

Muddy Card Responses Lecture M5

The statically indeterminate seems a little against logic, but I guess you can't assume things about forces? With a bit of thought and practice this should start to feel quite logical. At the moment it is simply that with only three equilibrium equations at your disposal (since there are only 3 degrees of freedom of rigid body motion in a 2-D system) if you have more than 3 reaction forces you cannot solve for them with the equilibrium equations alone.

Please explain why you cannot solve for statically indeterminate problems. Two comments. Firstly, you need to understand that you can solve for statically indeterminate problems, but you need more than the equilibrium equations to do so (the constitutive behavior and compatibility must be taken into account). Secondly, you cannot solve using equilibrium alone because, in 2-D you can only write down 3 equilibrium equations (2 for forces, one for moments), and in a statically indeterminate problem there are more than three reaction forces.

What are compatibility and constitutive laws that apply here (presumably to the statically indeterminate example). We will meet this next term. The compatibility conditions are that the beam must remain attached to the wall at the clamped end, and to the support at the end on a roller. In addition, a clamped support has the property that the beam does not have a slope at that end. The relevant constitutive behavior is the force-deflection response of the beam (which we will meet next term).

What would you recommend for someone who does not have a strong background in mechanical physics for a review of concepts needed for materials and structures. I am assuming a basic knowledge of 8.01. We have only just started to go beyond material covered in 8.01. I would suggest reviewing your 8.01 notes as a starting point.

Why can loads only be applied at the joints of a truss. Why not on the bars as well? This follows from the idea that bars can only carry axial loads in a truss. If we loaded a truss mid way along a bar, it would require the bar to carry a moment in addition to a transverse force.

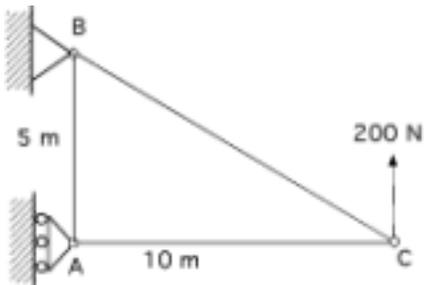
Why in the PRS question could we take moments when we said that pin supports could not support moment reactions? (several people asked variations on this) This is another important point. Although pins (and rollers) cannot provide a pure moment reaction on their own, the reaction forces that they apply do exert moments about other points. You might think of the reverse problem. If I were to open a door supported by a hinge I will pull or push on the handle by exerting a (linear) force, because this force exerts a moment about the hinge the door rotates.

In the final example, why was there no reaction forces at point C? Is it because it is not secured to something? (In the statically indeterminate example right before, where C was a rolling joint, there were reaction forces at C). Everything you say is correct.. In the example of the 3-bar truss point C is where the load is applied, but there is no support at this point, and so no reaction.

How can you say bars in trusses are massless? Is the mass included into the joints? For smaller systems, sure, but what about large planes? We have to consider the bars in a truss

as being massless otherwise we will contradict our assumption about the bars not carrying transverse loads or bending moments. If we want to take the self-weight of a truss into account we need to apply the weight of the bars at the joints.

Rollers are confusing me some. If there is no deformation in the bars, it looks to me like most of the systems you show cannot roll, e.g.:



What's up?

Exactly correct. The structure is statically determinate, so it is a statics problem and not a dynamics problem. If joint B was also a roller then the truss could roll along line AB and would have ceased to be statically determinate.

Can you give a "hint list" of when you know what forces act on what types of points of contact. E.g. roller has no horizontal forces or vertical forces etc. The idealized support conditions are supposed to be quite straightforward to interpret, and simply fulfill the function of reducing the supports/connections in a 2-D system to a single component reaction force, two component reaction forces, and two component reaction forces plus a moment reaction.

Will you always tell us where to take the moment about? Part of the skill is to pick the location of taking moments so that it makes the analysis easiest. Problems M2-4 have started to illustrate this and when we do analysis of trusses over the next week we will see this again.

How do you calculate the degrees of freedom? The degrees of freedom are the degrees of freedom for rigid body motion. In 3-D there are 6 degrees of freedom. 3 components of translation and 3 axes of rotation. In 2-D there are only 3 degrees of freedom. 2 components of translation and one of rotation.

If we were using multiple trusses, how would we do the FBD's. Not sure what you mean by "multiple trusses". I suspect that you are thinking that a truss is the 3-bar assembly that I have brought to a couple of lectures. This is merely the simplest possible example of a truss. We will see that the basic procedure does not change as we have more complicated trusses.

When is the lab that you were talking about earlier? We will have the lecture introducing the lab on 10/30, and you will do the lab work in the week following.

With the PRS question why didn't you draw in moments? I think that you are referring to the second PRS question. The supports were all either pins or rollers, and so not capable of applying pure moment reaction forces.

In 2-D $M=F \cdot d$, but only if F is perpendicular to d , right? Absolutely correct, thanks for pointing this out..

For a FBD in problem set can you just add reaction forces to your original sketch or do you want us to redraw the figure w/o the idealized support conditions. I encourage you to get into the habit of redrawing the FBD. Adding the support reactions on top of the idealized supports can sometimes result in confusion in the subsequent analysis.

3 bar trusses are OK for me; trusses bigger than that are trouble. I will wait for the next lecture and look at the notes. As you will see, once you have the basic concepts of analyzing a 2 or 3-bar truss, larger trusses are no different, just a bit more algebra.

For the last example, what would a physical example of the system be? 3-bar trusses are examples of simple brackets - if you want to hang something off a wall, a 2- or 3-bar truss might be a good approach. As I look from my office window, I can see some examples holding up part of an overhanging roof of the Aero/ Astro deptment's Neumann hanger.

Is a two bar truss drawn as a closed shape in a free body diagram? Yes - the internal structure does not matter, just the points of application of the loads and the reaction forces.