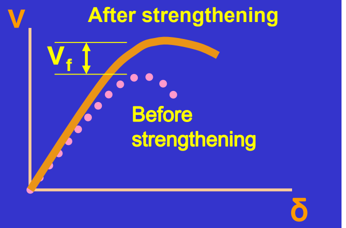
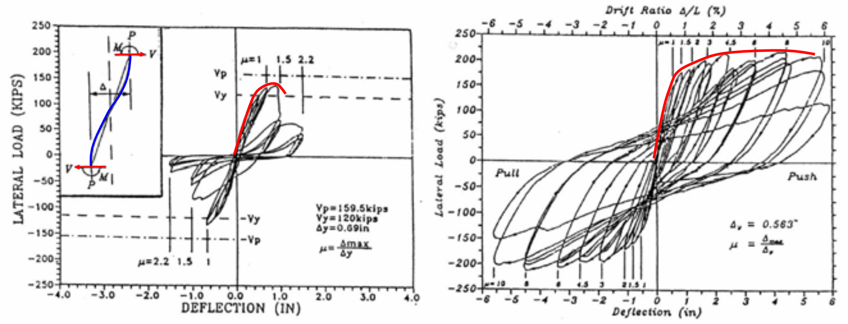
# SHEAR STRENGTHENING OF RC





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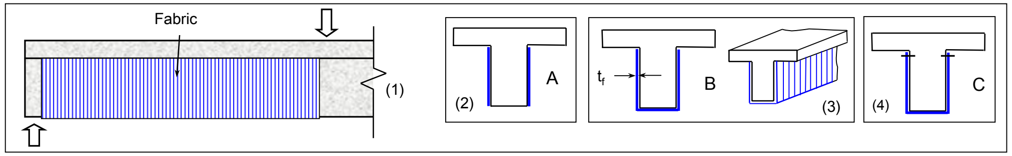

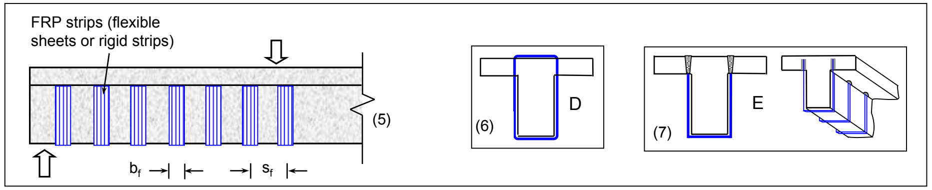

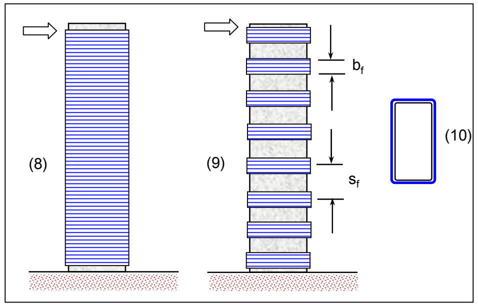

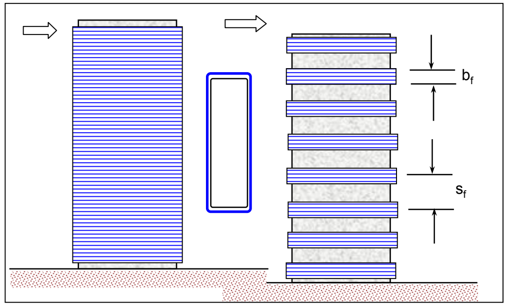

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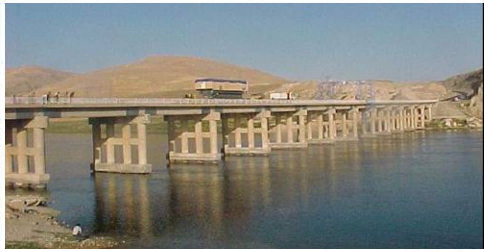

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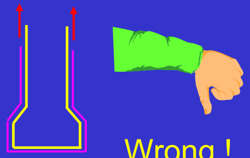
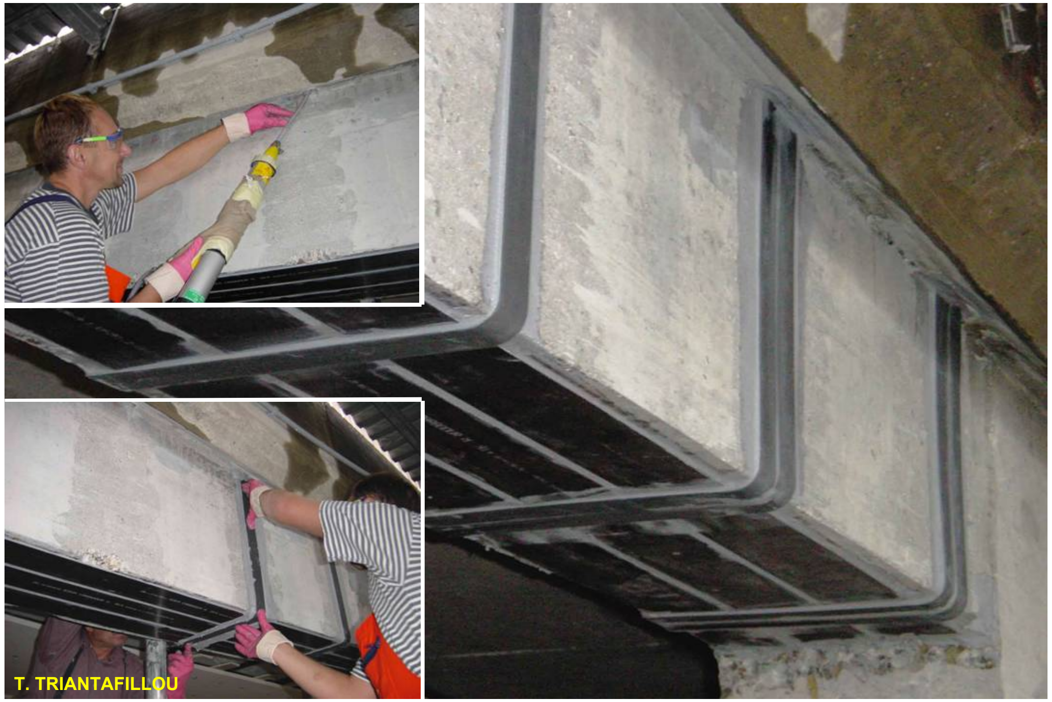
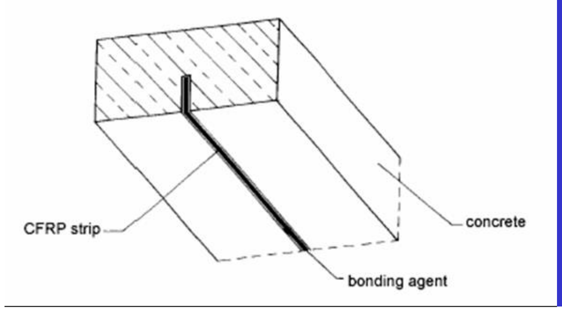
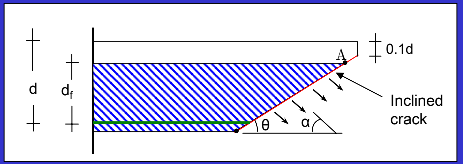


Wrong !





## CALCULATION OF REQUIRED THICKNESS $t_f$



$$V_{Rd} = \frac{1}{\gamma_{Rd}} \min\left(V_{Rd,c} + V_{Rd,s} + V_{Rd,f},\ V_{Rd,max}\right)$$

**Strips of width $b_f$ and thickness $t_f$ at distance $s_f$**

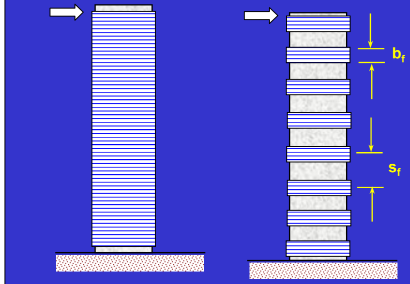
$$V_{Rd,f} = \frac{2t_f b_f}{s_f} d_f \boxed{\sigma_{fed}} (\cot\theta + \cot\alpha)\sin\alpha$$

**Continuous jacket $t_f$**

$$V_{Rd,f} = 2t_f d_f \boxed{\sigma_{fed}} (\cot\theta + \cot\alpha)\sin^2\alpha$$

**$d_f$ = depth of jacket intersected by the inclined crack, measured from the level of longitudinal steel**

**= 0.9d for closed jackets**



Maximum spacing of strips

$$s_f \le \min\left(\frac{d_f}{2}, \frac{0.9d}{2}\right)$$

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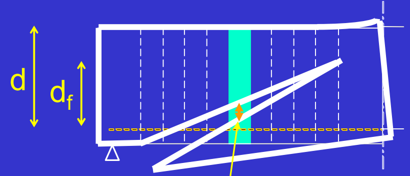
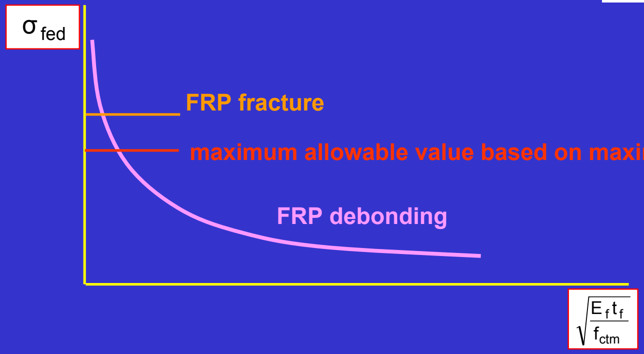


**"EFFECTIVE" FRP STRESS** $\sigma_{fed}$



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$$\sigma_{fed} = f_{fdd}\left[1 - \left(1 - \frac{2}{\pi}\right)\frac{\ell_{b,max}\sin\alpha}{2d_f}\right] + \frac{1}{2}\left[f_{fu,W}(R) - f_{fdd}\right]\left[1 - \frac{\ell_{b,max}\sin\alpha}{d_f}\right]$$

$$f_{fu,W}(R) = f_{fdd} + \left\langle \eta_R f_{fd} - f_{fdd} \right\rangle \qquad \eta_R = 0.2 + 1.6\frac{R}{b_w} \qquad 0 \le \frac{R}{b_w} \le 0.5$$

**closed jacket**

$$\sigma_{fed} = f_{fdd}\left[1 - \left(1 - \frac{2}{\pi}\right)\frac{\ell_{b,max}\sin\alpha}{d_f}\right]$$

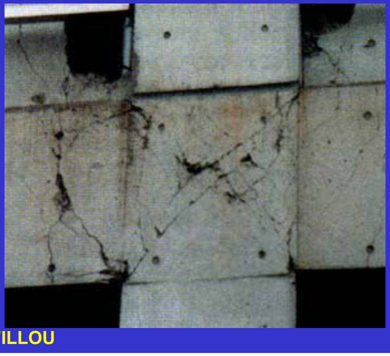
**U jacket**

$$\sigma_{fed} = f_{fdd}\frac{d_f - \ell_{b,max}\sin\alpha + \frac{k_b E_f}{3f_{fdd}}\sin\alpha}{d_f}\left[1 - \sqrt{\frac{\left(1 - \frac{2}{\pi}\right)k_b E_f \sin\alpha}{3f_{fdd}\left(d_f - \ell_{b,max}\sin\alpha + \frac{k_b E_f}{3f_{fdd}}\sin\alpha\right)}}\right]^2$$

**I I jacket**

$$\sigma_{fed} = 0.004E_f$$ **Maximum allowable stress**

# SHEAR STRENGTHENING OF JOINTS



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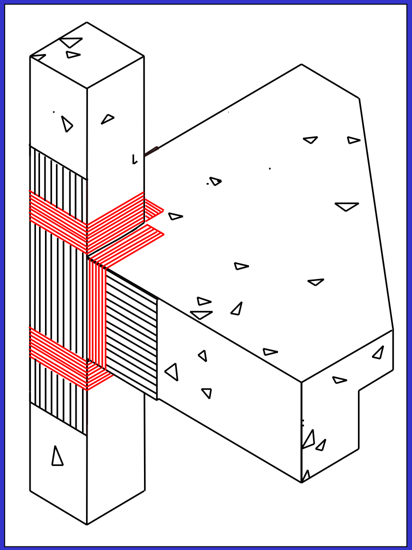

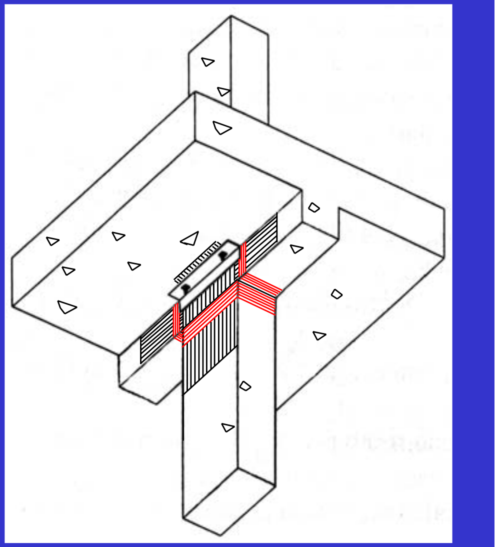

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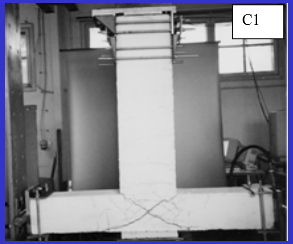
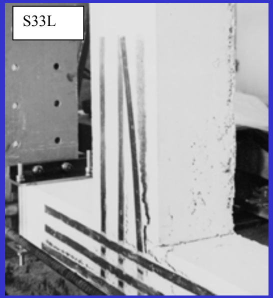
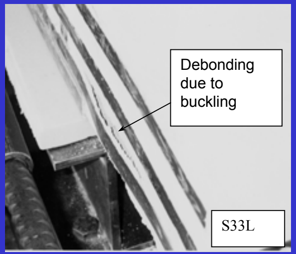
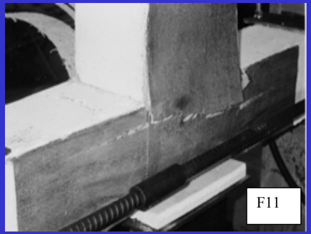
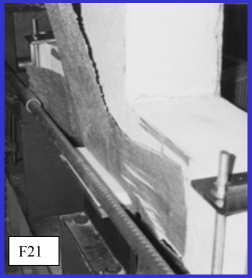


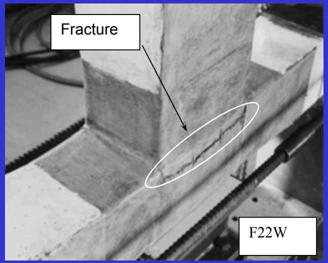


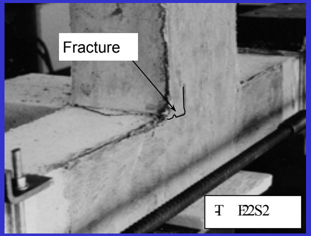


Debonding due to buckling









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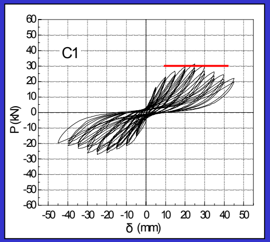
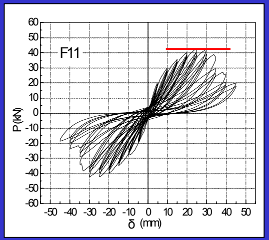
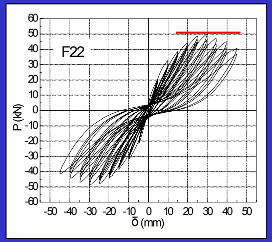
## TYPICAL RESULTS







| | $\rho_{fb} = \rho_{fc} = 0.0013$ | $\rho_{fb} = \rho_{fc} = 0.0026$ |
|---|---|---|
| STRENGTH | 40% | 65% |
| DISSIPATED ENERGY | 30% | 50% |

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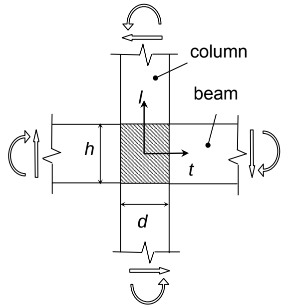
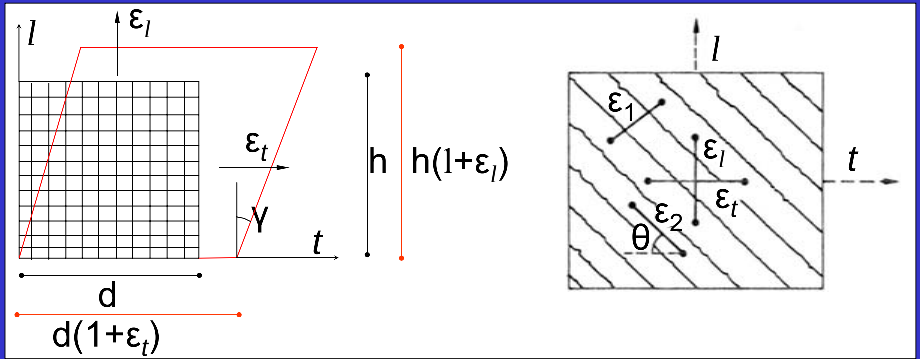


1st strain and stress invariant:

$$\varepsilon_1 + \varepsilon_2 = \varepsilon_t + \varepsilon_l$$

$$\sigma_2 = \sigma_t + \sigma_l \quad \text{διότι} \quad \sigma_1 = 0$$



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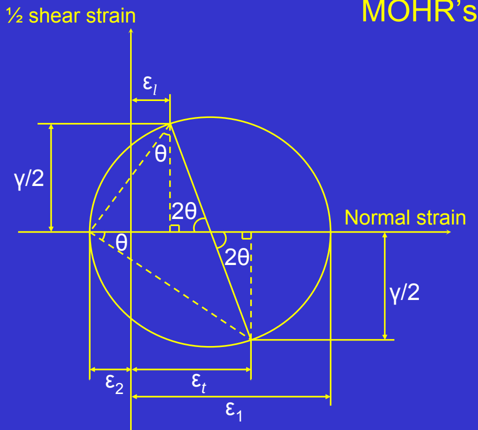
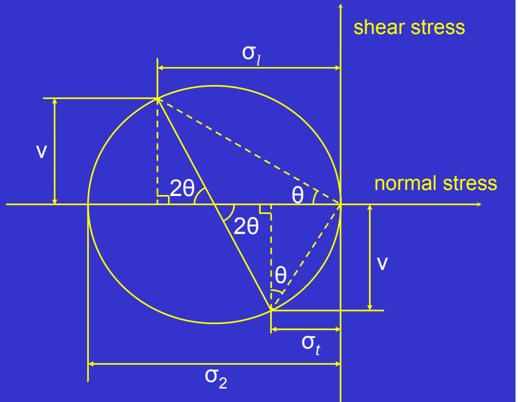
## MOHR's circle





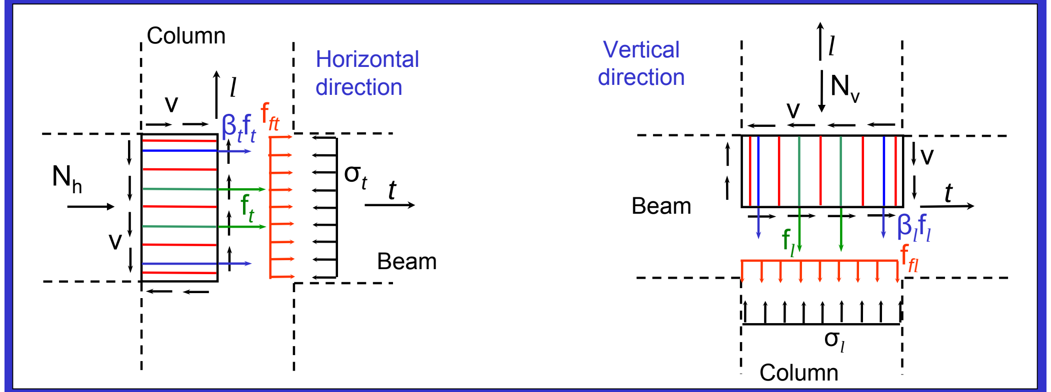
$$\gamma = \frac{2(\varepsilon_1 - \varepsilon_t)}{\tan\theta} = 2(\varepsilon_1 - \varepsilon_l)\tan\theta$$

$$\tan^2\theta = \frac{\varepsilon_1 - \varepsilon_t}{\varepsilon_1 - \varepsilon_l} = \frac{\varepsilon_2 - \varepsilon_l}{\varepsilon_2 - \varepsilon_t}$$

$$\sigma_t = -\,v\tan\theta \qquad \sigma_l = -\frac{v}{\tan\theta}$$

$$\sigma_2 = -v\left(\tan\theta + \frac{1}{\tan\theta}\right)$$

# FORCE EQUILIBRIUM



$$\sigma_t = -\rho_t f_t - \rho_{ft} f_{ft} - \frac{N_h}{bh}$$

$$\sigma_l = -\rho_l f_l - \rho_{fl} f_{fl} - \frac{N_v}{bd}$$

$$\rho_t = \rho_s + \beta_t \rho_b$$

$$\rho_l = \rho_{c,in} + \beta_l \rho_c$$

Perfect bond
$\beta_t = \beta_l = 0$

No bond
$\beta_t = \beta_l = 1$

$$\rho_{ft} = \rho_{fl} = \rho_f = \frac{n\,t_f}{b}$$

**T. TRIANTAFILLOU**