Muddy Card Responses Lecture M3 2/6/2004

Synopsis: Continuing to develop understanding of resultant shear force and bending moment distributions along beam. Considered cases with central point load and uniform distributed load. Need to be methodical in sectioning beam and applying equilibrium to section. Maintain conventions for positive bending moments and shear forces.

There are some residual questions on the definitions of unknown shear forces and bending moments. I have done my best to answer them via muddy responses. If this continues to be a confusion please come and talk to me or the TA's – it is easier to explain in person.

How did you know to use integrals on the last two PRS questions? And how did you know which integrals to use and what signs? In general when we have a distributed load, q(x) we will need to integrate the load over the part of the beam it is applied to in order to obtain the resulting moments and forces. The load on a differential element of beam, length dx is qdx, and its moment about the point x=0 is qxdx. If this is confusing just remember back to how you calculate the center of mass of a body (weight is a distributed load).

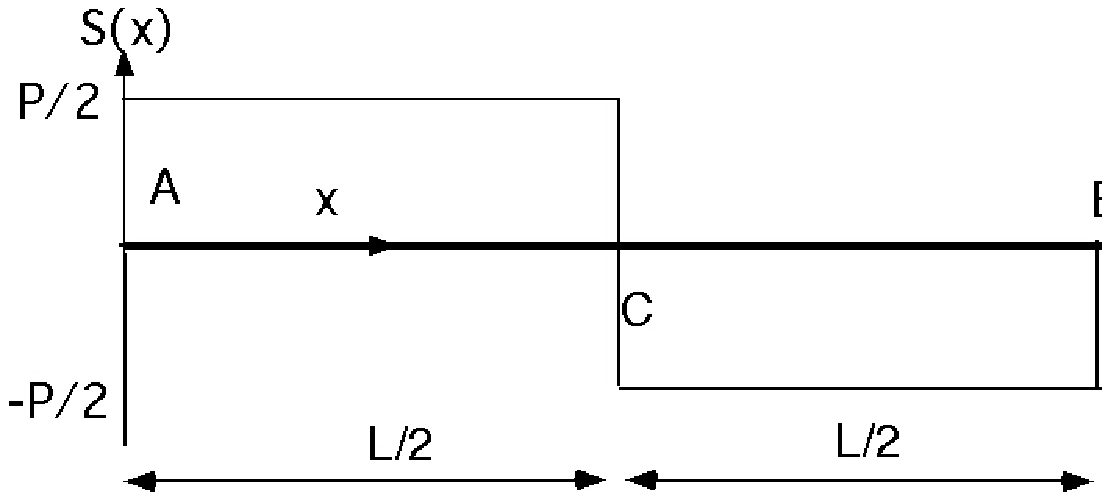
I am still uncler about the integral in the uniform distributed loading equations, exactly how is it arrived at? See above.

How do you get the integral $\int_0^x qxdx$. I thought it would be $\int_0^x qdx$ because the force =qx. But its only a fraction of the total force so that qx/x…. There are two points here. First we are dealing with forces $\int_0^x qdx$ and moments $\int_0^x qxdx$ due to the distributed load. Second, in general the force due to the distributed load acting on an infinitesimal segment of beam is qdx – which we then integrate up to obtain the whole force – not the reverse!.

Ah, I am a bit confused, where does the integral come into play? See above.

In the PRS question with the distributed load, I calculated the moment right but I setup the integral wrong. Why is it $\int_0^x qxdx$? I thought that would give you the force and not the moment…. See previous responses.

With the shear graph looking like:

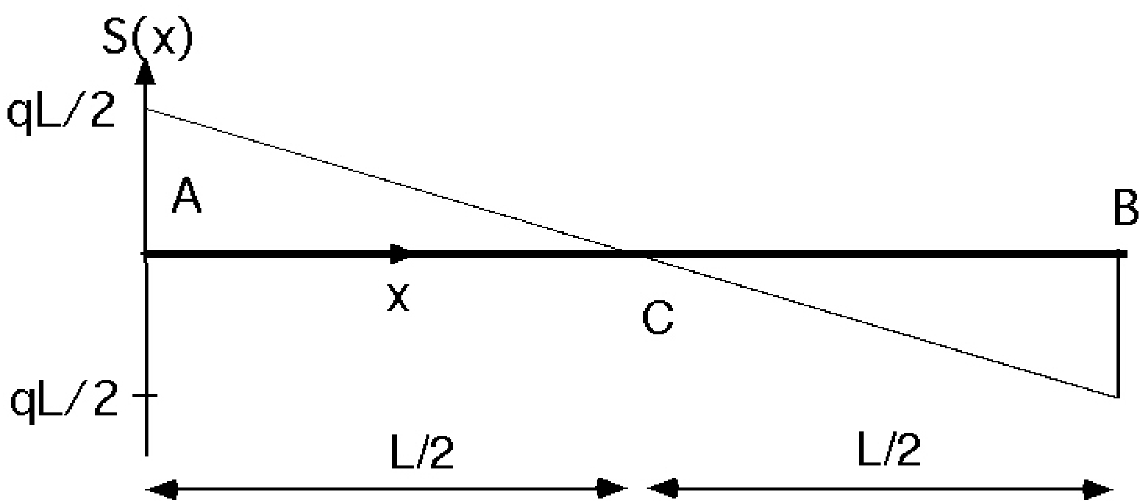


would it instead curve and gradually come to the zero point in the middle (a sketch of a backward "S"). This comes back to our modeling assumptions and St. Venant's principle. The discontinuity in the shear force distribution is abrupt if there truly was a point load applied at C. In reality the load will be applied over a short distance, meaning that the slope of dS/dx is finite in that region.

If there is a jump in the shear at a point where a discrete load is applied, can we know what the shear force is at that point and what would it be? Yes – we will discuss this more on Monday, or you can read ahead in the notes.

Don't understand last PRS on continuous loading. If load is applied downwards, then how is moment upward? I suggest you draw the free body diagram for the relevant section and calculate the moment for yourself, then apply intuition to ensure that it makes sense to you.

I don't understand the last concept question with the shear force. If your graph the shear force vs. x of the correct answer it is:



But if it is symmetrical (the beam set up) how can the graph not be symmetrical? Good question. The shear distribution is actually symmetric about point C , at least in terms of magnitude. The antisymmetry stems from the sign convention for the shear force. This will make a little more sense (I hope) after Monday's lecture.

For the second cut of the first PRS question you set your range as L/2<x<L. Doesn't this mean your starting point is the midpoint of the beam? I think your starting point was to the left of the midpoint. No. my origin for x was the left hand end of the beam in all cases. I must include the whole section in my free body diagram and the resulting equilibrium equations.

What was the shear force for the last example? See PRS question and answers. Remember you need to include the reaction at the LH end of the beam in the equilibrium equation.

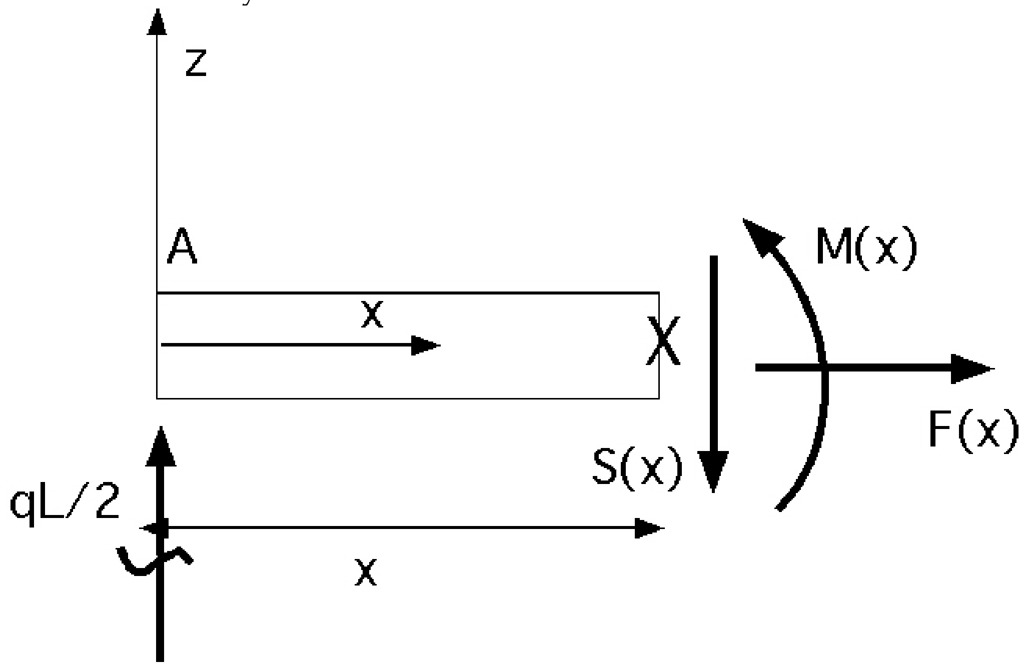
I do not understand how you draw the moment diagram. I calculate M(x) and then plot it vs. x.

No mud but there is an error in the equilibrium equation for S(x) in the last example (for continuous loading) Sx was written at one point instead of S(x). You are correct. Thank you.

I got the reverse answer on M3Q2 (bending moments) I took it about the cut. How come M doesn't cancel out. I suspect that you were not consistent in how you took moments. M shouldn't "cancel out" but it should be in equilibrium with the applied forces and moments acting on the section of the beam being considered.

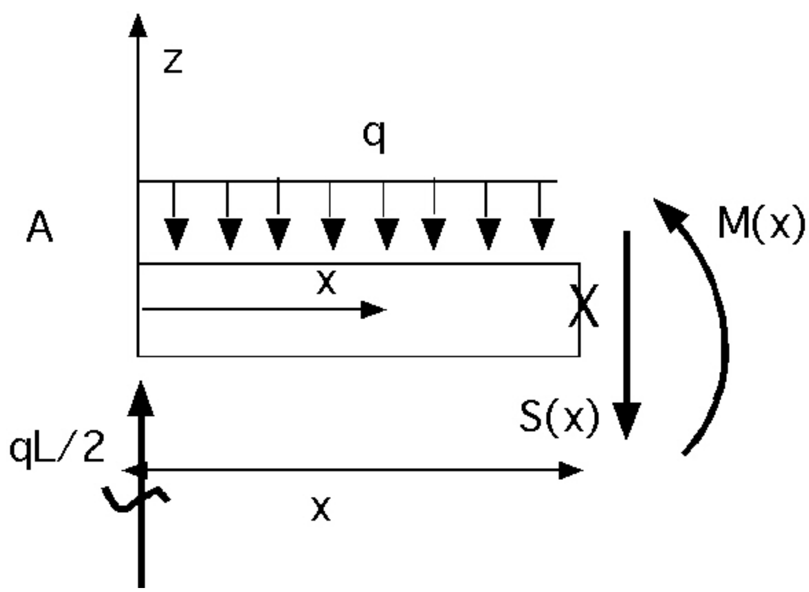
You said we should have introduced a dummy variable in the integral. Would we set it up like: $q\int_0^x (x' - x)dx'$**?** Yes, this is absolutely correct. I was a little casual about setting up the integral properly.

ON the last PRS you take a section:



It seems like you get an incomplete answer. M-qLx/2=0, M=qxL/2?

You have forgotten to include the applied load the integral in your free body diagram. The section I used, and the equilibrium equations that resulted were:



$$\sum \uparrow + \frac{qL}{2} - Sx - \int_0^x q\,dx = 0$$

$$\Rightarrow \frac{qL}{2} - qx = S(x)$$

$$\sum M_x \; {}^{+} \quad -\frac{qLx}{2} + M_x + \int_0^x qxdx = 0$$

$$-\frac{qL}{2} + M_x = \frac{qx^2}{2} = 0 \Rightarrow M_x = \frac{qLx}{2} - \frac{qx^2}{2}$$

The last "observation" was that values of S & M go to value of the reactions at boundaries. However in the PRS example the boundary condition was M=0 at both ends where the reactions had positive values. Is this statement incorrect? Yes it is!!!! The beam is simply supported (pin and roller) so there are no moments at the ends, and the bending moment goes to zero at the ends. The shear force equals the force reactions at each end. Thus the observation is consistent with the data!!

Are there any guidelines as to which end of the beam we should start from? Certain types of joints etc. It will not generally matter. I tend to always start at the left hand end unless there is a compelling reason to do otherwise.

There were 24 responses which had no mud, or positive comments. There were several who discovered an error in their understanding as they were writing it down!