Muddy Card Responses Lecture M9 2/18/2004

Synopsis. Spent some time covering the process of calculating deflections of a beam, following on the mud generated in lecture M8. Discussed use of superposition to analyze statically determinate beam problems. Reviewed limitations on beam theory. Discussed the limitations of simple beam theory: transverse loads, straight, slender, symmetric, members, linear elastic materials, small deflections. Started to introduce modeling assumptions for shafts under torsional loading.

Do arches have any practical applications or are they just for show. I can tell I am in an aero/astro department and not civil engineering. For many years when stone was the principal building material for large structures arches were the standard structural form for bridging a gap. They are still widely used for bridges over highways etc.

Why do stone structures not like tensile forces? Stone is a brittle material and so can be quite weak in tension. Also the joints between stones are particularly prone to failure under tensile loading.

Why is it that heavy loads strengthen a keystone arch? This is beyond the scope of Unified, you can probably work it out yourself, or look it up in a reference book..

With shafts is the deformation of an arbitrary disk that was written up on the board (P – p′ = rϕ(x$_1$) Just an estimate? Shouldn't it be a curved deformation since it is a rotation? Yes, but I said that $\phi(x_1)$ is small so we can approximate the circular arc length as the tangent, and since we are working in the small deflection regime this will be OK.

What is the reasoning for choosing the two structures for superposition in the example?.

Equivalent to:

$$(1)$$

A   q

B

δ_1

L

+

(2)

A

δ_2

L

R_B
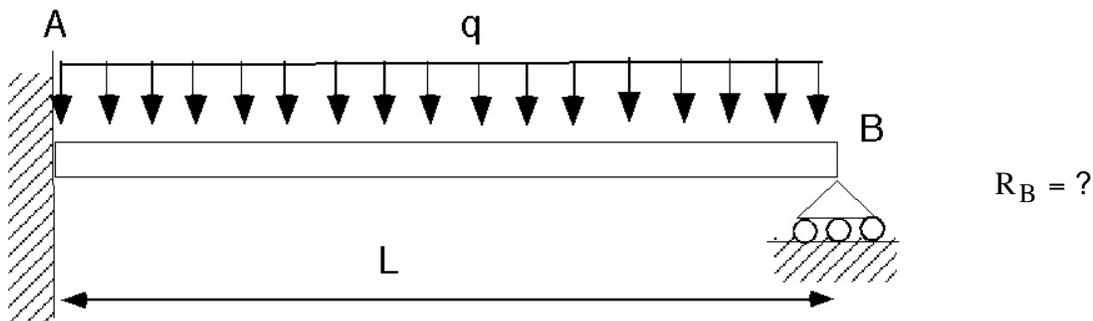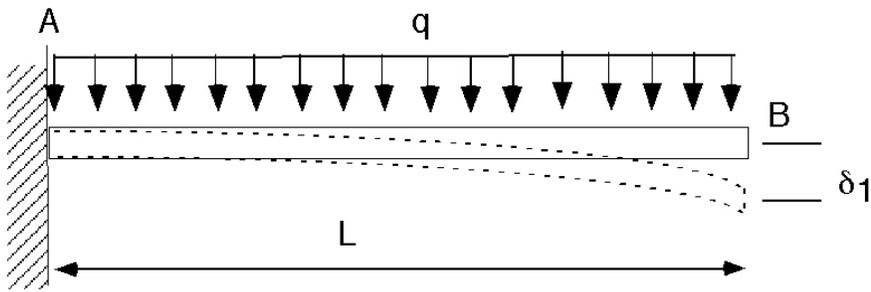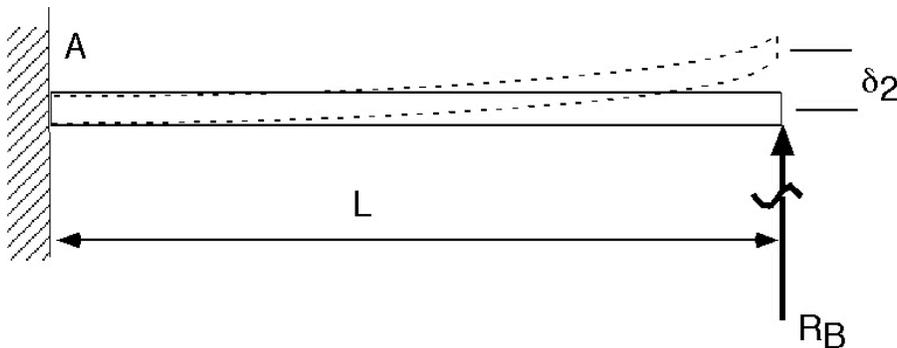
Here are the basic requirements.   Must keep the structure the same. If I relax a boundary condition I must replace it by an equivalent force. I want to minimize the amount of calculation I do. Since there is only one additional constraint in this problem, I only need to relax one boundary condition (i.e. the pin at B) and I must replace it by an unknown force (the reaction at B). I hope that this helps.

How would you treat a pass through joint differently from a clamp? (such as with an airplane wing). This was perhaps not the best example, but it is quite feasible to introduce a boundary condition that has a spring stiffness of its own. We will see an example of this next time when we start to talk about structural instabilities.

Can all materials withstand a certain degree of torsion? Or are there some that are two brittle (i.e. glasses) and fail as soon a s torque is applied? We will discuss some ideas behind this in the next module on the material aspects of structural integrity. One key point here is that materials do not fail due to torsion or bending or the axial force applied to them, what causes them to fail is the stress (which can arise due to all sorts of loading), and in some cases the presence of defects in the material.

Are we ever going to talk more about I-beams and box-beams in Unified. You will do a couple of problem set questions which involve these types of cross-section. The theory you have met thus far will allow you to cope with them.

Will we have to know how to deal with beams that are not orthotropic. Not in detail at this stage, but you might one day….

What do we need to know about limitations? That they exist or all about them. Basically just the former. It would be irresponsible of me to teach you a theory and then not give you any indication of when it breaks down. If you take higher level M&S classes you will have the opportunity to learn about structural mechanics models that will allow you to deal with some of these limitations.

What is anticlastic bending?   Please read Crandall, Dahl and Lardner section 7.5 for a more detailed explanation and figures.

You should draw straight lines on your example of a shaft so that if you twist it we can more easily see the deformation of the shaft. Good idea.

There were 9 muddy cards with no mud, or positive responses. Thank you.