

Mechanics of Material
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Pressure vessels and failure theories
Lecture - 94
Maximum normal stress or rankine condition

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The image shows a digital whiteboard with handwritten mathematical derivations. The equations are as follows:

$$\frac{2}{b^2} = \frac{3}{(\sigma_y)^2} \Rightarrow b^2 = \frac{2}{3}(\sigma_y)^2$$

$$\frac{3}{2(\sigma_y)^2} - \frac{1}{a^2} = \frac{1}{(\sigma_y)^2}$$

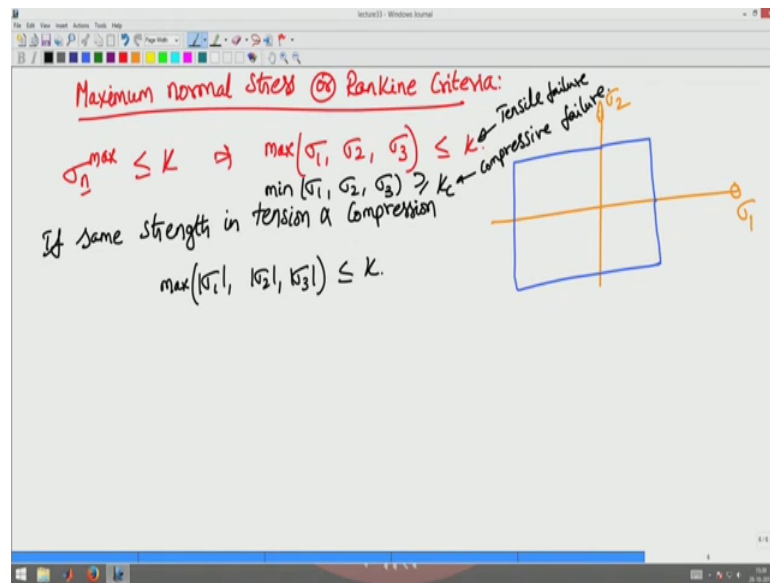
$$\frac{1}{a^2} = \frac{1}{2(\sigma_y)^2} \Rightarrow a^2 = 2(\sigma_y)^2$$

$$\frac{x^2}{(\sigma_y)^2} + \frac{y^2}{(\sigma_y)^2} - xy = 1$$

$$\frac{xy^2}{2(\sigma_y)^2} + \frac{3}{2} \left(\frac{xy}{\sigma_y} \right)^2 = 1$$

Now, let us look at the other remaining failure theories, which of a pressure hydrostatic pressure sensitive materials ok. Next for a theory we are going to look up this.

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What is called as the maximum normal stress or Rankin criteria what it says is, sigma n normal stress maximum has to be lesser than or equal to kappa the normal stress maximum is given by maximum of sigma 1 sigma 2 sigma 3 here it is not absolute value, it goes with the sign has to be less than or equal to kappa ok.

So, this theory allows us to have different values for tension and compressive strengths ok. The failure envelope for this curve would be in sigma 1 sigma 2 plane, it is going to be sigma 1 sigma 2 plane it is going to be just a square ok.

So, basically if the tensile strength of sigma in if the tensile strength exceeds in sigma 1 direction is going to fail, the tensile strength exceeds in sigma 2 direction is going to a fail the compressive strength in sigma 2 direction exceeds its going to fail, I am repeating I did not show the marker before. The tensile strength in sigma 1 plane exceeds is going to fail, if the tensile strength in sigma 2 direction is exceeds is going to fail the compressive strength in sigma 1 direction is exceeding is going to fail the compressive strength in sigma 2 direction is exceeding is going to fail ok.

So, anytime any of the compressive or the tensile strengths exceeds a particular element the module is going to fail ok. If it has equal sending tension and compression then I can use the following expression or I can put a modulus sign here, if same strength in tension and compression ok. Then I can say max modulus of sigma 1, modulus of sigma 2, modulus of sigma 3 has to be lesser than or equal to kappa ok.

Otherwise this assumes only tension causes failure this assumes tensile failure analogously I will have minimum of $\sigma_1, \sigma_2, \sigma_3$ must be less than or equal to or greater than or equal to κC this is compressive failure stress causing failure ok. If both are same then I can just one equation with says what is the failure strength this is maximum normal stress or Rankine criteria.