Muddy Card Responses Lecture M4 2/9/2004

Synopsis: Developed general expression for relationships between applied load, q(x), shear forces S(x) and bending moment distribution along beam. $\frac{dS}{dx} = q(x), \quad \frac{dM}{dx} = S(x)$
Continued to look at relative magnitudes of axial stresses $\square_{xx}$ in beams vs. applied loads and transverse stresses: $\square_{zz}$

(Sort of has to do with Scott's question). In real life a beam that has a load on it that is not uniform along the beam, q_1(x), the load q_1 (x) would have a gradient? In real life a beam that has a load on it that is uniform along the beam q_2(x) would not have a gradient? In real life q(x) could take any functional form that the physics dictates. The relationships between S(x), M(x) and q(x) still hold.

I am still a little confused how M, F and S can vary if q(x) doesn't vary over dx. I suggest that you redo the example for a uniform distributed load over a simply supported beam (which we did in M3). Think about this question – where would you expect such a beam to break? This will tell you where the bending moment is highest. This should also tell you that the bending moment must be varying with position along the beam, even though the distributed load is uniform.

Still don't understand how shear changes if q constant (will ask during office hours). I wish that you had asked – please talk to me – or do the example above.

If it's not too much trouble can you number the pages. Sure. I will try to do this.

For PRS #2? $\square_{xx} \square \square_{zz} \frac{L}{h}$: wouldn't $\square_{zz}$ vary along the length of the beam? AND vary along the height of the beam between the top of the beam and the bottom of the beam at the root? Yes absolutely. All I was trying to convey was that we are in a position to estimate the order of magnitude of $\square_{zz}$ and verify that it is much larger than the applied loads, and the through thickness stress $\square_{zz}$

$\square_{xx} bhh \square \square_{zz} b^2 L$ **where do both h's come from.** $\square_{xx}$ acts on an area b x h, and has a moment arm of order "h". This is therefore the moment due to $\square_{xx}$.

Why does $\square_{xx} bhh \square \square_{zz} b^2 L$? See response above.

In PRS #2 why is $M = \square_{xx} bhh \square \square_{zz} b^2 L$ I believe that you took the moment about the root? I did. Please understand that this is a very approximate estimate of the magnitude of the stresses on the cross-section of a beam. We will derive a better estimate on Wednesday.

If forces are equal and opposite (through the thickness of the beam) why doesn't $\square_{xx}$ cancel out and equal 0? In one sense it does – there is no net axial force, but there is a net moment. The stress distribution generates a couple – which is equipollent to the bending moment transmitted at that cross-section of the beam.

In M4CQ1 you said force =qb since the force was acting downward – shouldn't force =-qb?

You are correct and to be consistent I should have said $\sigma_{zz} = -\frac{q}{b}$, but since I was only looking for the magnitude of the stress, I did not bother to do this.

Can you explain M41Q2 again? How did moment $M = \sigma_{xx}bhh \approx \sigma_{zz}b^2L$ and how did you finally get $\sigma_{xx} \approx \sigma_{zz}\frac{L}{h}$? See truss example above – this is probably a clearer way to see this than what I did in class.

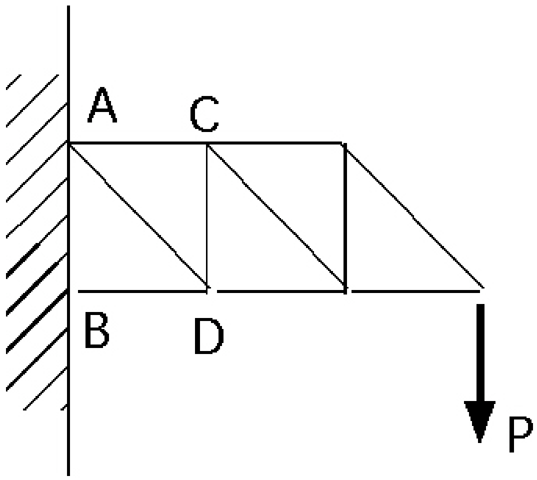
I don't see how did you arrive with the solution to the second concept question above? - see responses above.

I get lost when you take moment arms in the beam. I did not understand at how you arrived $\frac{dM}{dx} = S(x)$. I also do not understand how you were able to show that $\sigma_{xx} \approx \sigma_{zz}\frac{L}{h}$ in the PRS question. OK. Please tell me what you do know, or thought you understood about these two points and I can work from there to help you understand the rest.

Can you refresh my memory as to what the difference between the different stress types. I could, but you will learn it better if you do it yourself and come to me with particular questions.

What are the dif xtmal members and the dif loads they carry again (shaft, column, etc.). rods carry axial loads, shafts carry torsional moments, beams carry bending moments, columns carry axial compressive loads.

How can bending in one direction generate stresses in another direction? And how come half are tensile and half are compressive? Analyze the truss below, particularly bars AC and BD and you will determine the answer for yourself:



I thought that you need and axial force to have an axial stress? -see response above. There is no net axial (horizontal) force on the truss, but the vertical force does produce axial forces in the horizontal members AC and BD.

Why does a bending moment cause a tensile stress. – see response above.

How is it that bending forces can create such large axial forces? See truss above. The height of the truss (distance AB) decreases the forces in AC and BD must increase.

It seems as if a lot of estimation is needed. How do we know how much is too much?. When you get the answer wrong!! In all seriousness estimation is an important skill for engineers to acquire. A quick estimate of the solution is often an important step in the process of deciding whether it is worth performing a more detailed analysis, and how best to set up the more detailed analysis. In making estimates we need to develop some idea for how accurate they are likely to be.

Could you please explain Ryan's question again? The question asked about why if there is no load applied on the beam there is no σ_{zz} in the beam. It seems the load would be felt by the entire beam because the entire beam will deflect. My apologies, I misunderstood Ryan's question. We will see in the next couple of lectures that the deflection of the beam is actually due to a distribution of axial (σ_{xx}, σ_{xx}) stress through the thickness of the beam.

σ_{zz} varies over the entire length of the beam? (in PRS) Yes.

No axial force, but is there an axial stress? Yes

When the piece of chalk breaks, it starts to snap at the top right? Once that initial fault starts σ_{xx} must attempt to increase making another failure likely, making the break propagate straight through? Or even if it started to fail at the bottom same would happen just failing through compressive forces… Good question. Brittle materials fail due to tensile stresses acting on flaws (cracks). We will examine this in detail later in the semester (approx lecture 17/18) . If you want to learn more about failure please read Ashby and Jones Ch. 14/15.

Why is the expression $M_0 = \int_0^x x \frac{d(load)}{dx} dx$ **an approximate? (As opposed to exact, I understand where the equation comes from) .** I think that I am missing something here. I actually wrote: $M_0 = \int_0^x xq dx$ - which is exact given an exact value of q(x) (distributed load/unit length). If I said it was approximate then it was a slip of the tongue – for which I apologize.

Also when we broke up the beam by dx on a non-uniform loaded beam were the directions of the bending moments, shear forces etc. drawn as a matter of convention? Or is that characteristic of how it is loaded? Yes I did follow our convention for what constitutes a positive bending moment, shear force etc.

There were 12 cards signifying no mud, or with positive comments. Thank you.