joints, forces are transmitted only in the direction of each of its members. That is, the members experience tension or compression forces, but not bending forces. Trusses have a high strength to weight ratio and consequently are used in many structures, from bridges, to roof supports, to space stations.



In this simulation, trusses are created by attaching members to nodes (joints). First, nodal locations are specified; then the nodes are linked by members to create a structure. Once the structure is established, two of the nodes must be assigned as support nodes. One must be a "fixed" node, i.e., one that can provide support in both the x- and y-directions; the other must be a "rolling" node, one that can provide support in only the y-direction. Finally, one or more nodes can be assigned to bear loads.



Once these elements are specified, a click on "Calculate" will check your design. Another click will generate a complete force diagram showing compression/tension forces in each of the members and reactive forces at the support nodes.

This simulation uses the method of joints and works only for statically determinate, stable trusses. A necessary (but not sufficient) criterion for a determinate, stable structure is $M + 3 = 2 \cdot N$, where M is the number of members and N is the number of nodes. The simulation will not calculate forces unless this condition is met. The method of joints will be presented in the next section.

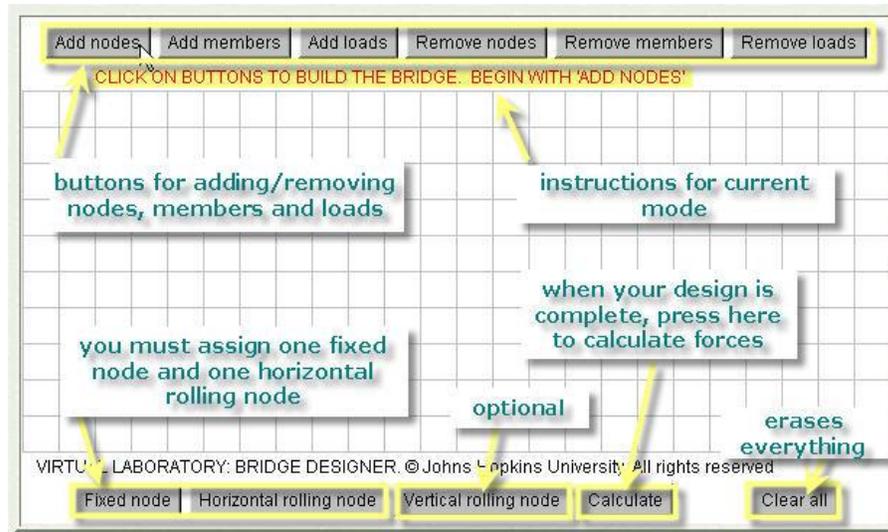


Figure 1: Bridge Designer software interface

Homework (due next class)

1. Complete the worksheet.

a) Hang a 75 Newton load from the center node (see example above). Make a sketch and record the force (magnitude and direction (compression or tension)) on each beam. What is the downward force on the center node.

b) Hang 3 25 newton loads from the center 3 nodes. Make a sketch and record the force on each of the 3 nodes. Compare this result to your result above.

3. Remove all the truss work, so that there is only the bottom horizontal beam left. Hang the same 75 N weight from the center node. How does the downward force compare to the earlier example. Explain the difference in terms of dissipation.

JHU Truss Design Problems

Instructions:

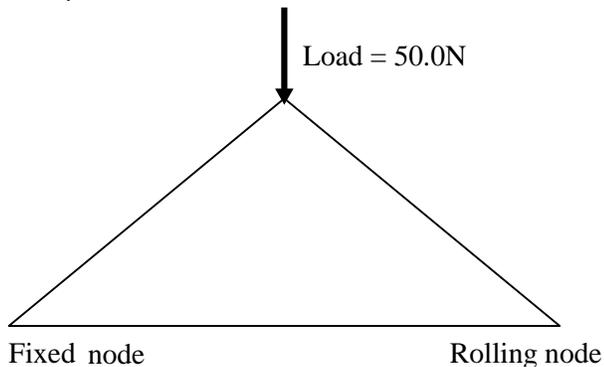
Go to <http://www.jhu.edu/virtlab/bridge-designer>

Read the description of how to use the simulator.

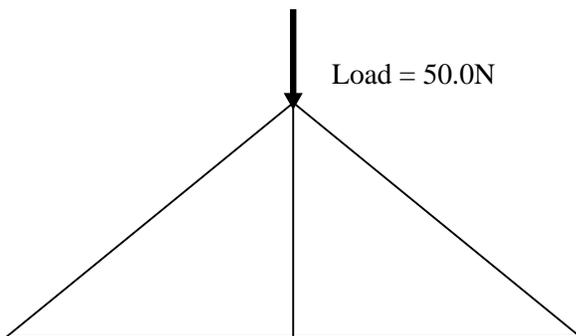
Go to <http://www.jhu.edu/virtlab/bridge/bridge.htm>

What conditions (yes, more than one) must be met for the simulator to calculate loads? If the JHU simulator calculator does not complete the calculation, check to be sure that these conditions are met.

1. Design a basic triangle as shown. Apply a 50.0 N load at the top node of the triangle. Record the values. Write a (T) after the value if it is in Tension and write a (C) after the value if it is Compression.

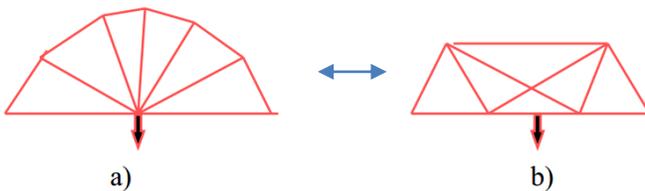
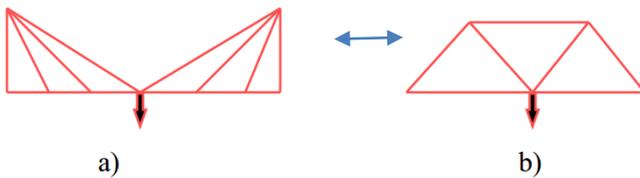
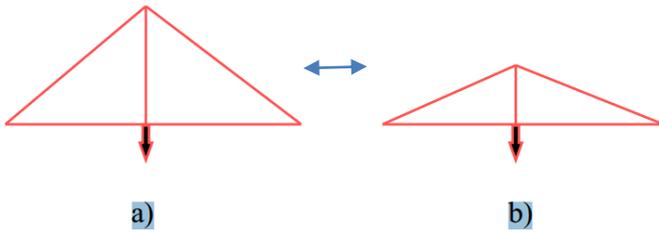
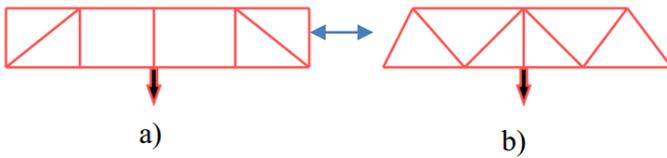


Clear the values and add the additional member as shown. Repeat the procedure. Then put the load on the center node on the bottom member and compare the results. Does the additional member add benefit?



2. A short problem that can help explore the effects of different factors on truss design. These results for your later can help to guide the design of your groups bridge

Which of each pair is the better design? Show the results of the simulation and give the reasoning. (The downward arrow indicates the location of the load)



3. Select one of the Truss Bridge designs that can be calculated by the simulator. (You can begin with the examples on the Truss Bridge Handout and research additional details if needed. Model at least 3 variations of the truss.

4. Analysis: Based on these examples, draw some conclusions from the results. Consider the height, the number of members, position of load etc.

Note: It is not required that your final bridge design be meet the requirements for calculation by the JHU Simulator.