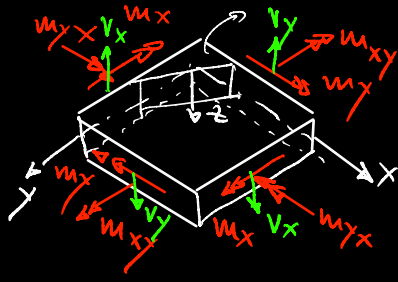


Reinforced concrete slabs

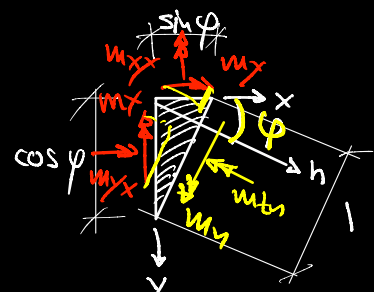
Internal actions / stress results



bending moments:
 normal moments m_x, m_y
 twisting moments $m_{xy} = m_{yx}$
 transverse shear forces v_x, v_y
 ($v_0 = \sqrt{v_x^2 + v_y^2}$)

$$\frac{\partial^2 m_x}{\partial x^2} + 2 \frac{\partial^2 m_{xy}}{\partial x \partial y} + \frac{\partial^2 m_y}{\partial y^2} + q = 0$$

"beam x" additional to "beam y"



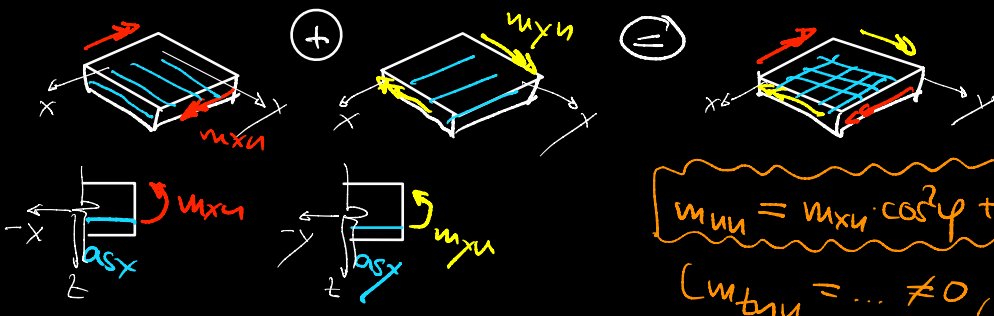
Equilibrium (in forces !!)

$$m_{n \cdot l} = m_x \cdot \cos^2 \varphi + m_y \cdot \sin^2 \varphi + m_{xy} \cdot 2 \cdot \sin \varphi \cdot \cos \varphi$$

$$m_{t \cdot l} = (m_y - m_x) \sin \varphi \cos \varphi + m_{xy} (\cos^2 \varphi - \sin^2 \varphi)$$

Normal moment yield criteria

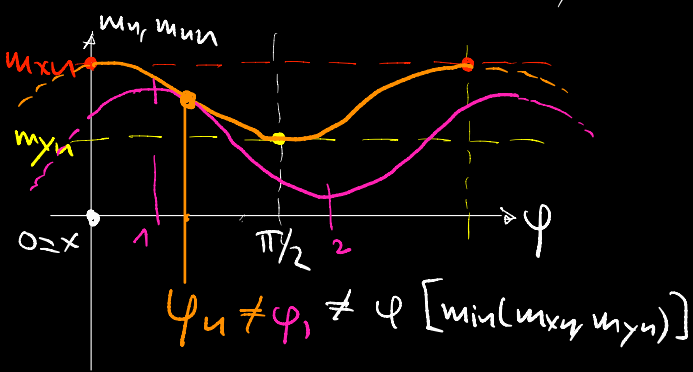
① Superimpose $m_{xu} + m_{yu}$



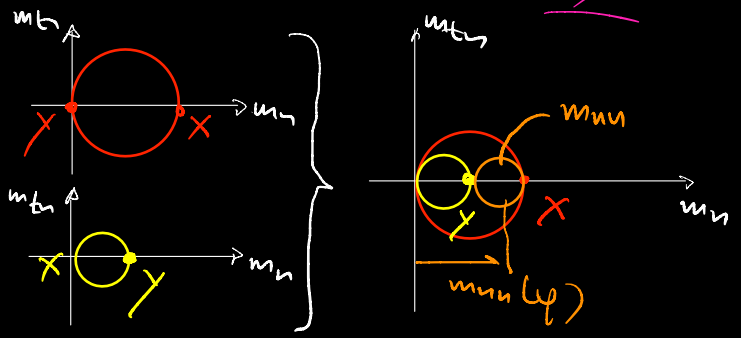
$$m_{nu} = m_{xu} \cdot \cos^2 \varphi + m_{yu} \cdot \sin^2 \varphi$$

($m_{t \cdot nu} = \dots \neq 0$, not considered!)

② request $m_n \leq m_{nu}$ $\forall \varphi$



applied bending moments: m_x, m_y, m_{xy}



normal moment in any direction φ must be smaller than moment resistance \checkmark

analytically

$$\left. \begin{aligned} m_n &= m_{nu} \\ \frac{\partial m_n}{\partial \varphi} &= \frac{\partial m_{nu}}{\partial \varphi} \end{aligned} \right\} \text{solve} \rightarrow$$

$$\left. \begin{aligned} m_{xu} &\geq m_x + \tan \varphi_u |m_{xy}| \\ m_{yu} &\geq m_y + \cot \varphi_u |m_{xy}| \end{aligned} \right\}$$