CIVI02 - STRUCTURES and MATERIALS

Topic: Reinforced Concrete

1) Concrete

- Synthetic Stone
- Made from:
  - Cement
  - Sand] Volume instead of cement
  - Aggregate (Gravel)] Volume stability (does not shrink)
  - Water] Water + Cement turns into solid
  - Air] Water expands when freezes and can break
  - Admixtures concrete, air is needed to stop it

Cement and concrete are not the same
↳ Cement is more powdery, used to make concrete
(Cement : Concrete → flour : Cake)

When concrete sets, it gets smaller

Cement

- Made of grinded up limestone
- Heated up to over 1000°C with coal
  ↳ Gives off CO_2 and water
- Turns into ceramic
- Grind up the ceramic into cement
  ↳ add water → lime stone

Why Concrete?

- Most used construction material
- Cheap to make and export
- Local production
- Durable
- Make any shape (Since it starts as a liquid)

Negative: Carbon intensive

2) Types of Concrete

a) Plain Concrete

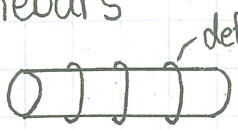
- No reinforcing steel
- Like stone
  ↳ But has time dependent properties
- Carries compression well, but not tension

b) Reinforced Concrete

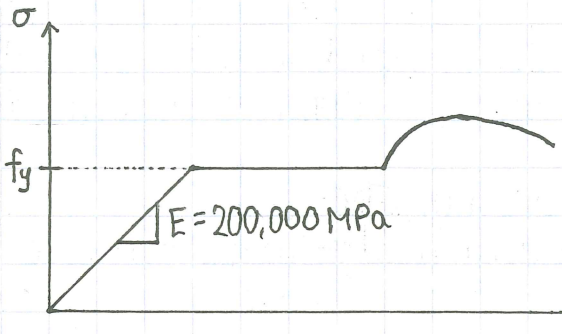
- Concrete + Steel Reinforcing Bars (Rebar) where there is tension
- Use deformed rebars

C) Prestressed Concrete
- Reinforced concrete where before loading, steel is in tension and concrete is in compression

3) Rebars



Helps to bond the steel and concrete
Rusty bars have a better bond



Ignore Strain Hardening

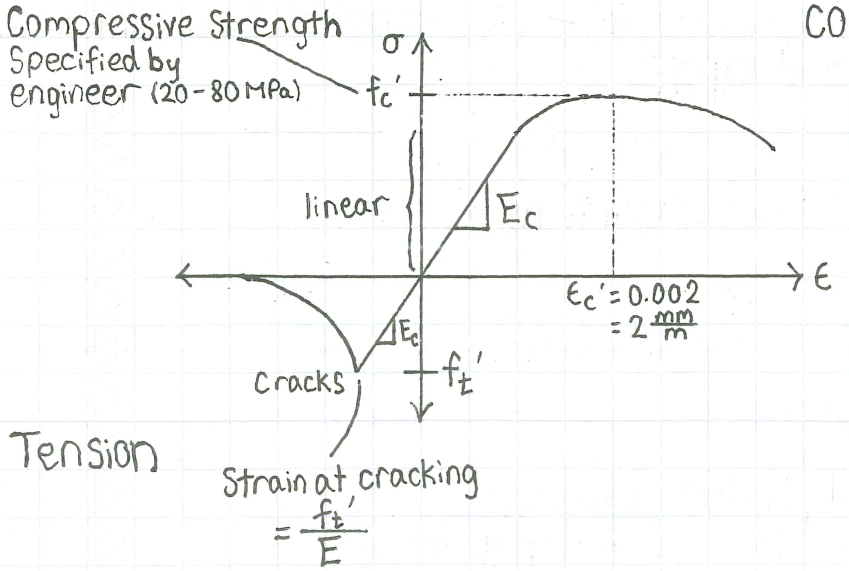
f_y = 400MPa
Rest of World, f_y = 500MPa

Standard Bar Sizes

Size	Area
10M	100mm^2
15M	200mm^2
20M	300mm^2
25M	500mm^2
30M	700mm^2
35M	1000mm^2

The size relates to its diameter

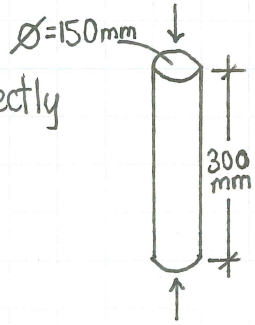
4) Concrete Stress - Strain Relationship (not reinforced)



compression

Must Consider f_c', f_t', and E when working with concrete.

f_c' → Measured in compression test @ 28 days of age (test all trucks)



f_t' → Estimated indirectly
$f_t' = 0.33\sqrt{f_c'}$

$E_c = 4730\sqrt{f_c'}$

Composite Material

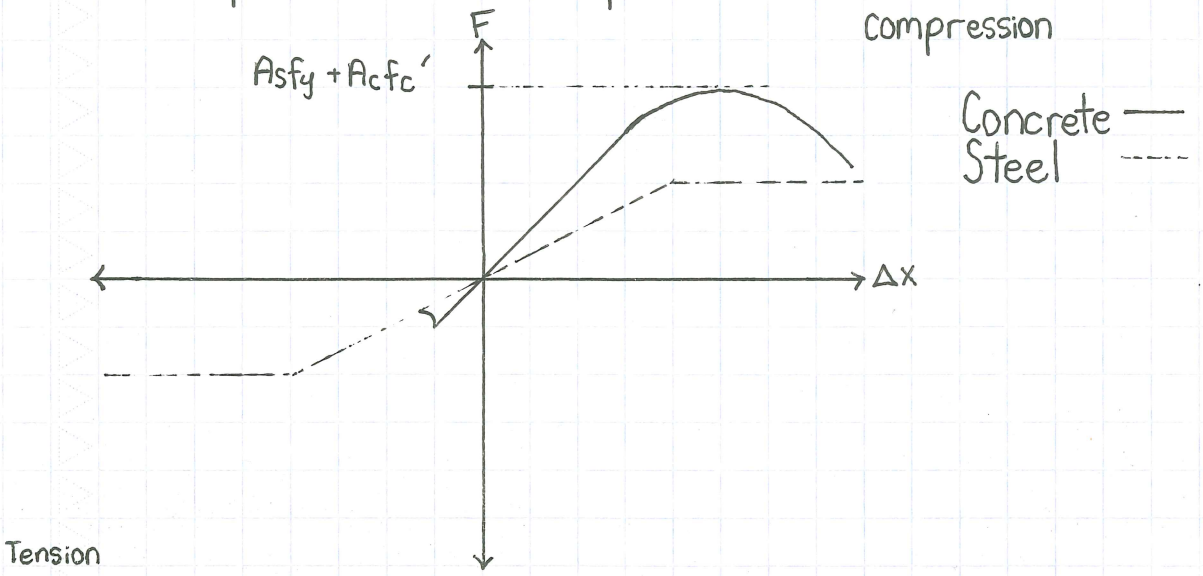
- Contains at least 2 different materials
- Assume that concrete and steel have same strain

ϵ = Constant f_c = concrete stress ($\epsilon \cdot E_c$)
f_s = Steel Stress ($\epsilon \cdot E_s$)

Max Compressive Capacity $\simeq f_c' \cdot A_c + f_y \cdot A_s$

- A_c = area of concrete (total area - A_s)
- A_s = area of steel rebar
- Able to do this since yield (f_y) and crush (f_c') happens at the same strain

Graph of Force vs Displacement



- After cracking, the concrete does not do anything