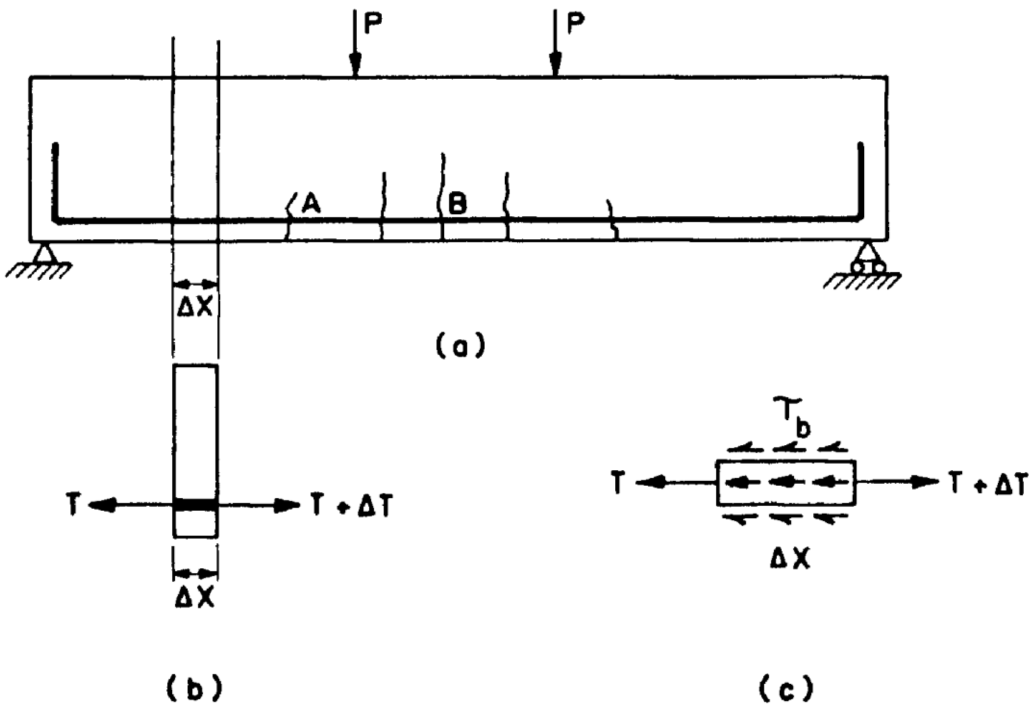
CE 382 Reinforced Concrete Fundamentals

Bond & Anchorage

Introduction

- Basic assumption of RC Theory
  - Perfect bond between concrete and steel bars
- Flexural Bond



$$\tau_b u \Delta x = \Delta T = \frac{\Delta M}{z}$$

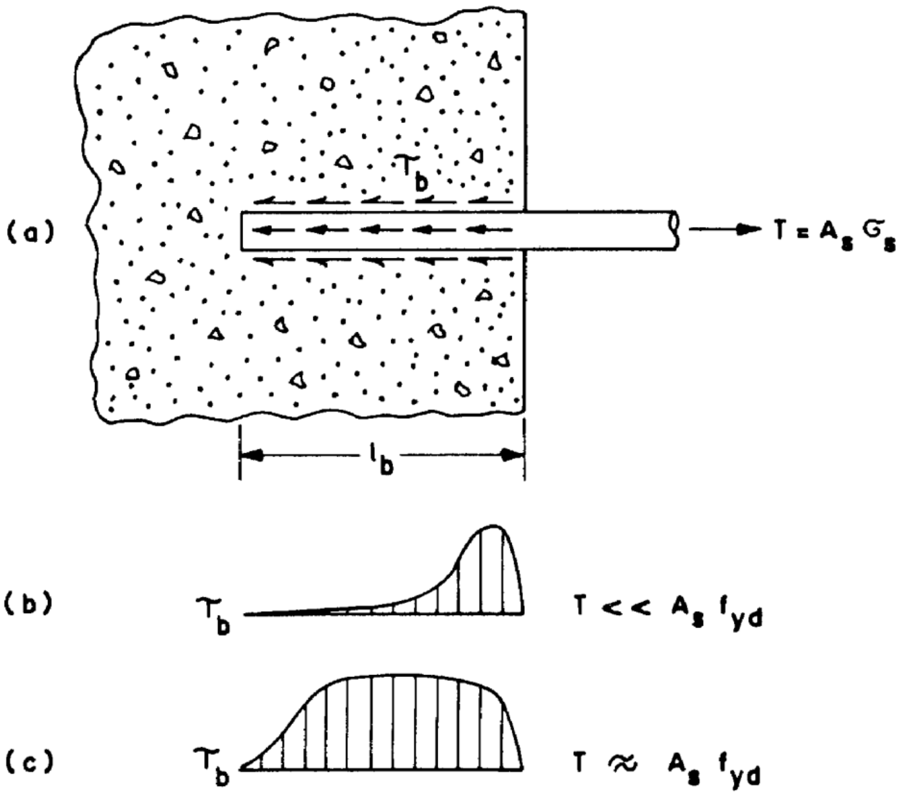
$$\tau_b = \frac{\Delta M}{\Delta x}\frac{1}{uz}$$

$$V = \frac{\Delta M}{\Delta x}$$

$$\tau_b = \frac{V}{uz}$$

Anchorage Bond

- For a bar subjected to tension
  - It should not be pulled out of concrete
  - Steel should yield



$$\tau_b \ell_b \pi \phi = A_s f_{yd}$$

$$\tau_b \ell_b \pi \phi = \frac{\pi \phi^2}{4} f_{yd}$$

$$\ell_b = \frac{f_{yd}}{4\tau_b} \phi$$

$$\ell_b = C_0 \frac{f_{yd}}{f_{ctd}} \phi$$

Development length in TS500:

$$\ell_b = 0.12 \frac{f_{yd}}{f_{ctd}} \phi \geq 20\phi$$

For plain bars $\geq 40\phi$

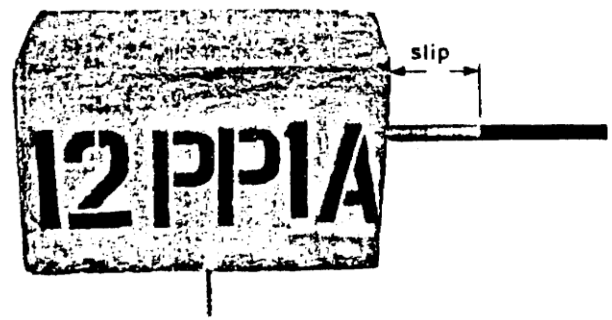
If $32 \leq \phi \leq 40$ mm

multiply ℓ_b by $\frac{100}{(132-\phi)}$

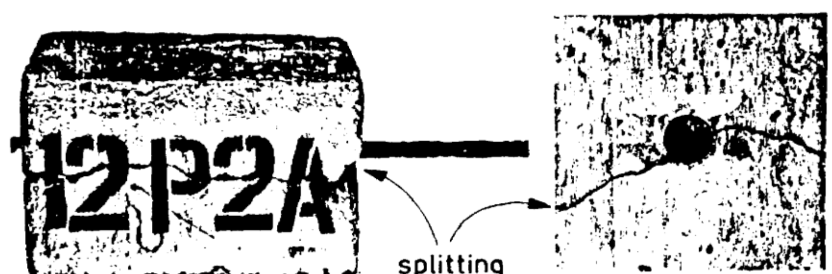
The Nature of Bond

- Resistance provided mainly by:
  - Adhesion b/w steel & concrete
  - Friction b/w steel & concrete
  - Bearing of deformations on steel surface against surrounding concrete

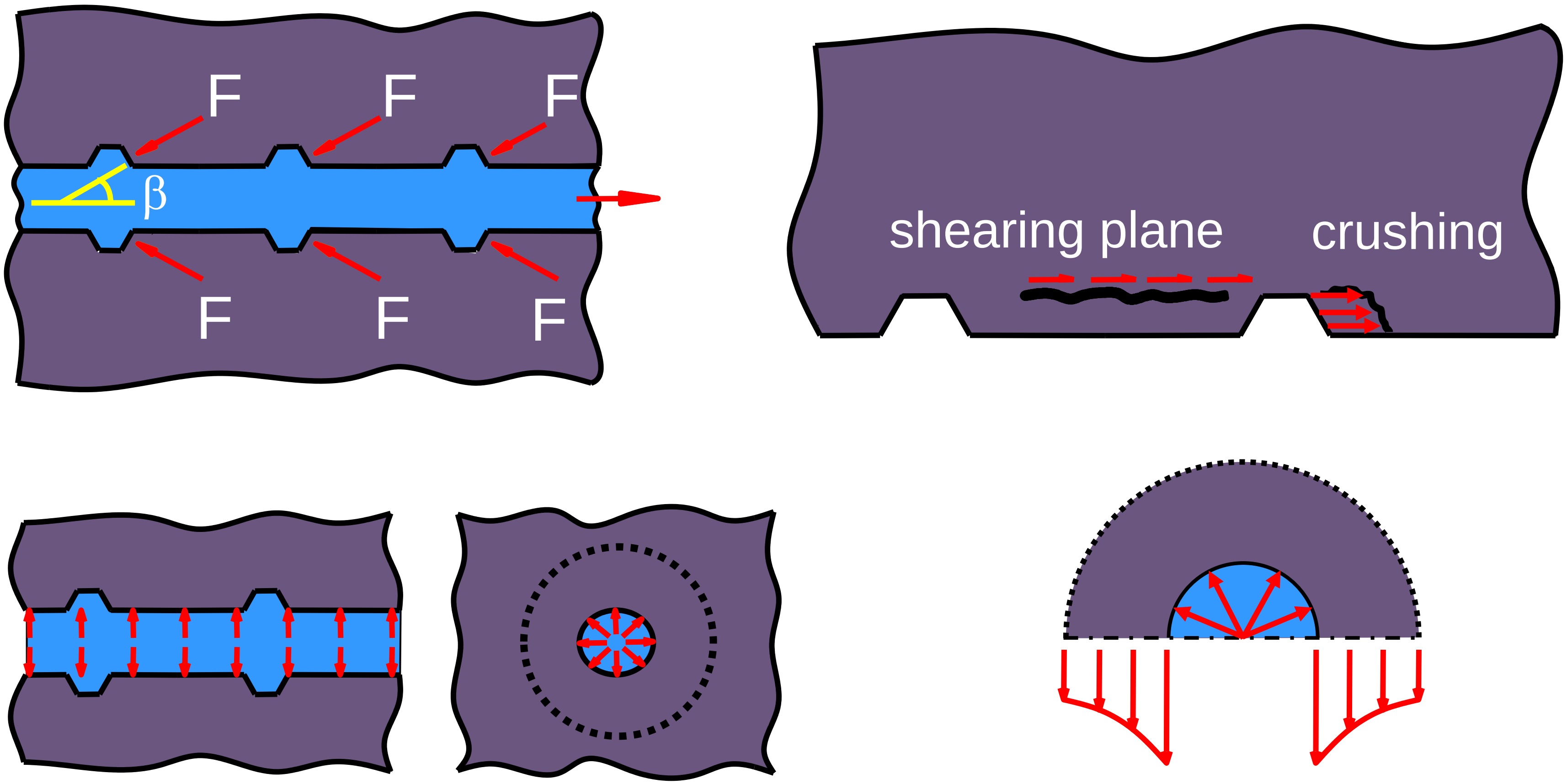
Plain bar → failure due to SLIP



Deformed bar → failure due to SPLITTING



Deformed Bar



Variables influencing bond

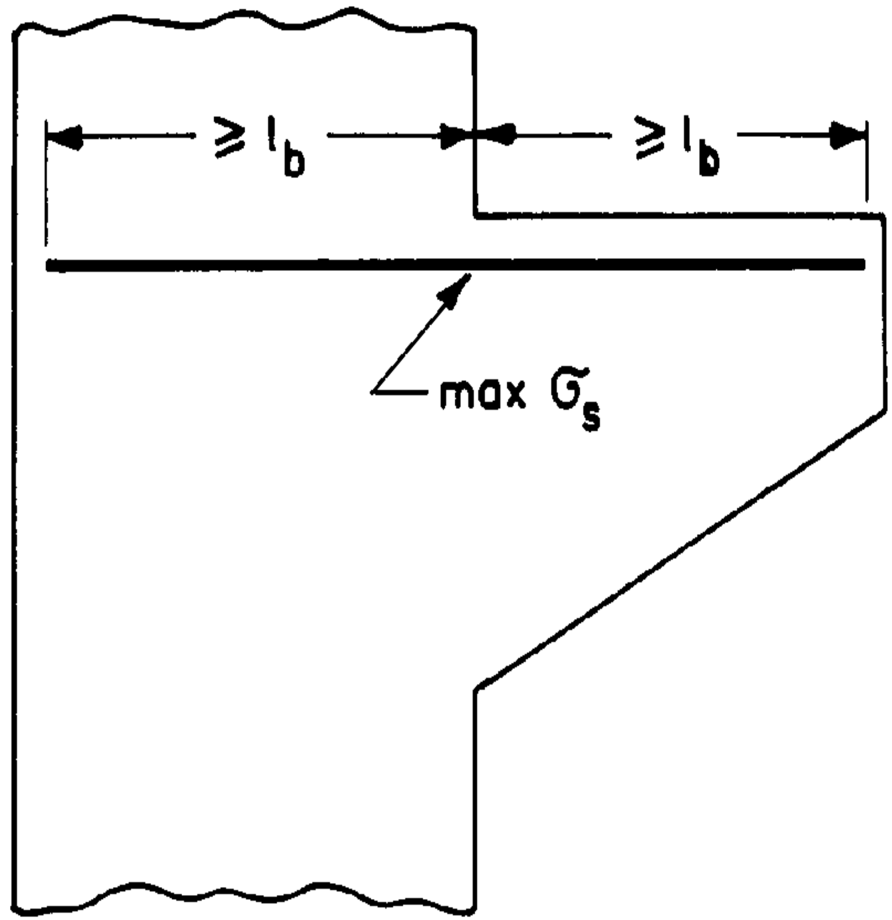
- Concrete tensile strength
- Type of aggregate and cement; mix proportion
  - light weight concrete $\rightarrow$ lower bond strength
- Curing and compaction
- Yield strength of steel; $\sigma_s \nearrow \rightarrow$ bond more critical
- Surface conditions of bar;
  - plain bar $\rightarrow$ irregularities & rust improve bond characteristics
- Geometry of deformations
- Bar diameter
  - $\phi \nearrow \rightarrow \dfrac{perimeter}{bar\ area} \searrow \rightarrow$ bond strength $\searrow$

Variables influencing bond

- Development length ↗ $\rightarrow$ bond strength ↗
- Concrete cover & clear distance ↗ $\rightarrow$ bond strength ↗
- Position of bars during concreting
  - Top bar $\rightarrow$ lower bond strength because of the accumulation of excess water and air under bars
  - Bottom bar
- Local stress
  - Local compressive strength can increase bond strength
- Hoops or ties $\rightarrow$ bond strength ↗

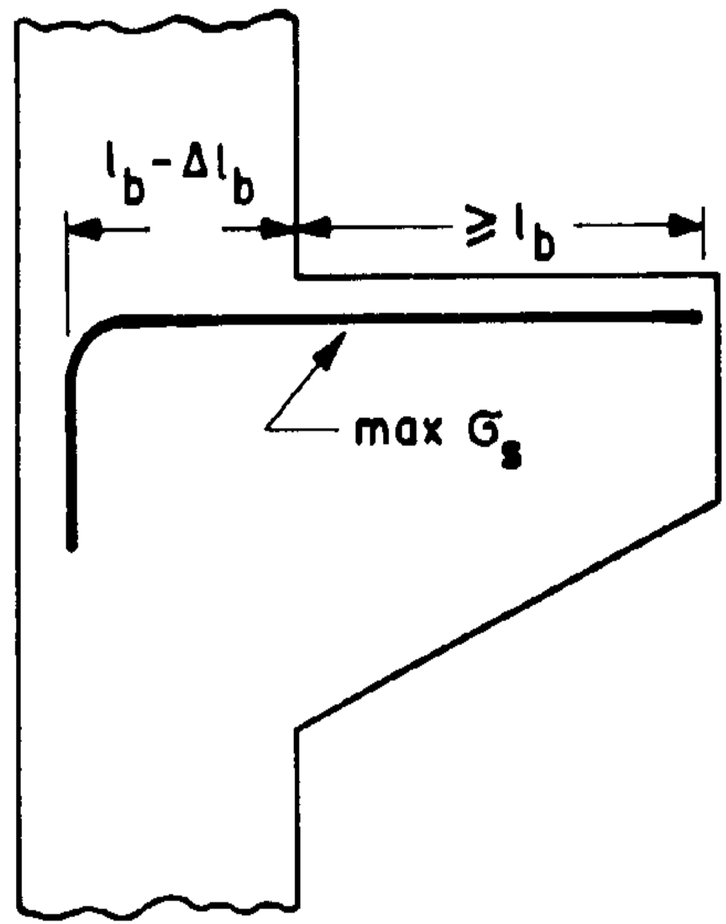
Development length for tension bars

- Straight anchorage



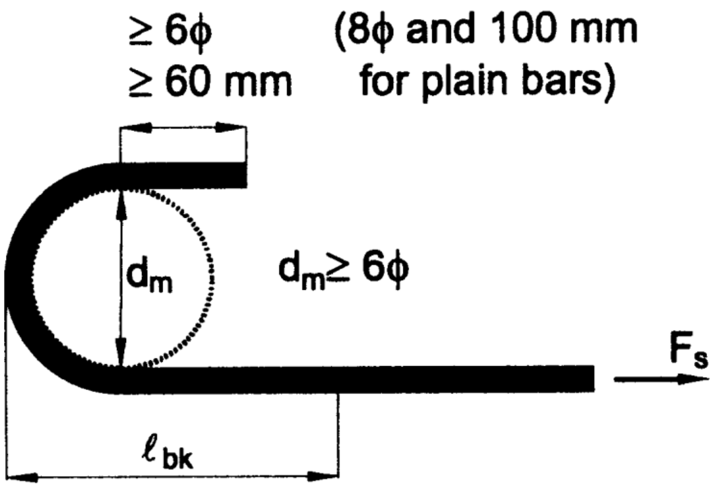
Development length for tension bars

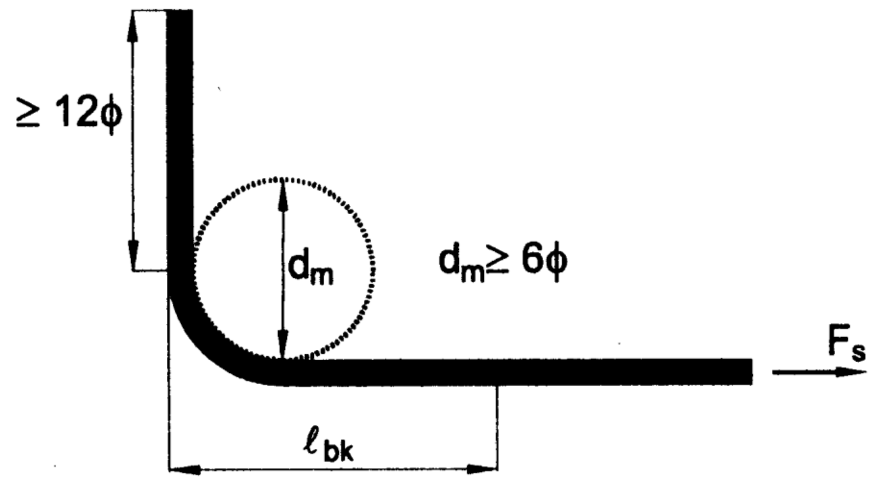
- Hooks or loops



Development length for tension bars

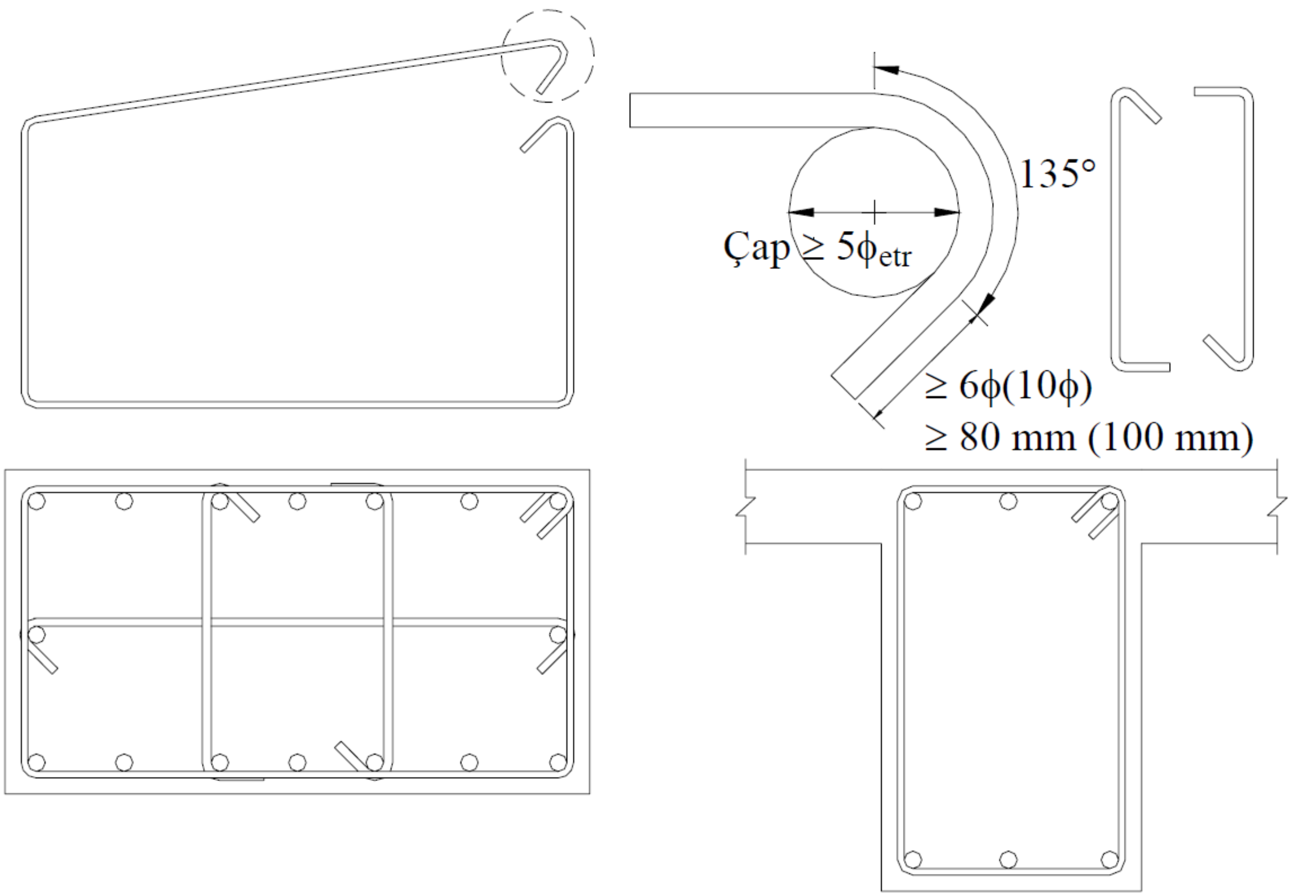
- Hooks or loops





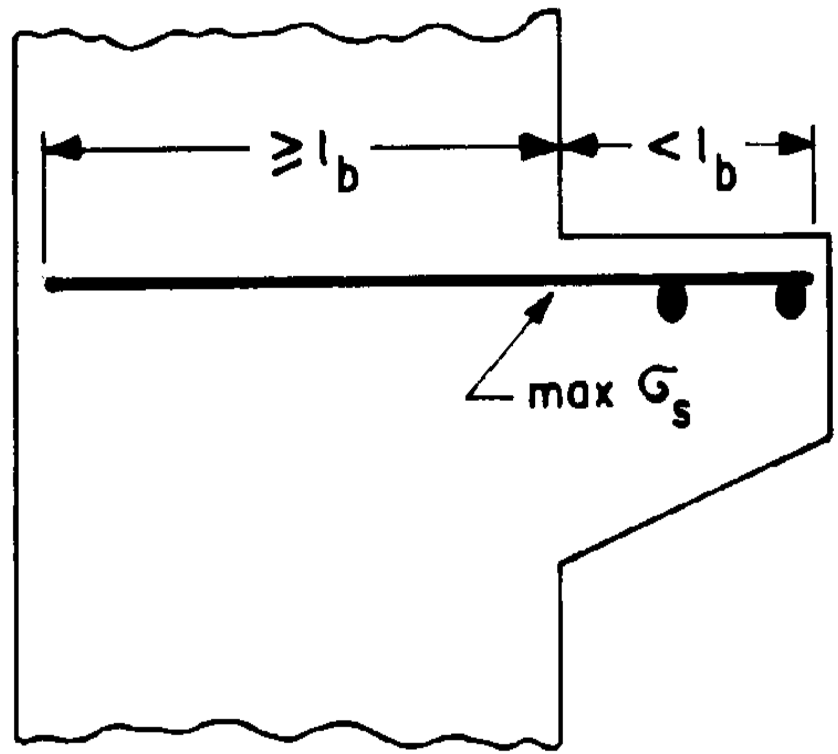
Development length for tension bars

- Stirrup hooks



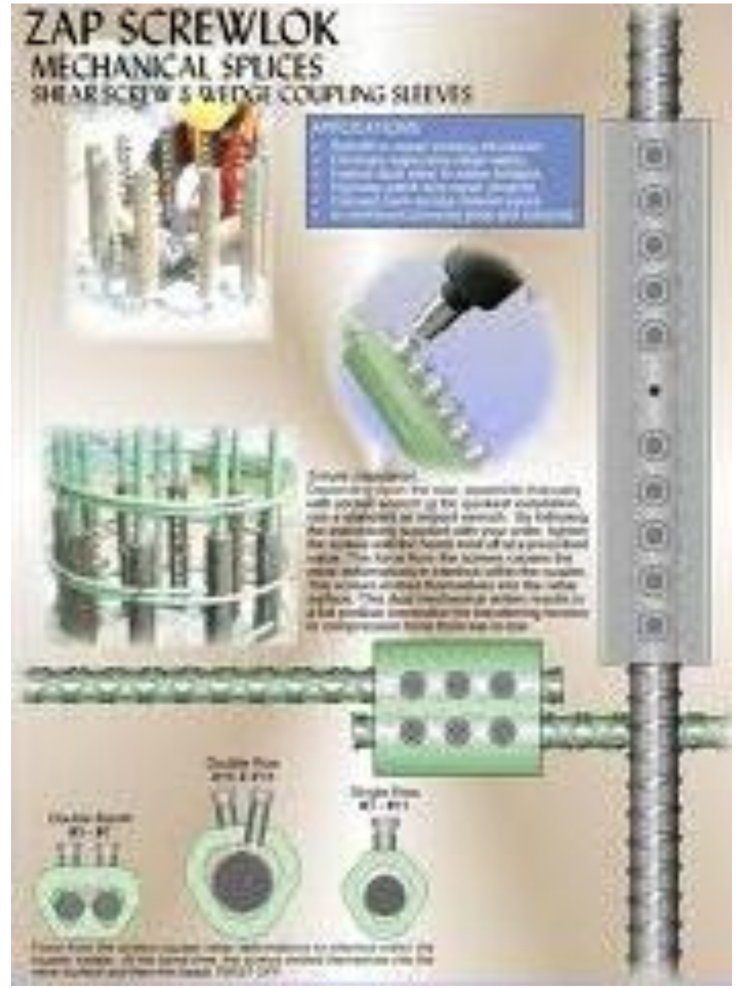
Development length for tension bars

- Welded transverse bars



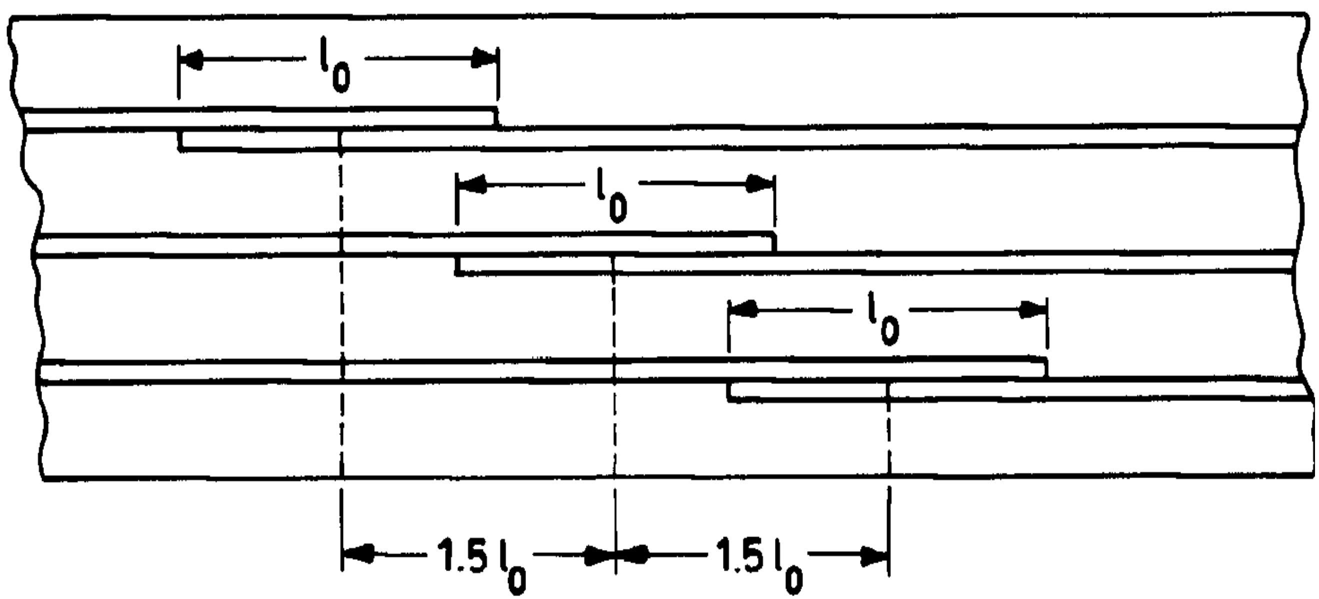
Development length for tension bars

- Mechanical devices

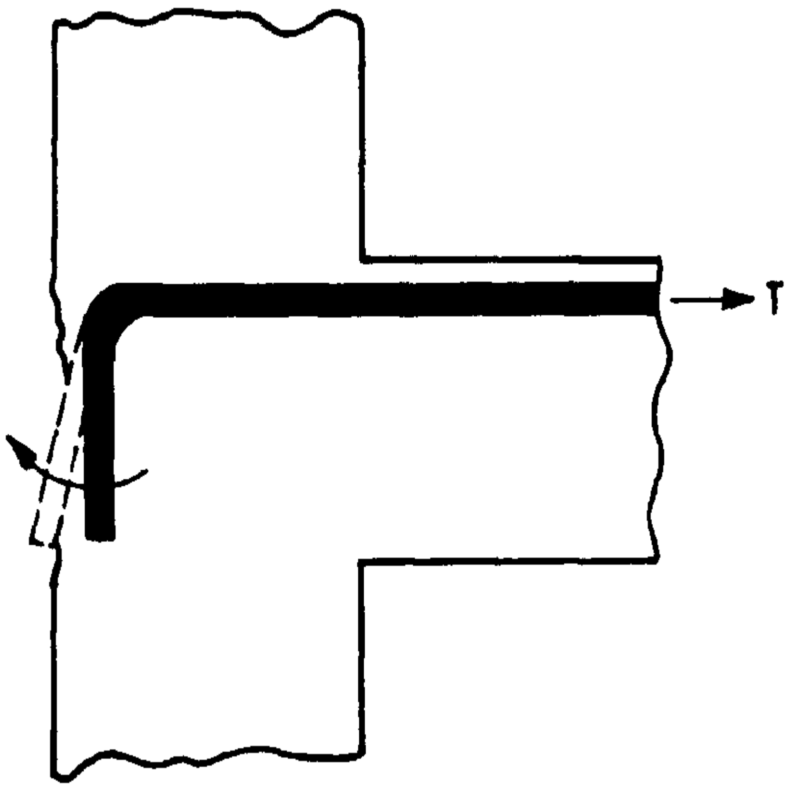


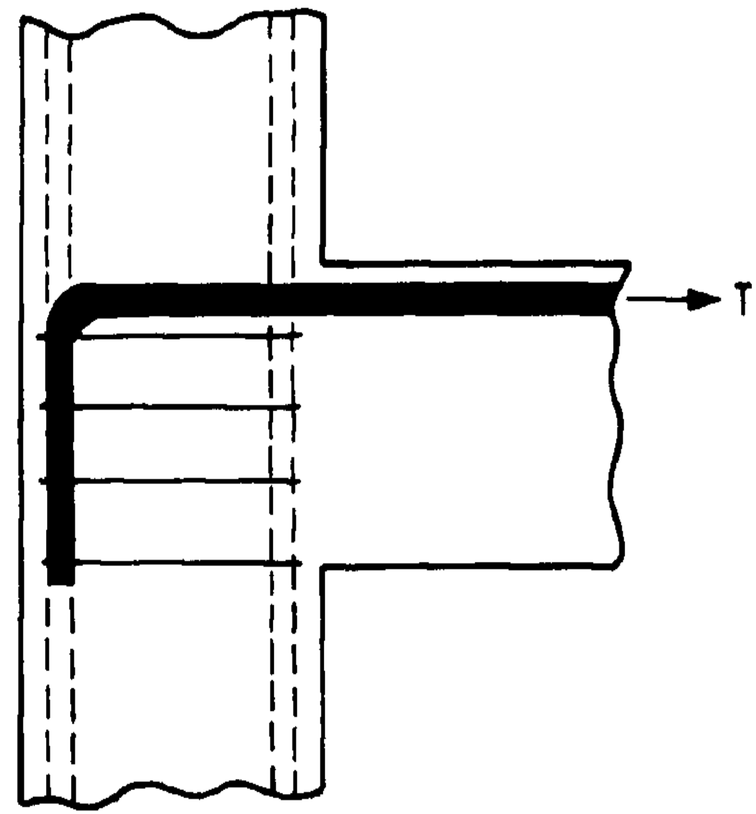
Lap Splice

- $\ell_0 = \alpha_1 \ell_b$
- $\alpha_1 = 1 + 0.5r$
- r: the ratio of spliced reinforcement to total reinforcement at the same section.



Problems associated with hooks





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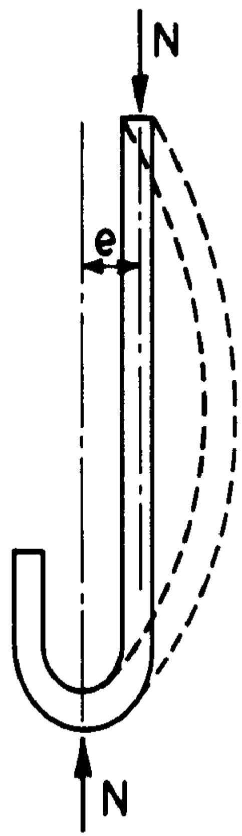
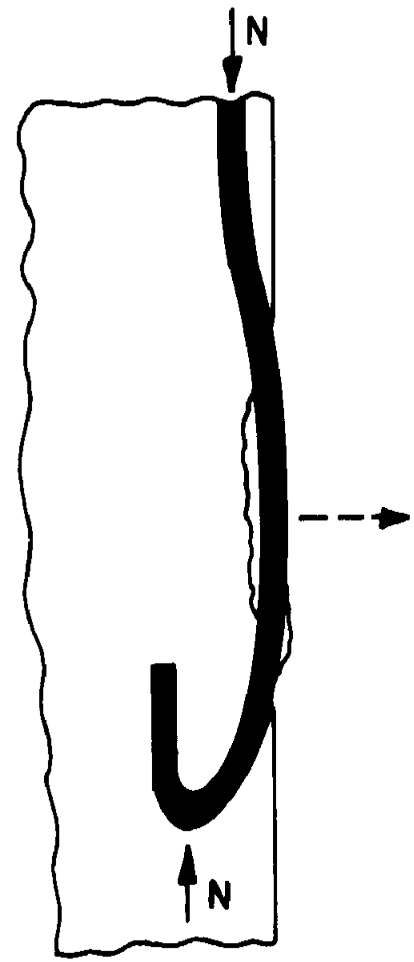
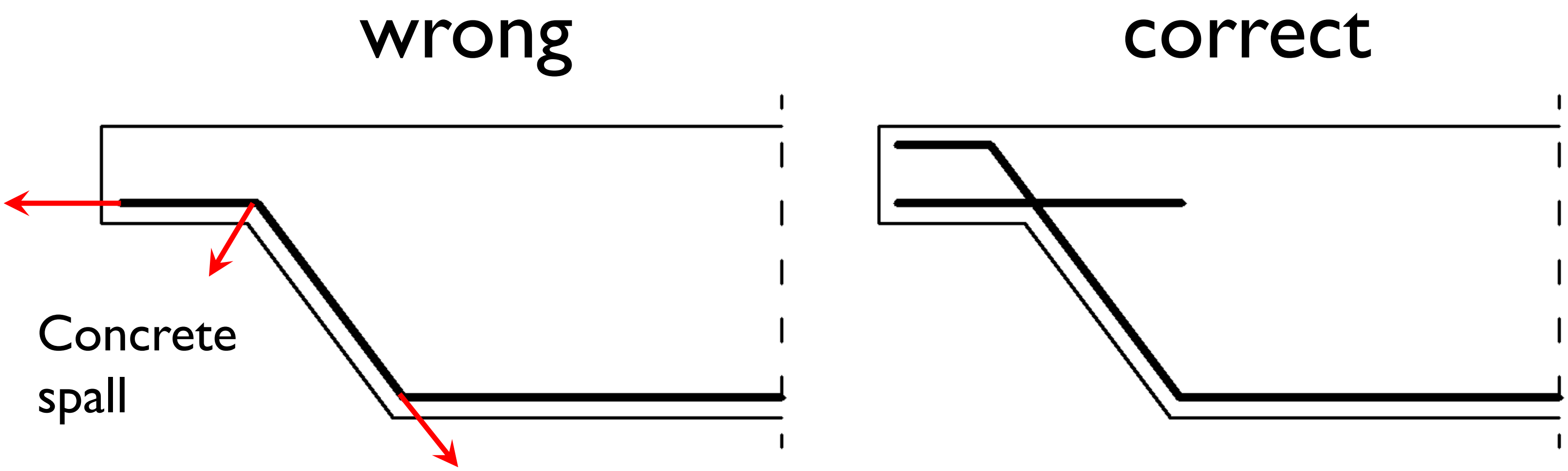




Problems associated with anchorage



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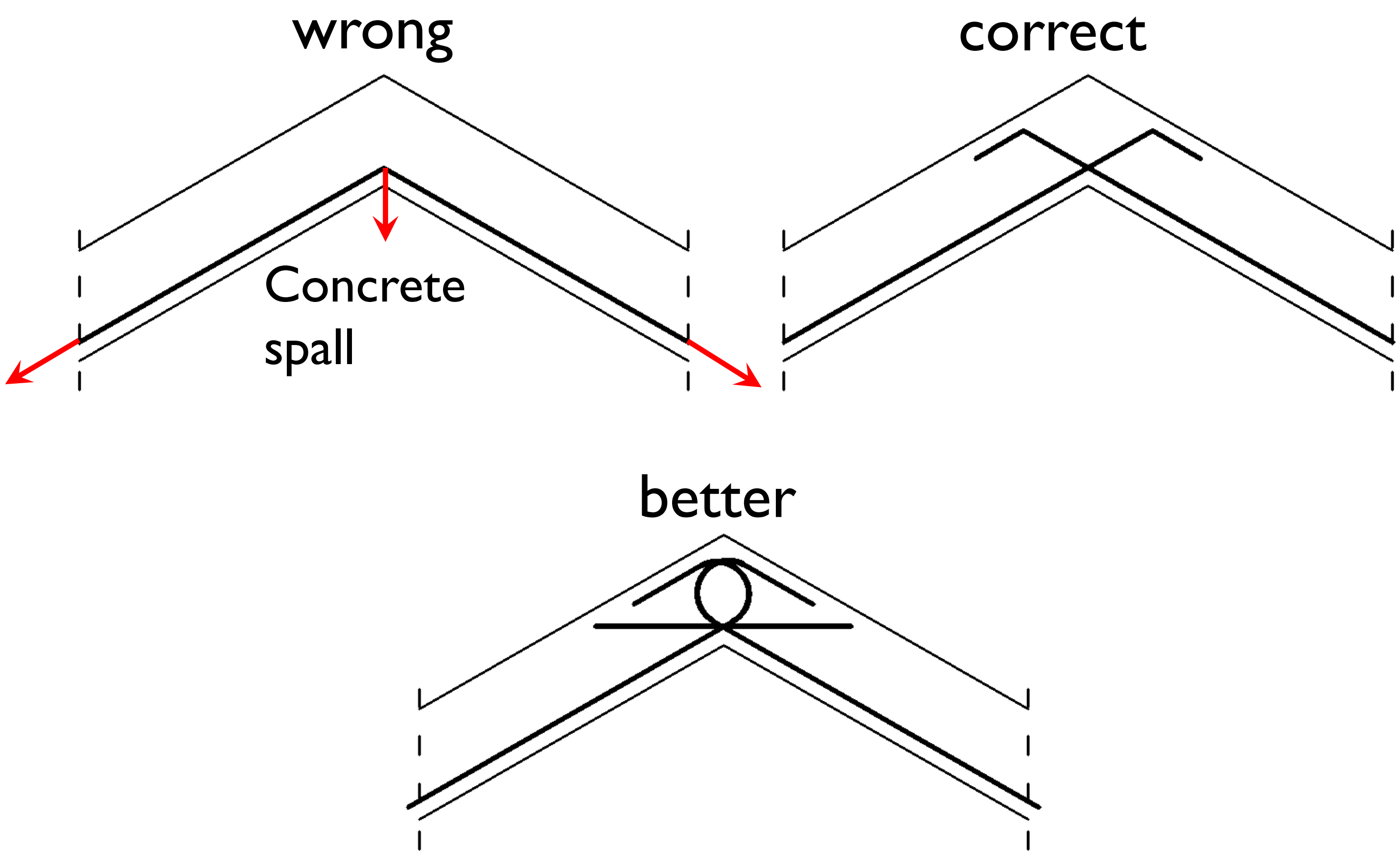

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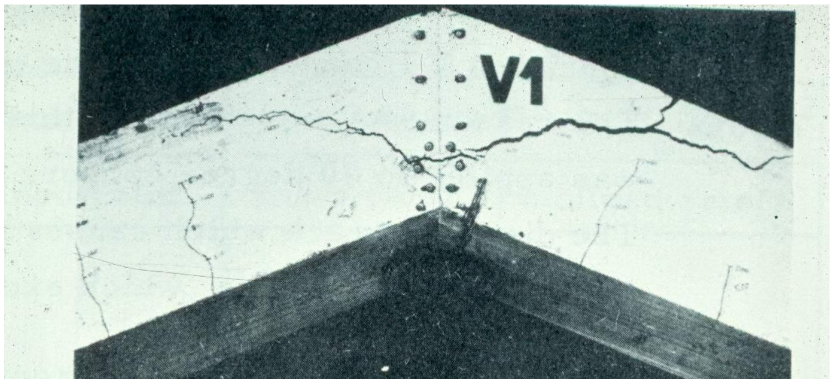
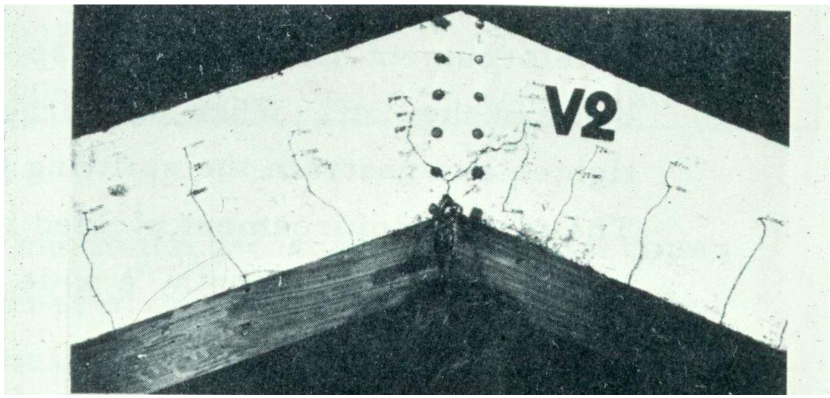
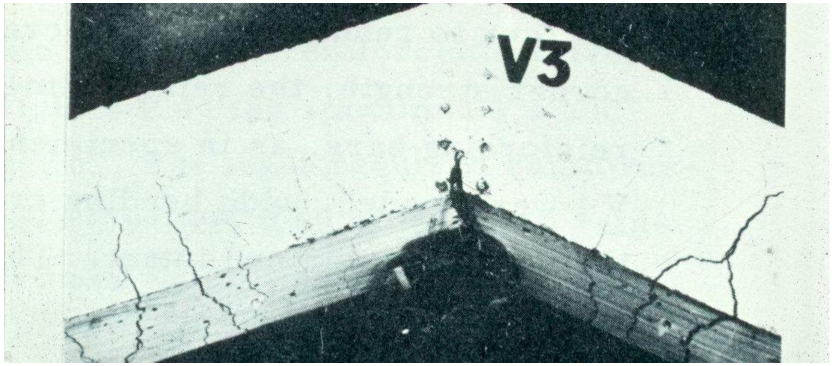
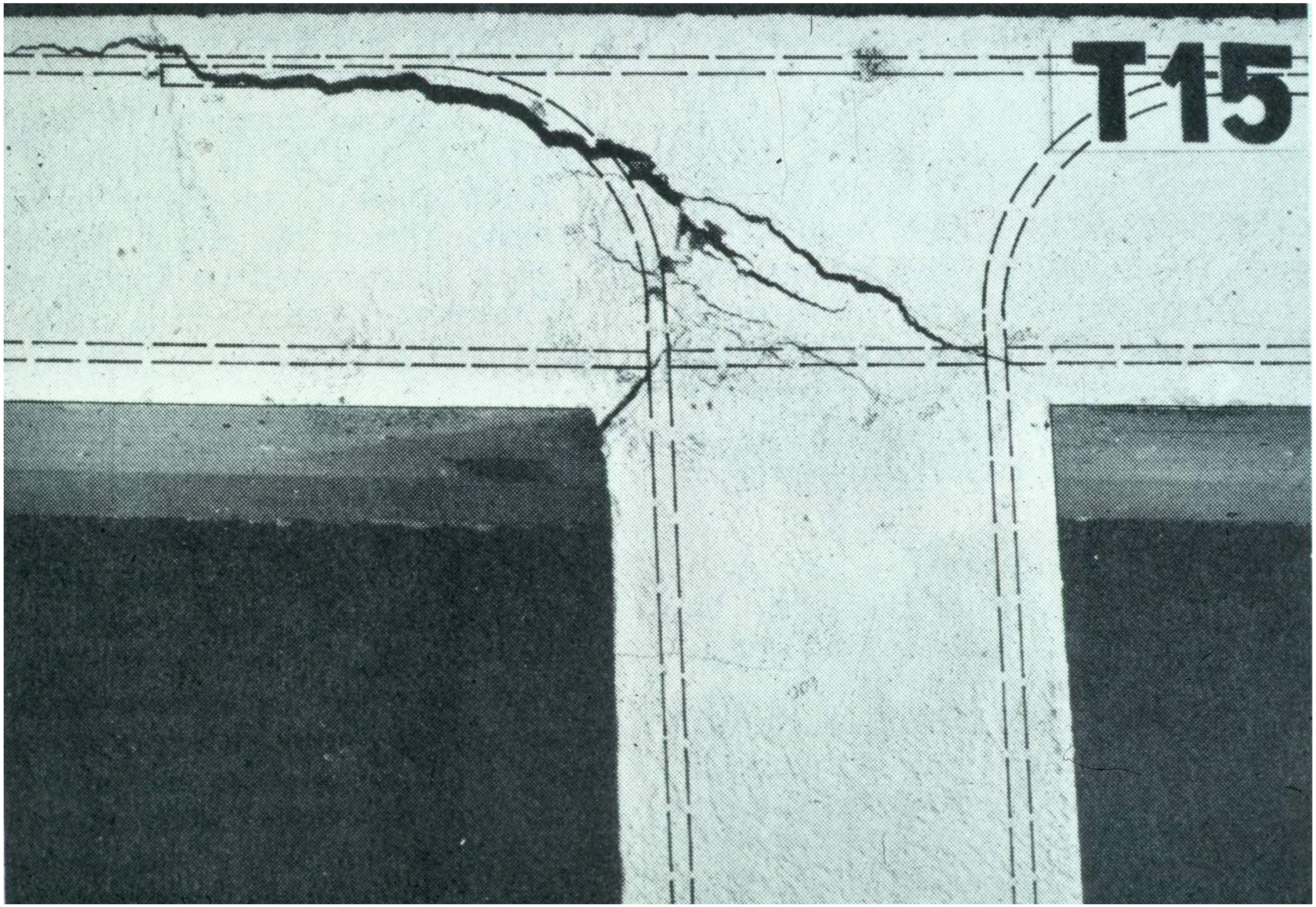






What is wrong here?



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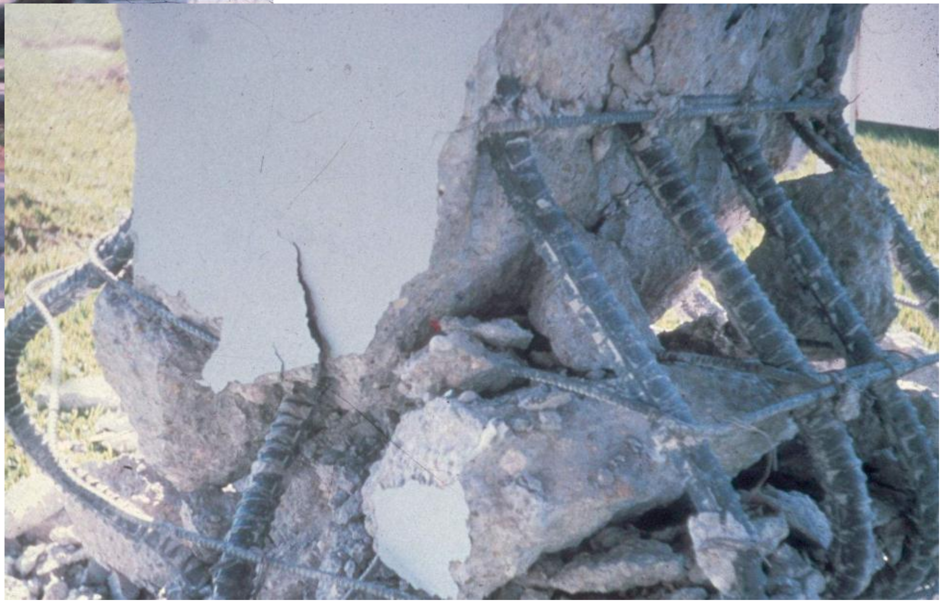
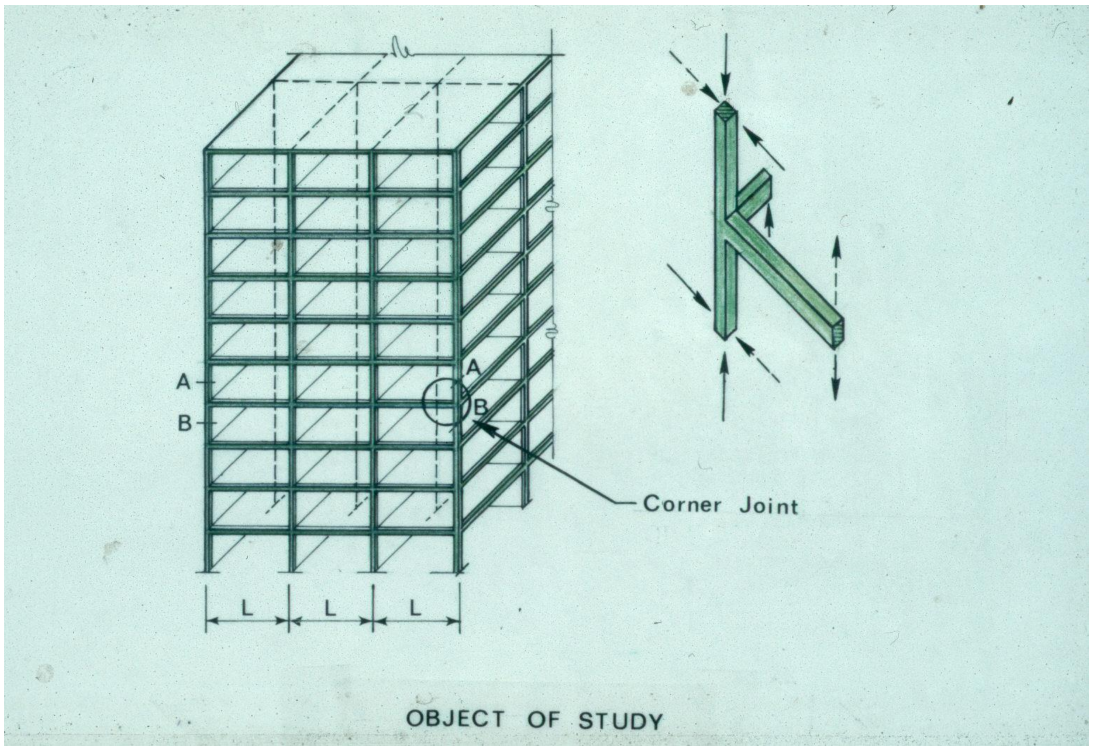
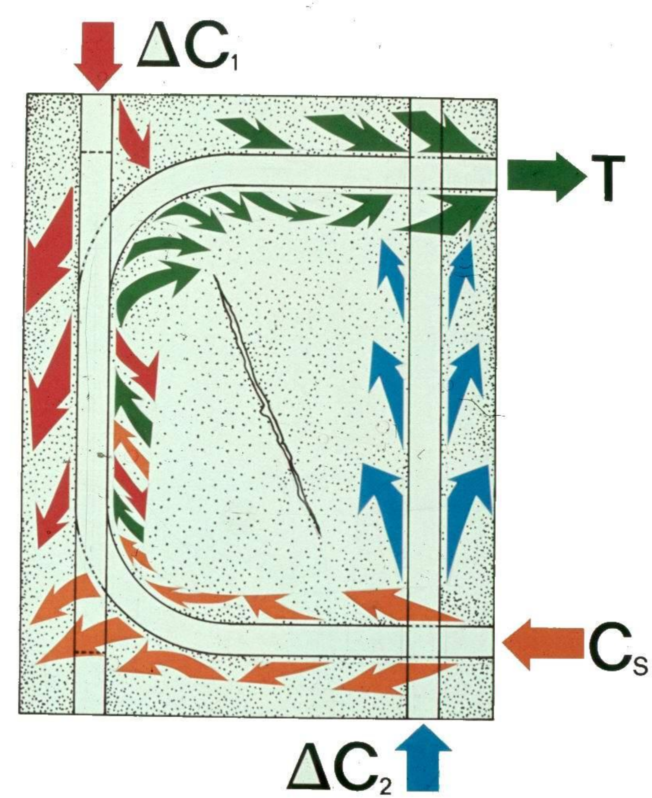


What is wrong here?

Beam-column joints deserve attention!..





Can you bend an R/C Column into U-Shape?

I wish you the best of luck in your final exams…

Dr. G. Özcebe