

Muddy Card Responses Lecture M15

What is “principle stress” First up it should be “principal” - a pet hate of mine. The principal stresses are the maximum and minimum (extremum) extensional (normal) stresses in a stress state at a point. The principal directions are the corresponding directions. The principal directions have no shear stresses associated with them

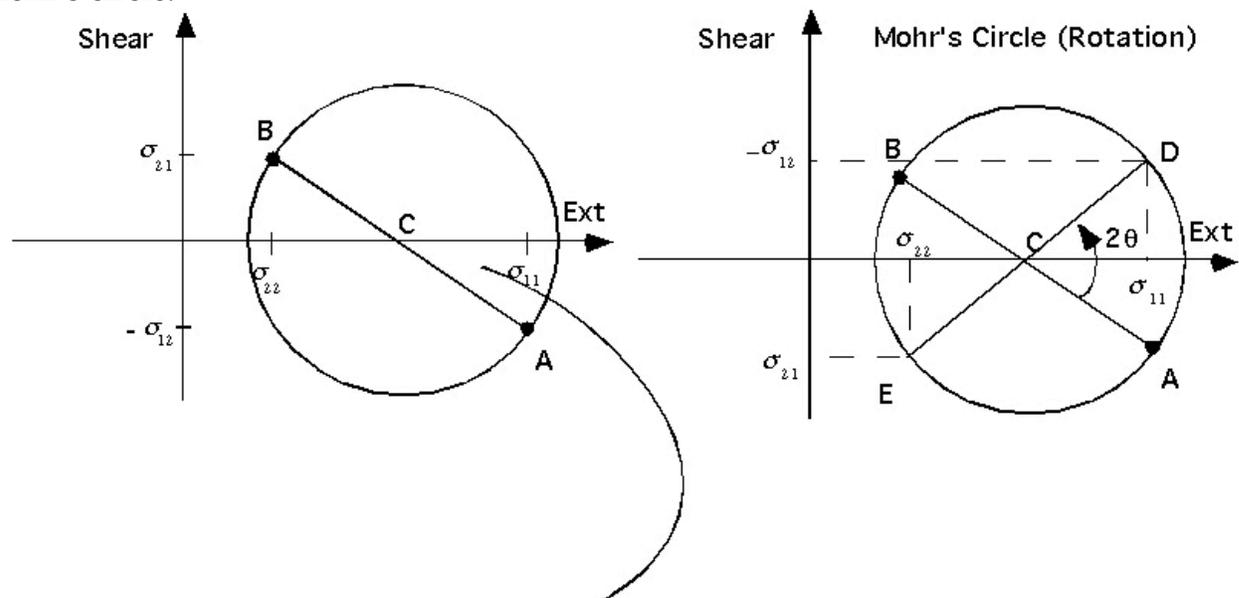
More explanation of Mohr’s circle. How do we know what to plot where? I have put a step by step guide in the notes. If you follow this you should be able to do it correctly.

Are there any readings that would help explain some of these concepts. Yes. If you look at the M&S syllabus (on the M&S part of the materials web site) you will see reading assignments with each lecture. The material we are covering now is covered in Crandall, Dahl and Lardner chapter 4. It is worth looking at. Beware that CDL use a different notation for stress which we will discuss in the next lecture or so.

On the second Mohr’s circle concept question, would the two most popular choices (#1 and #2) produce the same circle? Since they are simply rotations of one another, I would expect that the circle is defined to be the same, Why, then, was it wrong to answer #2? It is true that all of the answers produced circles of radius 50 MPa centered on the origin. However, in the circle given, the direction of τ_{21} was defined. This means that the correct stress state was acting at 45° to answer #2. Note although the circles are identical, the directions are not – and the directions matter (in fact they are the most important feature of the Mohr’s circle).

2nd PRs question not clear. See comments above. **M&S is cool.** I am very glad that you think so!

For Mohr’s circle:



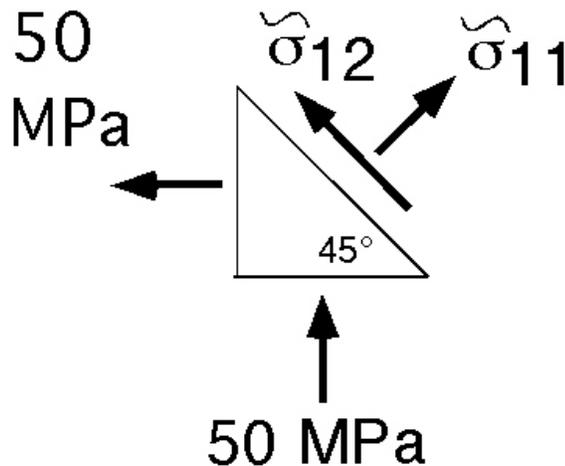
This angle isn't necessarily θ is it?

When you draw the rotated diameter it seems you just reflected it about the x-axis, but that's not what it really is right? No it is a rotation not a reflection – the way I drew the right hand figure above it just happened that the angle the line AC made to the extensional axis was about 45° but this was just a coincidence.

What does tensor mean? It is a mathematical term that allows us to quantify parameters that vary with one or more directions. Vectors can be expressed as 1st order tensors (a single index is required to define the single direction involved) stress and strain are 2nd order tensors, and we will meet a 4th order tensor in due course.

Are principal stresses just the max stress ext directions? Not exactly. They are the values of stress in directions with no shear stress associated with them, this makes them the extremum values of stress, and in a two dimensional stress state one will be the maximum (most tensile) and the other then minimum (most compressive).

In the second (?) PRS: Can you explain how rotating the unit cube can result in no tensile stresses, for option "2". Where do the shear stresses arise from, and why is the maximum not equal to σ_{21} ? The combination of equal tension and compression applied at 90° to each other results in pure shear at 45° . If you want to convince yourself of this consider the equilibrium of the following wedge element, assume the straight side lengths are L and the out of plane thickness is t:



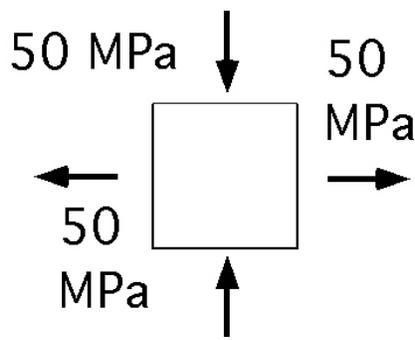
Performing equilibrium $\sigma_{11} \frac{Lt}{\cos 45^\circ} + 50Lt \cos 45^\circ - 50Lt \sin 45^\circ = 0$

Given that $\sin 45^\circ = \cos 45^\circ$, we can see that $\sigma_{11} = 0$

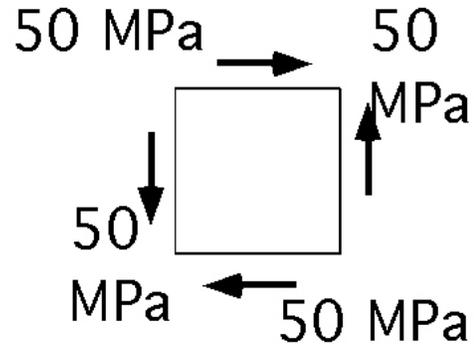
And $\frac{\sigma_{12} Lt}{\cos 45^\circ} + 50Lt \cos 45^\circ + 50Lt \sin 45^\circ = 0$

Hence $\sigma_{12} = -50 MPa$

At the end of the second PRS you explained how:



is the same as



except rotated through 45° . Is this correct and can you explain further?. Yes this is correct. The previous reply should help explain how this works.

Does σ_{III} only appear in 3-D stress applications? If not when does it appear.? We are mostly interested in 2-D stress (also called “Plane Stress”) in this case there are no out of plane stress components. This means that σ_{III} is zero. For a 3-D stress distribution it will take on non-zero values. We will meet some simple ones later in the term.

A bit confused about Mohr’s circle. OK – this is a difficult concept. I suggest you read the notes again, or look at the reading in CDL, and then feel free to come to me with specific questions.

Can you put a step-by-step method on drawing the Mohr’s circle. This is in the notes. Please do ask for further clarification if it is not sufficiently clear.

It seems like today , as we have done in most of Unified, we focused almost only on the convention, the “how to solve something” approach, as opposed to the science behind it. When I solve something I like to no more about what I am actually doing, as opposed to following a list of instructions to get an answer. Can you talk just a little more on physical interpretation/derivation/reason for discovery of Mohr’s circle? Thanks. We discussed this after class, but I think that this is worth repeating for the rest of the students. This is really important. The key idea is that we are applying equilibrium to resolve stresses into different coordinate systems, using the triangular element of problem M12. This is the underlying science. It just so happens that the equations that result from this (with their sine and cosine terms) can be represented as Mohr’s circle – there is no real derivation of this, although if you take Mohr’s circle you can obtain the equations we derived from the equilibrium considerations. The nice aspect of Mohr’s circle is that it provides a ready way to visualize the state of stress as a function of orientation . Stress is a difficult quantity to visualize, so I think that this is helpful, even at the expense of following a mechanical set of steps in order to set it up.

This may be obvious, but I don’t really understand the difference between strain and stress. Could you explain, (or reexplain as the case may be)? Sure. Stress is the continuum representation of forces (i.e forces acting per area). Strain is the continuum representation of deformation (i.e. changes in length per initial length, or changes in angles (for shears). They are completely different quantities.

I don't like having the entire 2nd half of lecture on the overhead. I like work on the board.

Certainly a valid comment. Just so that you are aware of how I am approaching this, here is some explanation. I try to put routine ideas on the overhead, when I need to expand on these ideas I use the black board. Using the overhead in this way allows me to pace the lecture better, as I can spend more time on the difficult points, and go quickly through the obvious or incidental points (for instance the basic definitions of strain are not conceptually taxing, and the idea of principal stresses as eigenvalues is incidental to the general understanding of the subject – but it might help a few people connect to this material. Also please note that the material I put up on the overhead is directly taken from the notes posted on the web.

Can you put results/answers from the PRS on the web. I guess your persistence is wearing me down. I will do this.

Just muddy..... Oh dear. Please do give me a little bit more to work with here.

Class is too early. How do you think I feel – I actually spend an hour or more before class preparing - and sleeping through it is not really an option for me.!

Muddy- none, such a cool circle! Yeah for pictures! Graphical rocks! I am completely with you on this!

Is soccer (“football”) the best sport on earth?? Not by a long shot, I would take Rugby as number one (England are due to win the world cup this weekend!), Cricket as number two and then perhaps soccer (although I would rather play Ultimate myself).

There were 18 replies signalling no mud or with positive comments. Thankyou.