The physics of a truss bridge

Science, Physics

There are many reasons that we need bridges in every day of our life, from sufficient means to pass over a roadway, waterway, railway, or other structure. You don't even think about them because it takes no effort to get over them and they are just there for your use. So if you don't think of them foreveryday useI highly doubt that you would think of the physics that is involved in putting one together or the kind of force the bridge can actually take. I am going to show you the max force a truss bridge can take by demonstrating it to you in class and also by trying to calculate it. I am also going to go over the many ways that truss bridges can fail and come to a tumbling crash. Before I get into the physics of the bridge you need to know what a truss bridge is and how it works. A truss is a structure composed of members connected together to form a rigid framework. Members are the load-carrying components of a structure. In most trusses, members are arranged in interconnected triangles, as shown below.

Because of this configuration, truss members carry load primarily in tension and compression. Because trusses are very strong for their weight, they are often used to p long distances. They have been used extensively in bridges since the early 19th century; however, truss bridges have become somewhat less common in recent years. Today trusses are often used in the roofs of buildings and stadiums, in towers, construction cranes, and many similar structures and machines. An easy way to understand how a truss bridge works is to use a nutcracker and a string tied to the ends of the nutcracker. So even if you push down on the nutcracker it will not move or slide on the table. This is because the nutcracker is in equilibrium.

I am going to show you a little of a harder way of calculating it with three triangles that are in the shape of a truss bridge so you can understand how the bridge works 400N 800N A B C D E 2m 500 N 700 N

Sum of torques = (1m) (-400N) + (3m) (-800N) + (4m) (E) = 0 E= 700N

Sum of forces = Ay +E -400N- 800N Ay = 500N.

Now that we know how the forces are laid out, let’s take a look at what is happening at point A. Remember that all forces are in equilibrium, so they must add up to zero.

500N 60° A T Ac T AB Sum of Fx = Tac + Tab Cos 60 = 0 Sum of Fy = Tab sin 60 +500N = 0.

Solving for the two above equation we get

Tab = -577 N Tac = 289 N.

When you apply external loads to a structure, external reactions occur at the supports. But internal forces are also developed within each structural member. In a truss, these internal member forces will always be either tension or compression. A member of tension usually stretches, like a rubber band because the tension force tends to make a member longer. This is the opposite of compression.

When a member is in compression it is usually being squashed, like squashing a block of foam between your hands.

B 289 N 289 N 577 N TAB = -577 N TAC = 289 N B A A 577 N.

The negative force means that there is a compression force and a positive force means that there is a tension force. Now let’s take a look at point B.

700 N 500 N 2m E D C B A 800N 400N 577 NB 60° TBC TBD 400 N Sum of FX= TBD + TBC Cos 60 +577 Cos 60 = 0 Sum of FY = -400 N + 577 Sin 60 – TBC Sin 60 = 0.

Once again, solving the two equations

TBC = 115 N and TBD = -346 N.

If we calculated the rest of the forces acting on the various points of out truss, we will see that there is a mixture of both compression and tension forces and that these forces are spread out across the truss. When I am going to test the maximum force of my paper truss bridge, I have calculated that it should hold 5 kilograms with no problems and probably will even get up to 10 kilograms. My bridge weighs about 55 grams so my bridge should have a strength-to-weight ratio of over 90, which is very good, and if I can get it to hold 10 kilograms it will be wonderful. Once we hit the maximum load we are going to see my bridge come to a crashing end.

My crash will be due to overloading, but there is much more reason why bridges come to crashing ends. Some of the more common ones are overloading, collisions that cause damage to the bridge, poor construction, and wear and tear. There are many other things that could make a bridge fail but they get particular, like a bolt in a joint rusting out causing the whole structure to become unsound. Overall we have learned the physics that it takes to keep truss bridges stands, which is a lot. We also came to understand that there is a lot of tension and compression in a truss bridge and that it is a key component of the bridge even though you can’t really see it happening. Plus how bridges will eventually come to a crashing end and what causes them too and hope that what we will see happen to my bridge when I demonstrate it in class. Bibliography Boon, Garrett.

Reference:

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