

Muddy Card Responses Lecture M2 2/5/2004

Synopsis: Reviewed lecture M1, reprised the basic process of making modeling assumptions (geometry, load, deformation), identifying boundary conditions, integrating up equations of elasticity between boundary conditions to obtain variations of stress, strain, displacement with position. Reprised St. Venant's principle – boundary conditions, and details of load application only matter locally.

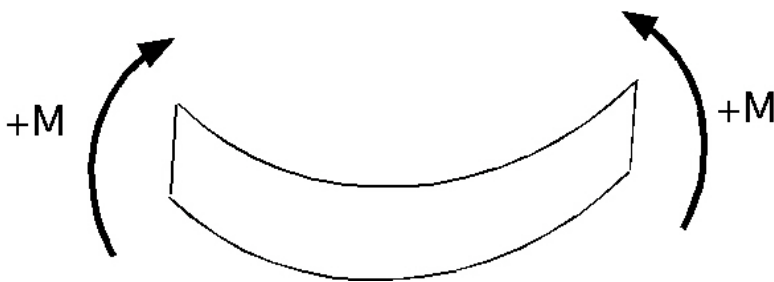
Moved on to look at beams – structural members that support transverse loads. Used method of sections and equilibrium considerations to link the external loads to internal resultant shear force and bending moment (and, in principle axial forces). The bending moment, M , and shear force S will vary as a function of position (x) on the beam. We invoked a convention for what direction we have an unknown bending moment and shear force acting before we apply equilibrium. The variation of these quantities with x can be presented graphically on bending moment and shear force diagrams.

How do you plot the forces, moments on the graphs at the end. I will go over this again – but basically just plotting the equation $M(x)$ vs x and $S(x)$ vs. x .

Could you go over why the moment was negative in the equation (PRS 2) what makes a moment positive or negative. This is important to get straight. Please look back at how we kept unknown bar forces in trusses as tensile until we applied equilibrium to solve for them. The basic issue here arises because we have two frames of reference. 1) the structural frame in which we have coordinates x, y, z and (2) the material (continuum frame) in which we have chosen to define tensile stresses as positive (and also defined positive shear stresses in a particular way). When we apply equilibrium a tensile stress (or force) can act in a negative x direction – and thus appear as negative in an equilibrium equation. The same logic applies to moments.

I had problems with the signs in the bending moment equation. I understand how the moments are found but I don't understand how to classify them as positive or negative. See response above.

Confused about moments: So would this be in equilibrium or would calculations be necessary?



I hope that it is obvious that this section of the beam only has equal and opposite moments applied to it, so it must be in equilibrium of moments as a result.

Does it matter what side of the bar you analyze in your last example? No – the moments and forces on both sides of the cut section are consistent – they must be in equilibrium (think about whether it matters which section of a truss you analyze – both must be in equilibrium).

There were several other comments on the issue of positive and negative moments and the sign convention. We will revisit this in M3.

Sketch of bending moment diagram – not sure what this means. This is just the graph of the variation of bending moment with position $M = -P(L-x)$ that we calculated by applying equilibrium to one or other section of the beam.

In the bending moment diagram what is the diagonal line from $-PL$ to B ? see answer above.

How do we gauge if represent or analyze the compression and tension or displacement in a beam. Not sure what the question is here. Please clarify.

Class is too early, breakfast should be served? See yesterday's comments!

Could you do an example using the left (clamped) half of the beam, instead of the right. Actually this is how I did it in the notes – take a look. Nabori just happened to choose the other half.

I am just a little confused about the technique involved but with a little review (solving PRS questions I should be fine). Good!

Do shear forces vary along the length of the beam? They can – we will see an example of this tomorrow.

I know bending moments cause bending. What causes some sections to bend more? This is a good question and one we should be able to answer in 3-4 lectures time.

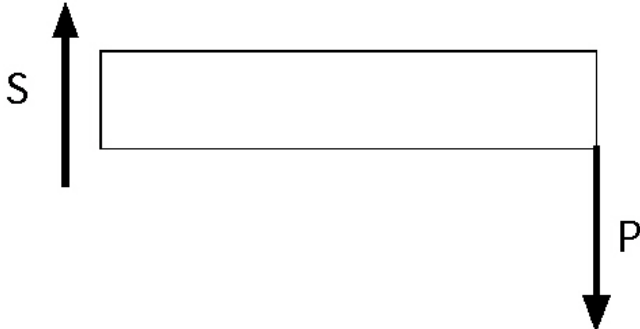
I didn't understand one thing. If the beam can transmit a moment then shouldn't the axial forces (and perhaps the others) be different along the cross-section of the beam in some sort of gradient perhaps? Absolutely. Great thinking. We will see that the bending moment in particular results in a linear gradient of axial stress through the thickness of the beam. This is consistent with the idea that a wing-like cantilever beam experiencing lift from below will have compressive stresses on its upper skin and tensile stresses in its lower skin.

We evaluated $M(x)$, $F(x)$ and $S(x)$ at x where x is along the center axis of the beam. There is no tension or compression at x in the cantilever beam example. But above X there is tension and below x there is compression (top and bottom of the beam. Absolutely. See previous response.

How does shear force determine the "shear" behavior of a beam? We will investigate this in 3-4 lectures time.

If x were close to the point of attachment of the rod we can't use the equation of $???$ because that would be inaccurate, right? Yes. The details of the attachment start to matter – we would need a more refined model.

If you have



: doesn't $S+P = 0$ and thus $S=-P$? No $S-P=0$ and $S=P$. P is acting in the negative z direction and is therefore $-P$ in the equilibrium equation.

When you are summing forces or moments how do you know when to use L or $L-x$ as the length? It does not matter which one you choose – it is a matter of convenience. **Why sometimes is it a function of position and sometimes not?** We will investigate this in M3. Just solve for the whole beam?.

There were 27 cards indicating no mud or general understanding of the material. There was one rather painful witticism, which I will not repeat.