CE 1001
Introduction to Civil Engineering

MATERIALS OF CONSTRUCTION LABORATORY

ACADEMIC STAFF

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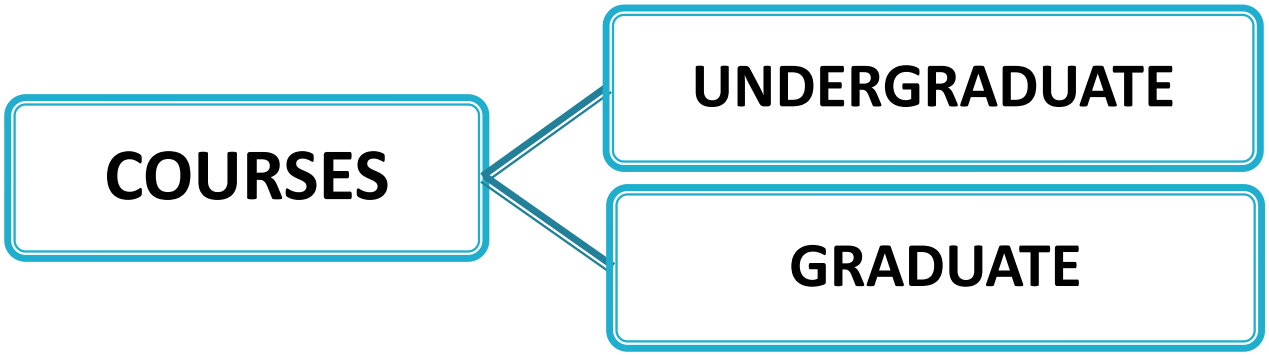


UNDERGRADUATE COURSES

- COMMON REQUIRED
  - CE 2001 “Structure and Behaviour of Civil Engineering Materials”
  - CE 4001 “Civil Engineering Design” (Structure)
  - CE 4002 “Civil Engineering Elective Design” (Structure)
- DEPARTMENTAL REQUIRED
  - CE 3505 “Materials of Construction”

UNDERGRADUATE COURSES

- TECHNICAL ELECTIVES
  - CE 4519 “Concrete Making Materials”
  - CE 4522 “Nondestructive Testing of Materials”
  - CE 4524 “ Properties of Fresh and Hardened Concrete”

GRADUATE COURSES

- CE 5528 “Theory of Elasticity”
- CE 5529 “Cement Replacement Materials”
- CE 5534 “Concrete Admixtures”
- CE 5536 “Advanced Concrete Technology”
- CE 5537 “Advanced Construction Materials Testing”
- CE5544 “Fibre Reinforced Cementitious Composites”
- CE5546 “Durability of Concrete Structures”

MATERIALS OF CONSTRUCTION

- deals with the mechanical, physical and chemical properties of construction materials
- tries to develop new materials to be used in constructions
- tries to develop new technologies for testing or application of construction materials

Chemical Properties

- Chemical composition, potential reaction with environment

  - oxide content
  - carbonate content
  - acidity, alkalinity
  - resistance to corrosion

Physical Properties

- Properties of physical structure
  - density
  - specific gravity
  - porosity
  - permeability
  - surface energy
  - texture (micro, macro)
  - other (color, thermal expansion, shape)

Mechanical Properties

- Resistance to applied loads (stress) initially & over time (stress-strain curves)
  - stiffness
  - strength
  - fracture / yielding (brittle / ductile)
  - tension
  - compression
  - flexure (bending)
  - torsion
  - direct shear
  - multiaxial

Mechanical Properties

- The properties of materials when subjected to stresses and strains are called "mechanical properties".
- In other words the properties that determine the behavior of engineering materials under applied forces are called "mechanical properties".

$$\text{Stress} = \frac{\text{Force}}{\text{Area}} \quad \text{or} \quad \sigma = \frac{F}{A}$$

$$\text{Strain} = \frac{\text{Deformation}}{\text{Original length}} \quad \text{or} \quad \varepsilon = \frac{\Delta L}{L_0} = \frac{L - L_0}{L_0}$$

Mechanical Properties

- Depending on the deformation characteristics, the behaviour of materials can be idealized in different groups:

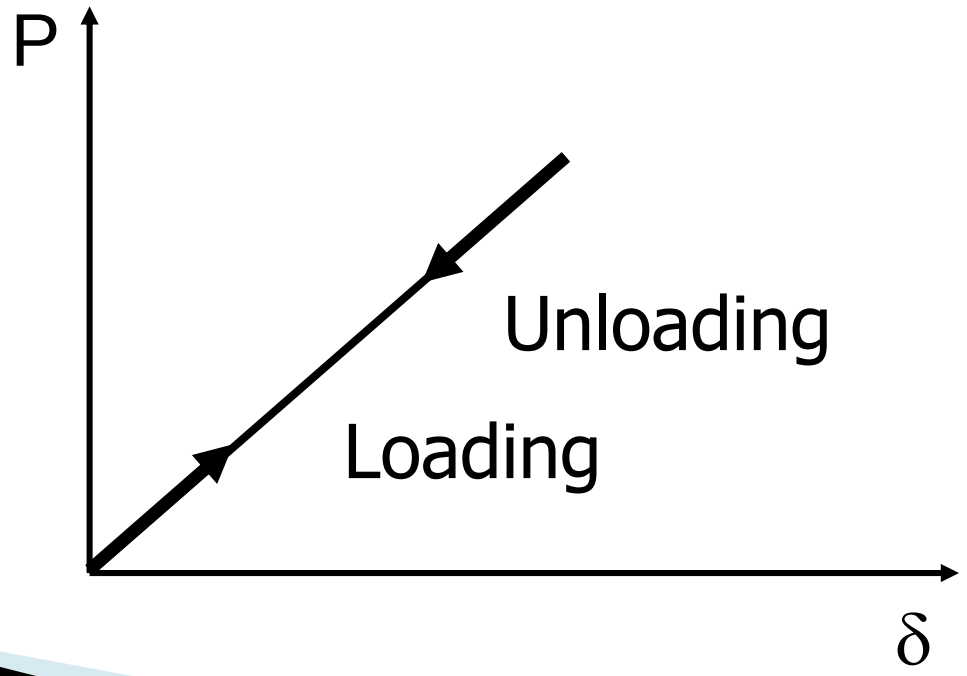
1. **Elastic Deformation**
2. **Plastic Deformation**
3. **Elastoplastic Deformation**

NOTE: DO NOT FORGET THAT THESE ARE IDEALIZED BEHAVIOURS!!

NONE OF THE MATERIALS EXIST IN THE WORLD ARE PERFECT!!!!!

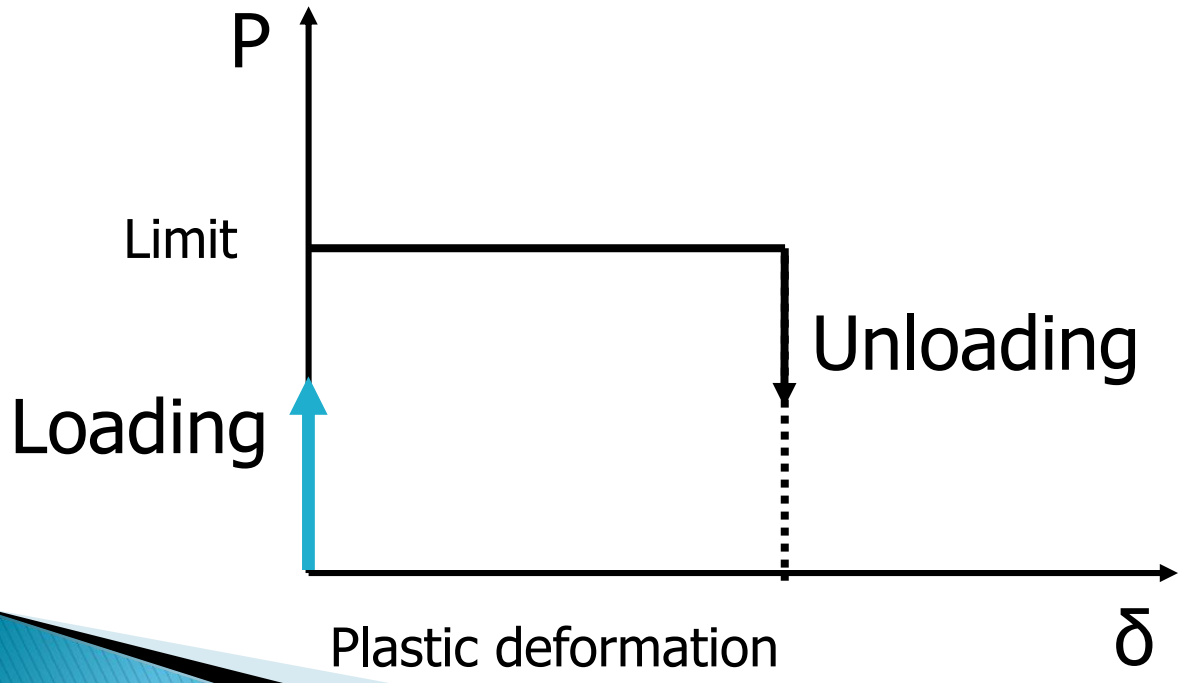
Elastic Deformation

Return to the their original shape when the applied load is removed.



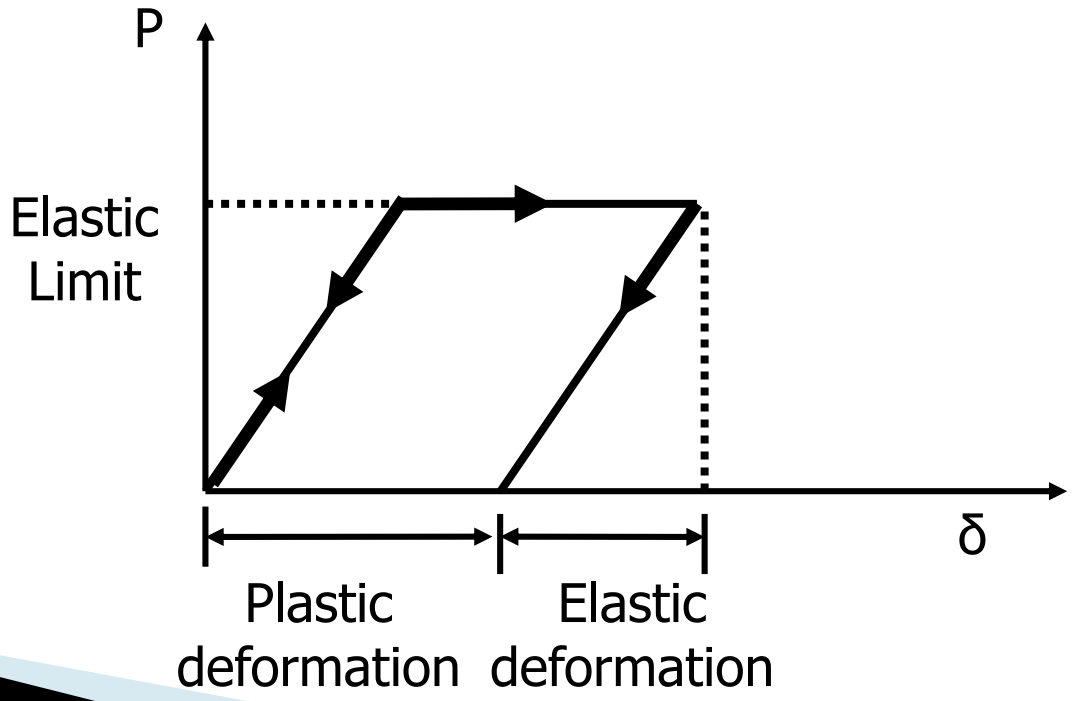
Plastic Deformation

No deformation is observed up to a certain limit. Once the load passes this limit, permanent deformations are observed.



Elastoplastic Deformation

Up to a limit shows elastic properties. Within this limit if the load is removed, returns to its original shape. If the load passes the limit, plastic deformations are observed.

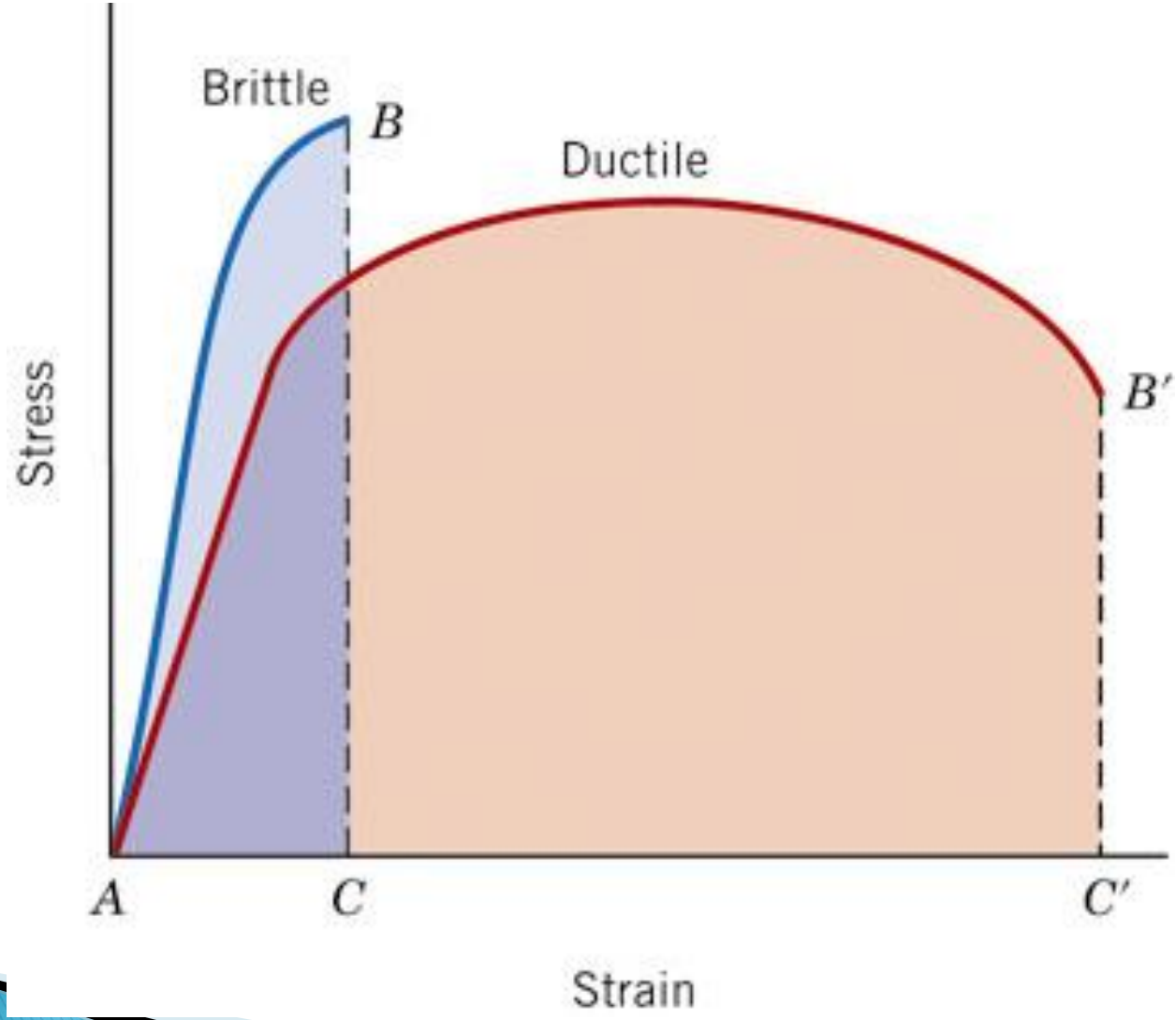


DUCTILITY & BRITTLENESS

- Depending on the behaviour during failure, the materials are classified into two groups:

1. DUCTILE MATERIALS (show excessive amount of plastic deformation before fracture)
2. BRITTLE MATERIALS (show little or no plastic deformation before fracture)

STRESS-STRAIN CURVES



Civil Engineering Materials ?

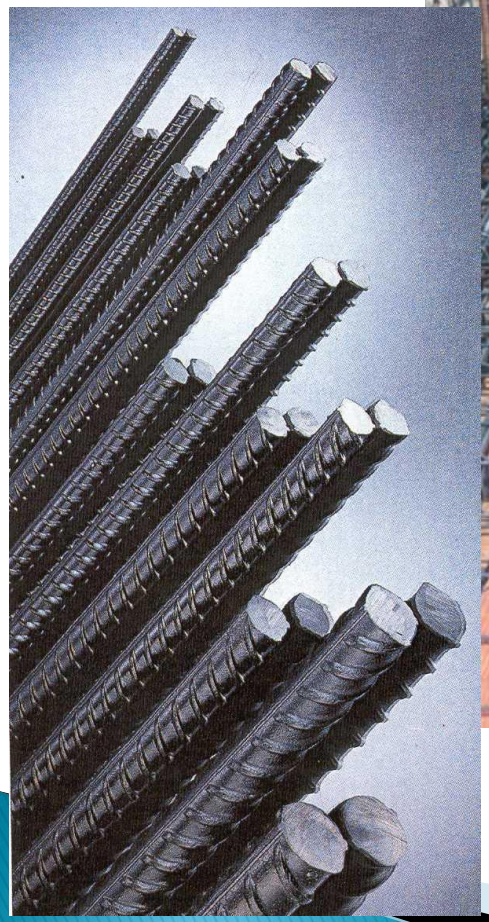
- Metals
- Building Stones
- Gypsum
- Lime
- Clay Products
- Timber
- Cements
- Aggregates
- Concrete
- Mineral Admixtures
- Chemical Admixtures
- Asphalt

METALS: STEEL

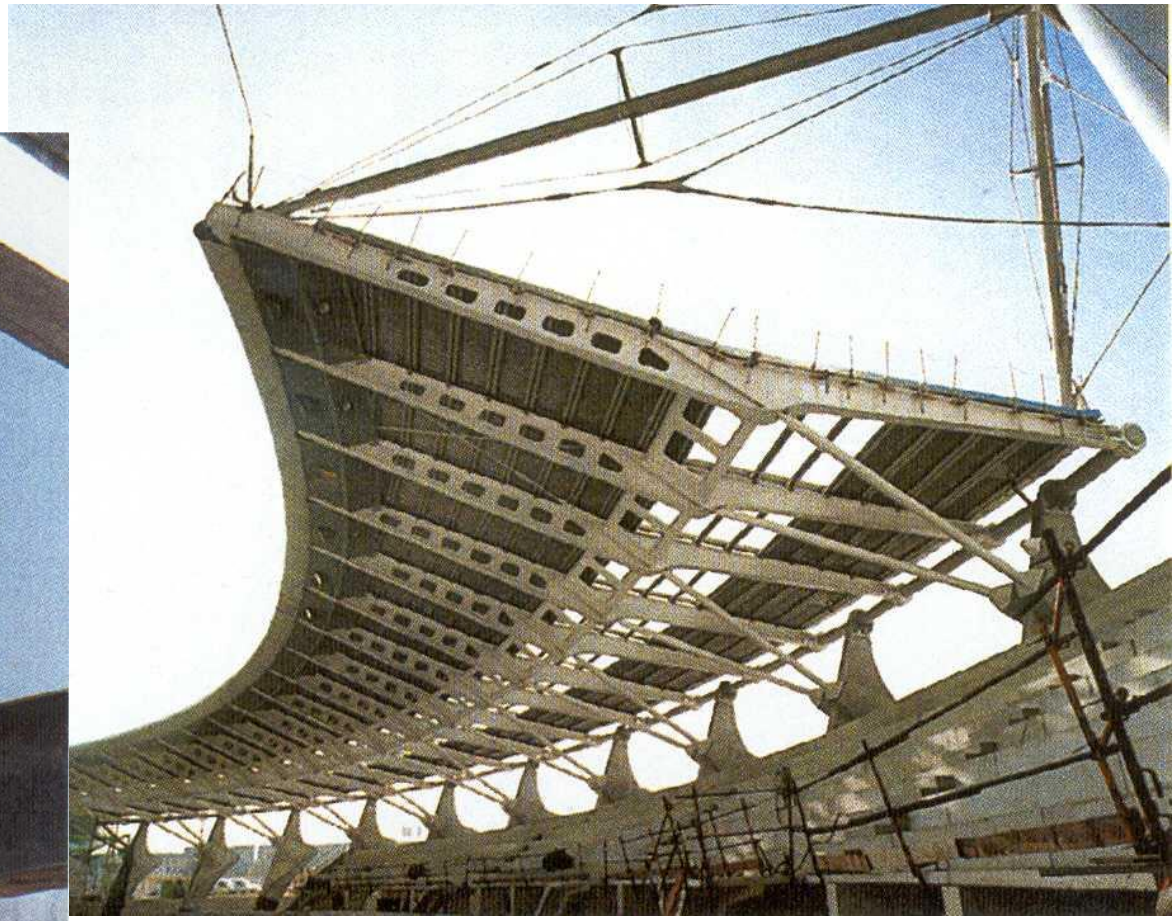
Steel can be used in various ways in the construction industry.

- Steel Reinforcement
- Structural Steel
- Fiber Reinforcement

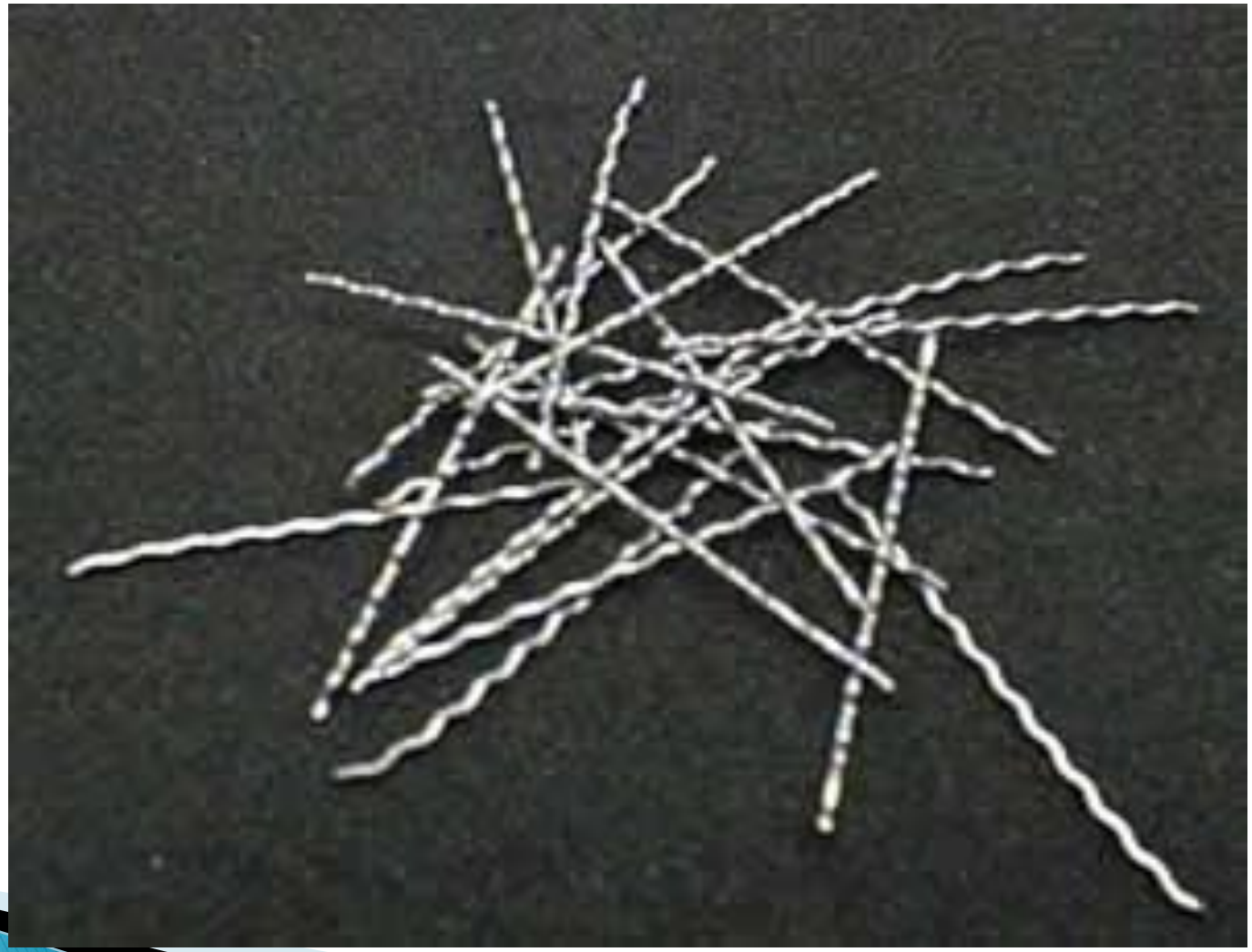
Steel reinforcement



Structural Steel



Steel Fiber Reinforcement



CONCRETE

- In modern society, people always encounter with concrete directly or indirectly

CONCRETE

- Concrete is the most widely used structural material in the world.
- Concrete is used more than any other manmade material in the world.
- Concrete is the 2nd most consumed substance in the world.
- ~10 billion tons of concrete are produced per year.

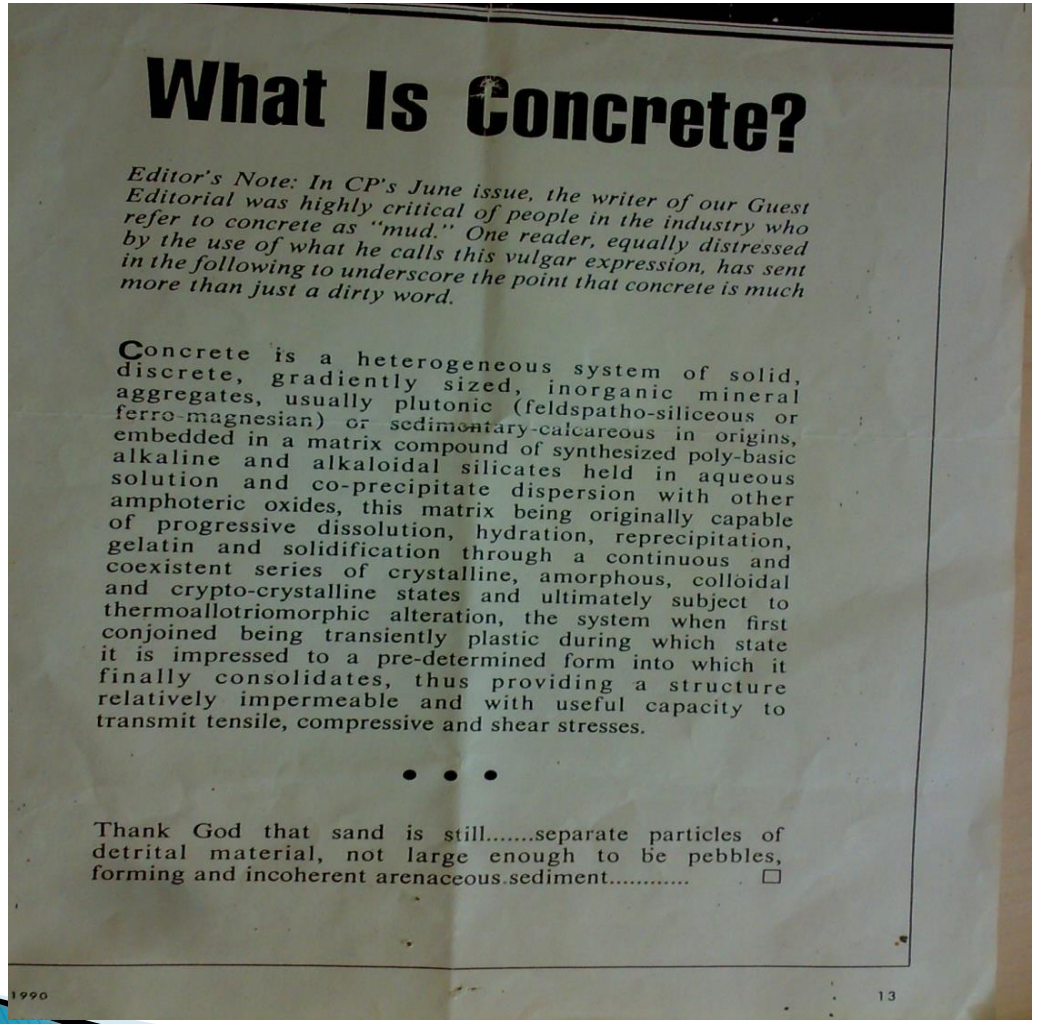
What makes concrete so popular??

1. Ability to be cast in desired shapes (plastic stage)
2. Economical (cement is the most costly ingredient)
3. Durable (maintenance free)
4. Good adherence to reinforcing steel bars (reinforced concrete)
5. Fire-resistant
6. Energy efficient (production of cement requires energy. Possible usage of supplementary cementitious materials. Concrete conducts heat slowly, so concrete buildings are more energy efficient)

Limitations of Concrete

1. Low tensile strength (reinforced concrete)
2. Low ductility (not resistant to impact loads)
3. Volume instability (shrinkage)
4. Low strength/weight ratio (for high strength, large masses of concrete is required)

Definition of Concrete



What Is Concrete?

Editor's Note: In CP's June issue, the writer of our Guest Editorial was highly critical of people in the industry who refer to concrete as "mud." One reader, equally distressed by the use of what he calls this vulgar expression, has sent in the following to underscore the point that concrete is much more than just a dirty word.

Concrete is a heterogeneous system of solid, discrete, gradiently sized, inorganic mineral aggregates, usually plutonic (feldspatho-siliceous or ferro-magnesian) or sedimentary-calcareous in origins, embedded in a matrix compound of synthesized poly-basic alkaline and alkaloidal silicates held in aqueous solution and co-precipitate dispersion with other amphoteric oxides, this matrix being originally capable of progressive dissolution, hydration, reprecipitation, gelatin and solidification through a continuous and coexistent series of crystalline, amorphous, colloidal and crypto-crystalline states and ultimately subject to thermoallotriomorphic alteration, the system when first conjoined being transiently plastic during which state it is impressed to a pre-determined form into which it finally consolidates, thus providing a structure relatively impermeable and with useful capacity to transmit tensile, compressive and shear stresses.

• • •

Thank God that sand is still.....separate particles of detrital material, not large enough to be pebbles, forming and incoherent arenaceous sediment..... □

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Components of Concrete

CONCRETE is a composite material that consists essentially a binding medium within which are embedded particles of aggregate

PASTE = Cement + Water

MORTAR = Cement + Water + Fine Aggregate

CONCRETE = Cement + Water + Fine Aggregate + Coarse Aggregate (+ Admixtures)

CONCRETE CLASSES (TS EN 206-1)

- According to the slump values

Çizelge 3 - Çökme sınıfları

Sınıf	Çökme, mm
S 1	10 - 40
S 2	50 - 90
S 3	100 - 150
S 4	160 - 210
S 5[1)]	≥ 220

- **Slump Test** is related with the ease with which concrete flows during placement (TS 2871, ASTM C 143)

CONCRETE CLASSES (TS EN 206-1)

- According to compressive strength

Çizelge 7- Normal ve ağır beton için basınç dayanımı sınıflar

Basınç dayanımı sınıfı	En düşük karakteristik silindir dayanımı $f_{ck,sil}$ N/mm^2	En düşük karakteristik küp dayanımı $f_{ck,küp}$ N/mm^2
C 8/10	8	10
C 12/15	12	15
C 16/20	16	20
C 20/25	20	25
C 25/30	25	30
C 30/37	30	37
C 35/45	35	45
C 40/50	40	50
C 45/55	45	55
C 50/60	50	60
C 55/67	55	67
C 60/75	60	75
C 70/85	70	85
C 80/95	80	95
C 90/105	90	105
C 100/115	100	115

C 30/37

- **30 MPa** compressive strength tested by cylindirical specimens 28 days after casting or,
- **37 MPa** compressive strength tested by cubic specimens 28 days after casting
- C 35/45??
- C 55/ 67??

Cylinder: h/D=2 with h=15

Cubic: 15x15x15 cm

High-performance Concrete

Definition: concrete meeting special combinations of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing, and curing practices. Examples include:

- High-strength concrete
- Self-compacting concrete
- Fiber-reinforced concrete
- Engineered Cementitious Composites
- Self-healing Cementitious Composites