



第三章 粘结与锚固

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粘結作用

• 裂縫出現前粘結的作用

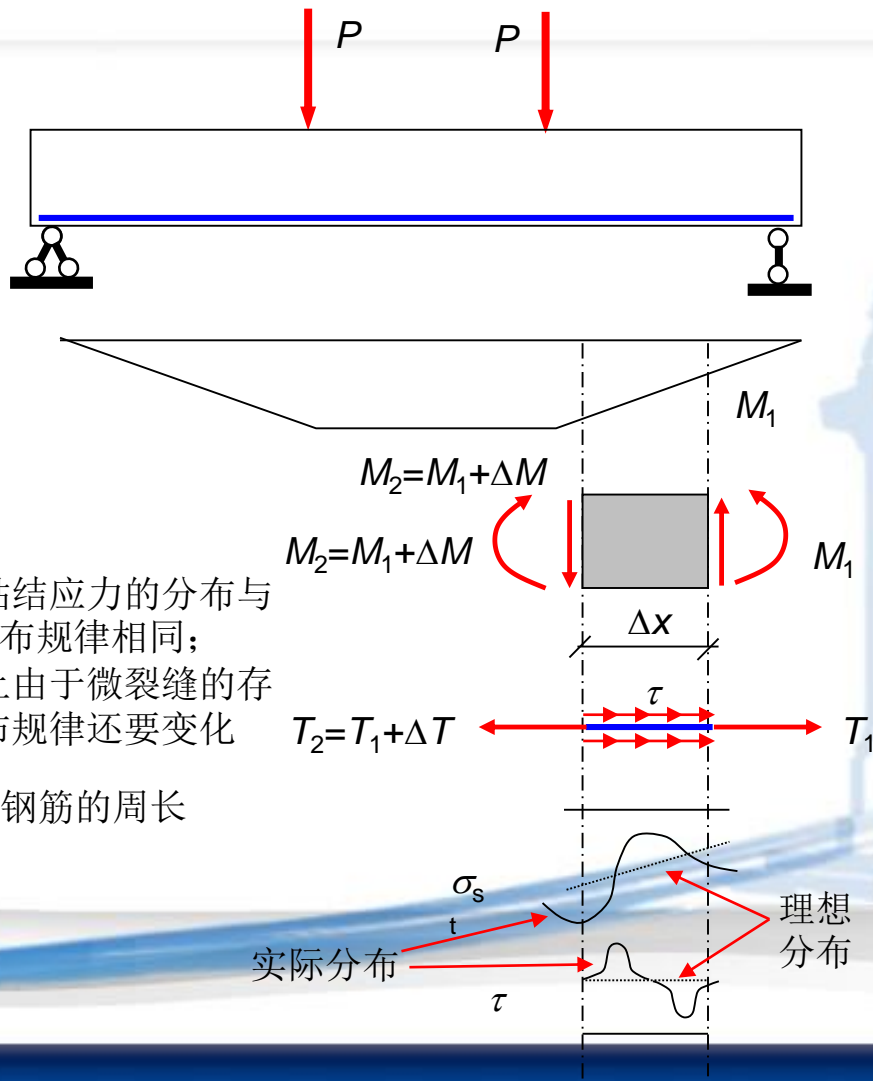
$$T_1 = \frac{M_1}{\gamma_s h} \quad T_2 \approx \frac{M_2}{\gamma_s h} = \frac{M_1 + \Delta M}{\gamma_s h}$$

$$\Delta T = \frac{\Delta M}{\gamma_s h}$$

$$\tau = \frac{\Delta T}{\Delta x \mu_s} = \frac{\Delta M}{\Delta x} \frac{1}{\gamma_s h \mu_s} = \frac{V}{\gamma_s h \mu_s}$$

梁中粘結應力的分布與V的分布規律相同；
實際上由於微裂縫的存在分布規律還要變化

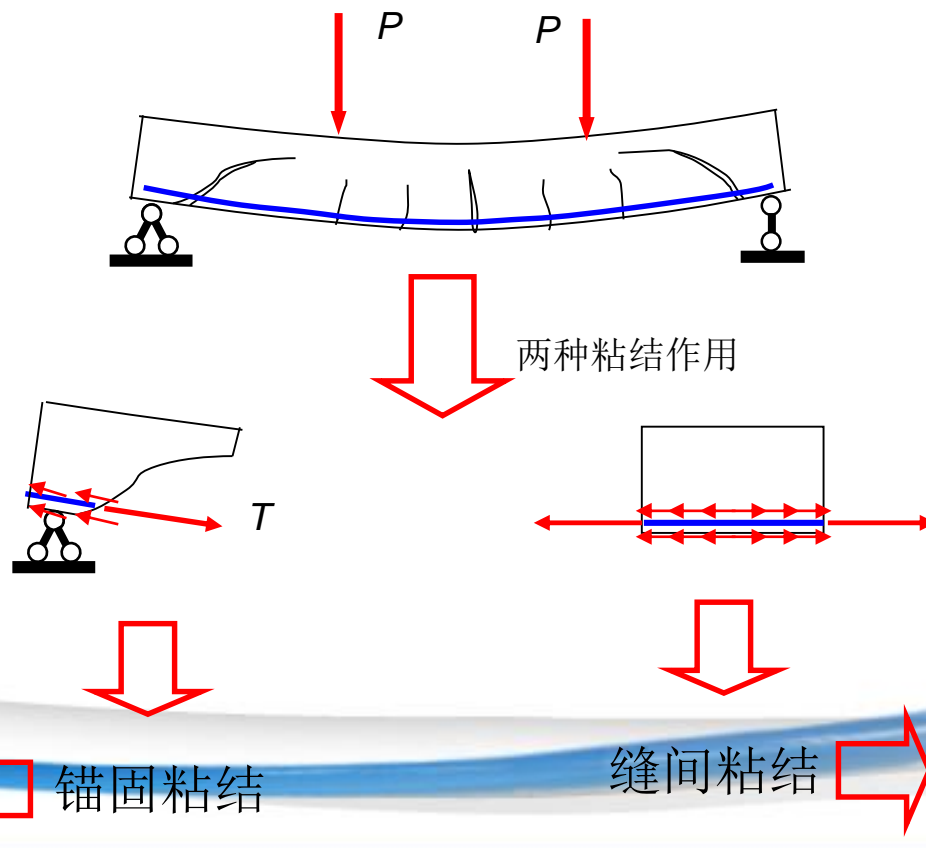
鋼筋的周長





➤ 粘結作用

- 裂縫出現後粘結的作用



保证钢筋和混凝土共同工作

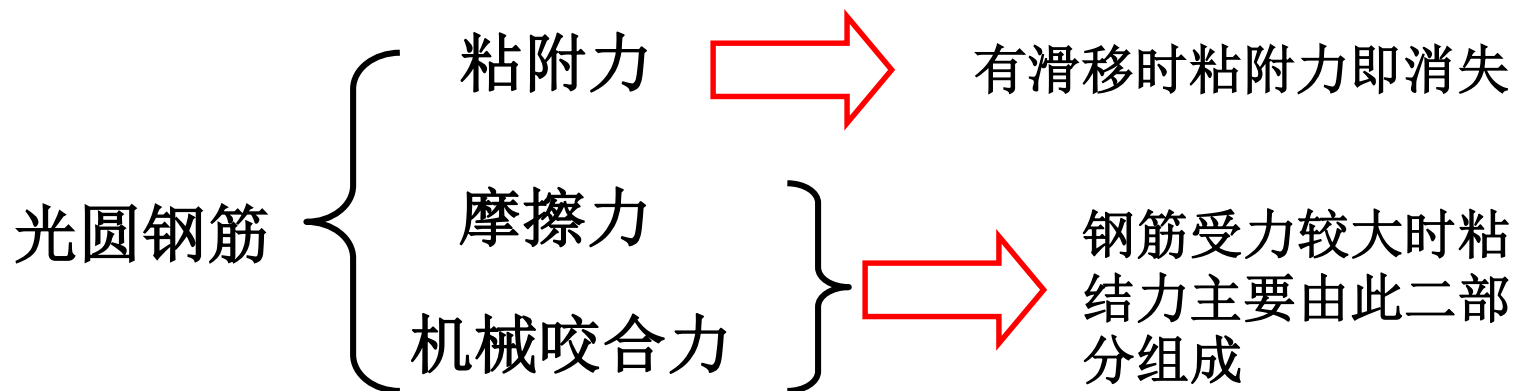
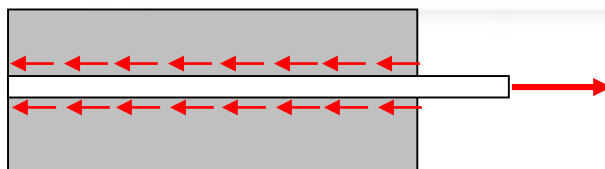
锚固粘結

縫間粘結

改善钢筋混凝土的耗能性能



➤ 粘結机理

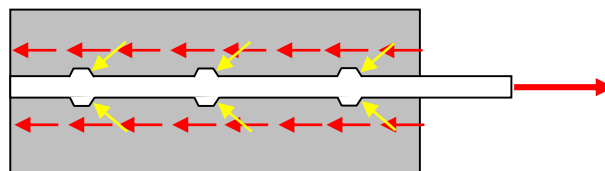


注：钢筋表面不平、微锈时可显著提高咬合力





➤ 粘結机理

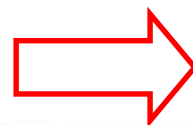


变形钢筋

粘附力

摩擦力

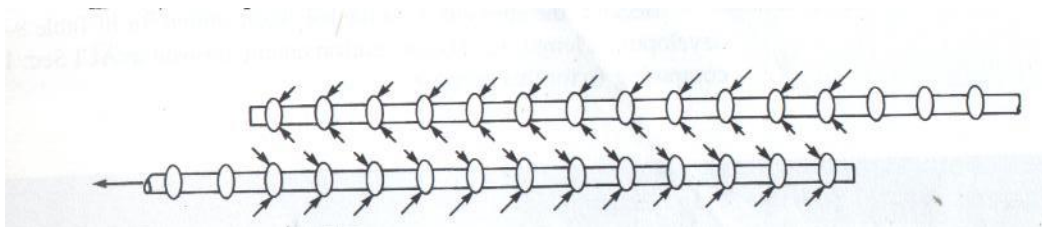
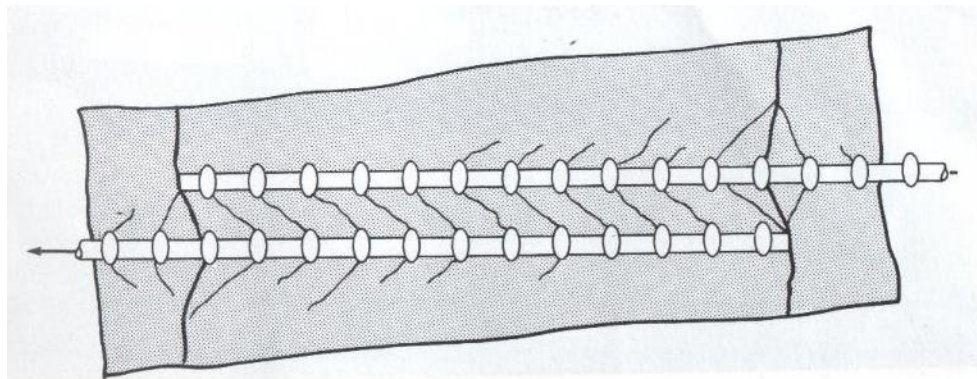
机械咬合力



主要作用

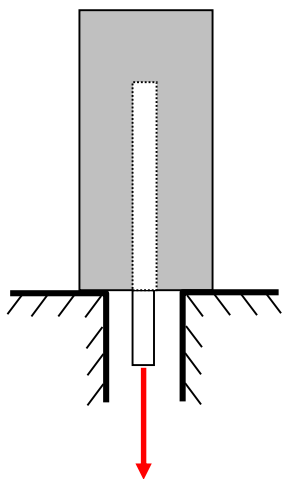


➤ 搭接机理

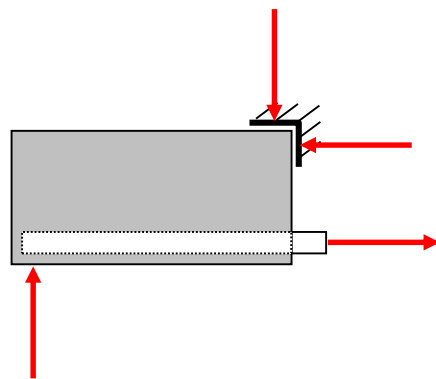




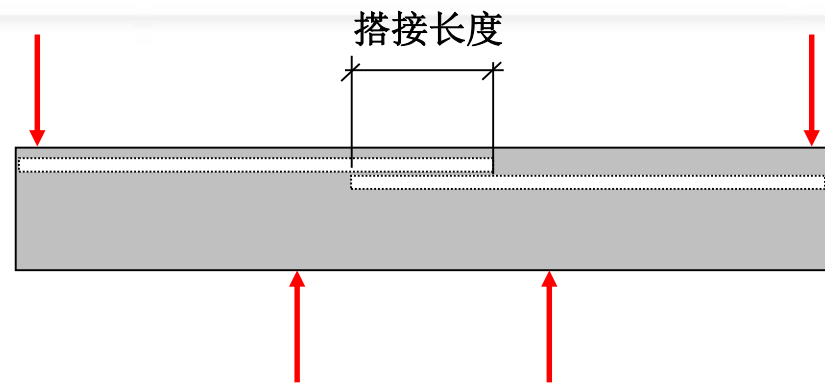
粘結、搭接試驗



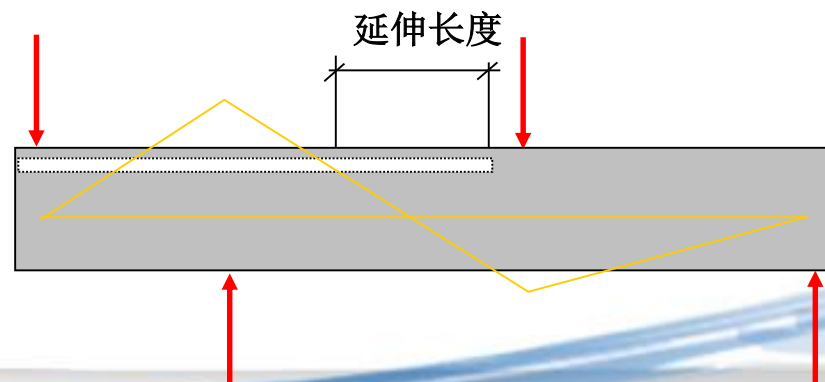
拔出試驗



半梁試驗



搭接長度試驗

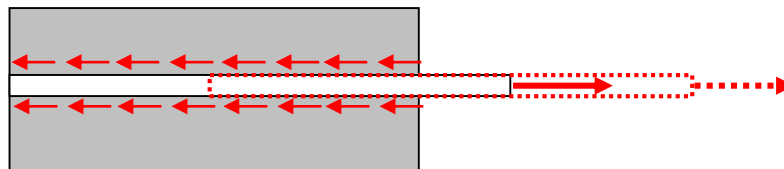


延伸長度試驗



➤ 粘結破壞形態

- 光圓鋼筋

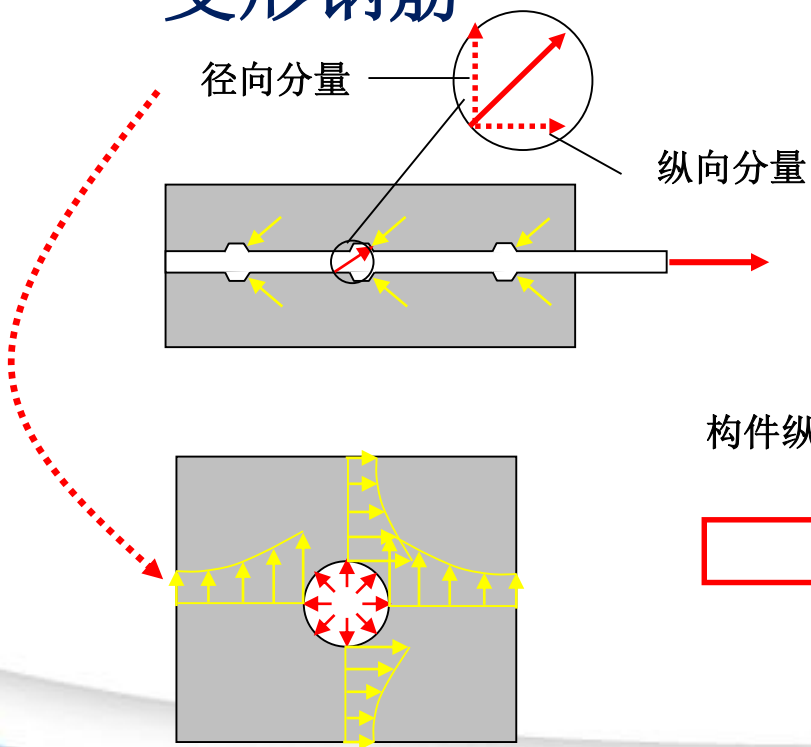


鋼筋拔出

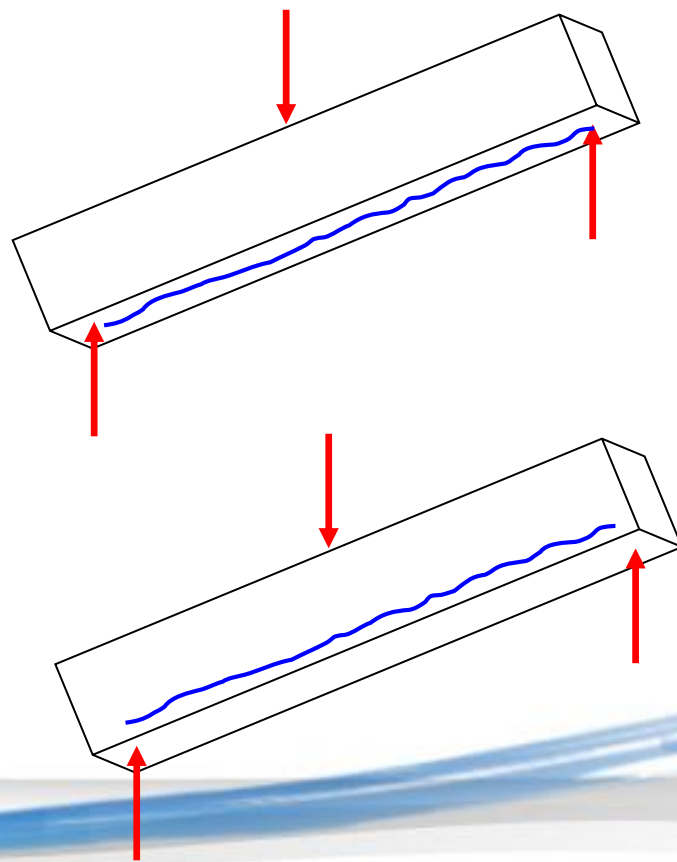
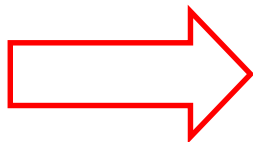


粘結破壞形態

• 變形鋼筋



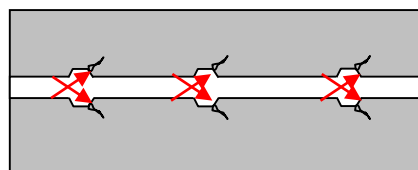
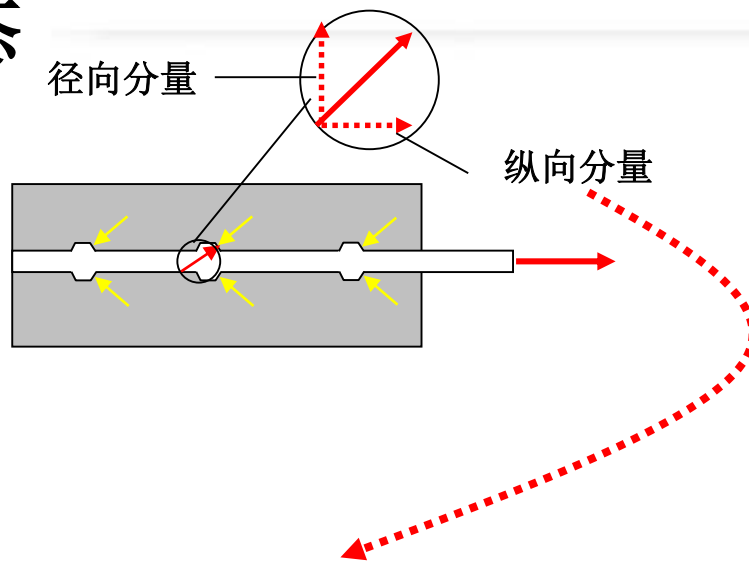
構件縱向開裂



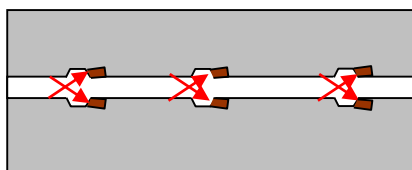


粘結破壞形態

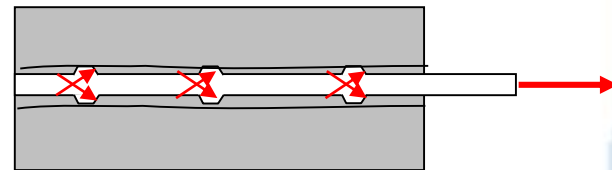
• 變形鋼筋



混凝土撕裂



混凝土局部擠碎



刮出式破壞



➤ 钢筋与混凝土间的粘结强度

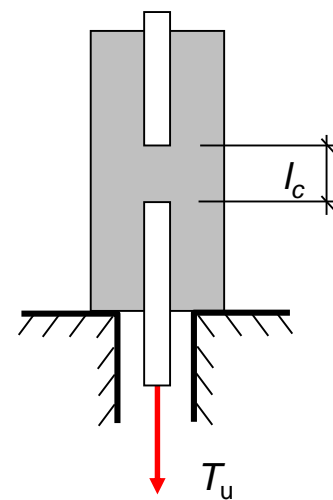
一般用拔出试验测出钢筋与混凝土间的平均粘结强度

$$\tau_u = \frac{T_u}{\mu_s l_c}$$

拔出拉力

钢筋周长

埋置长度




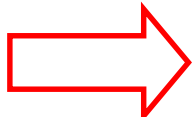
- 影响因素
- 混凝土强度
 - 浇注位置（水平浇注、竖向浇注）
 - 钢筋的外形特征
 - 保护层厚度和钢筋的净距



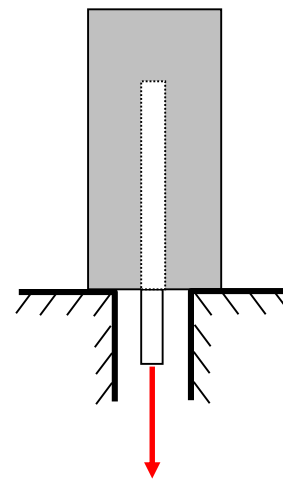
➤ 锚固长度

• 理论分析

原则  钢筋屈服时正好发生锚固破坏

对象  以直径为 $2c$ 的混凝土试件内配直径为 d 的变形钢筋为例

假定  纵裂发生在刮出式破坏以前





➤ 锚固长度

• 理论分析

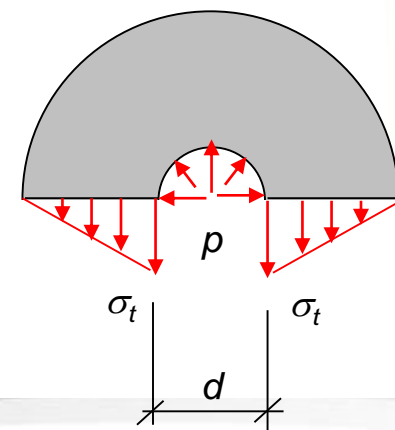
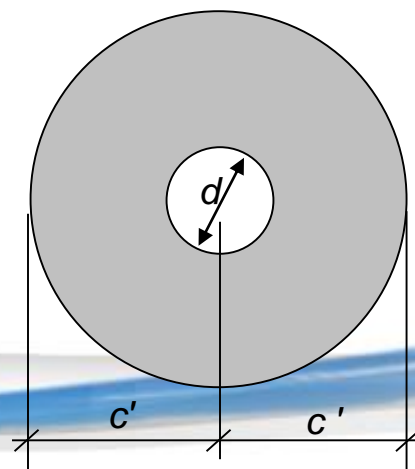
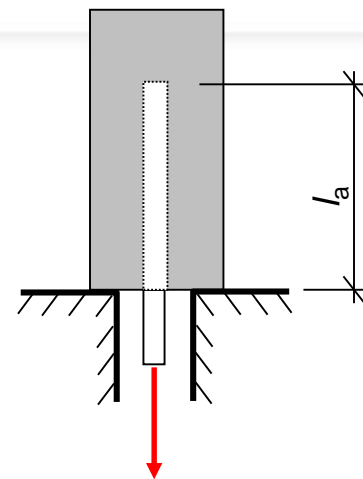
假定由于 p 引起的混凝土中的拉应力按线形分布

$$l_a \cdot p \cdot d = (2c' - d) \frac{\sigma_t}{2} l_a$$

$$p = \left(\frac{c'}{d} - \frac{1}{2} \right) \sigma_t$$

当 $\sigma_t = f_t$ 时，锚固破坏

$$p_u = \left(\frac{c'}{d} - \frac{1}{2} \right) f_t$$

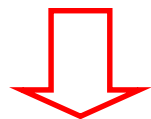




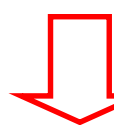
➤ 锚固长度

• 理论分析

当变形钢筋肋倾角为 45° 时

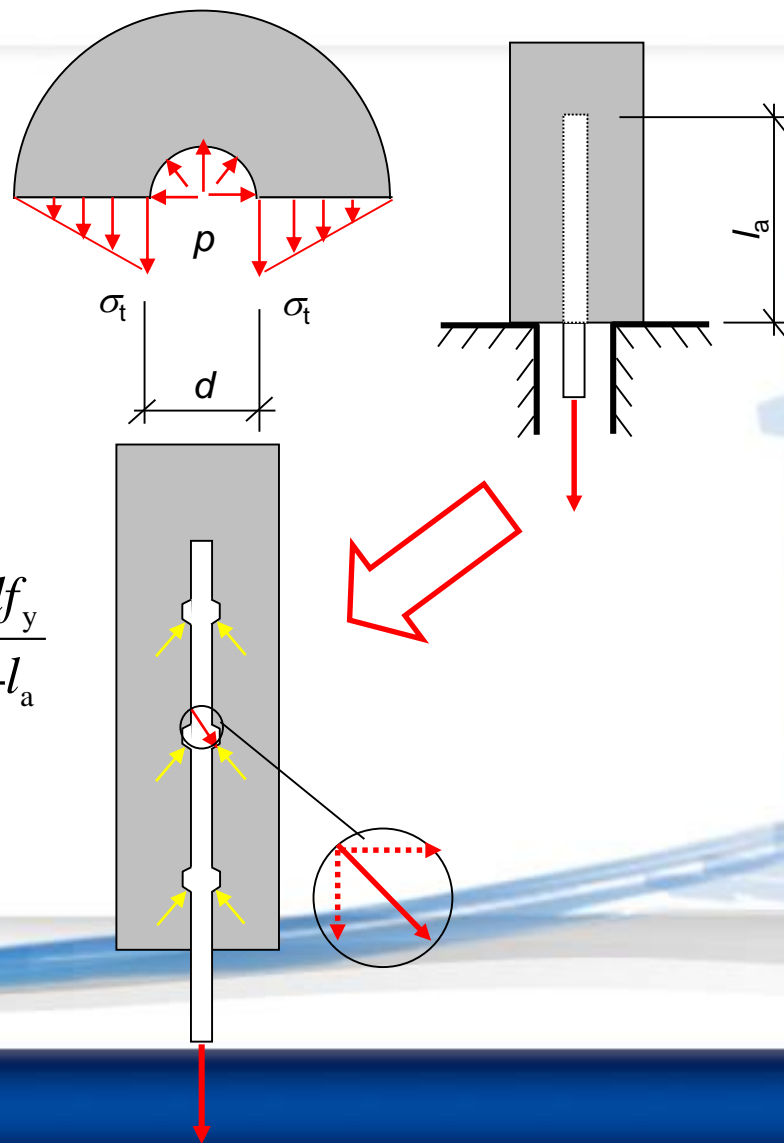


$$\tau_u = p_u$$



$$\tau_u = \frac{T_u}{\mu_s l_a} = \frac{\pi d^2 f_y / 4}{\pi d l_a} = \frac{d f_y}{4 l_a}$$

$$\frac{l_a}{d} = \frac{f_y}{\left(\frac{4c'}{d} - 2\right) f_t}$$





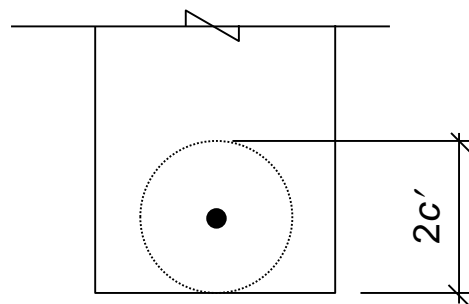
➤ 锚固长度

• 理论分析

$$\frac{l_a}{d} = \frac{f_y}{\left(\frac{4c'}{d} - 2\right) f_t}$$

↓ 令 $c' = 2d$

$$l_a = \frac{f_y}{6f_t} d$$



当 $c' > 2d$ 时, l_a 的数值比上式的数值要小

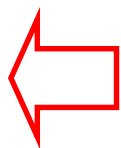


➤ 锚固长度

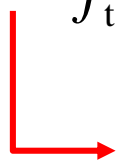
• 实用锚固长度计算公式

基本锚固长度（GB 50010）：

$$l_a = \alpha_v \frac{f_y}{f_t} d$$



对不同的情况还要作修正



锚固钢筋的外形系数，见教材表3-1



对上式作修正可得搭接长度

$$l_l = \zeta l_a$$

