- Sand, Lime, mortar, concrete, reinforced concrete (origin, characteristics, composition, production, preparation, properties, standards)

Sand

Chemical Composition

- most common constituent of settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz.

Object of mixing sand

- It prevents excessive shrinkage.
- To improve the strength of mortar, the crystals formed have a tendency to adhere to a rough nucleus. They adhere better to particles of sand than to each other.
- To improve the setting power; sand makes the mortar porous, which absorbs Co2 from air and becomes hard.
- To increase the bulk and thus reduce the cost.

According to mode of origin, sands are of three types, namely,

- pit sands(From quarry),
- stream sands
- marine sands.

**used with cement to make mortar for masonry work and plaster.

** used as a part of the concrete mix.

Requirements of sand :

- It should be clean and well graded (same particle size).
- Fine aggregates should be durable and free from gritty particles and injurious particles like dust, flaky particles of shale.
- Fine aggregates should also be free from salts.
- Sand shall not contain any harmful impurities such as iron, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft fragments,
- The sand should not contain more than 6% of silt and it should be determined by “silt content field test”.

How to test

- Take a glass of water (The diameter of glass should be uniform throughout height)>> add sand >> stir the mix>> allow the mix to settle and observe it after an hour.

Clean sand will settle immediately but if it forms the distinct top layer of silt than sand contains silt or clay particles. The thickness of the silt layer should not exceed the thickness of the sand layer by 6%. If it contains more than 6%, the sand should be washed with clean water.

- You should taste a sand if it tastes salty. If the sand had a salt, it should not be used for construction. Such sand is naturally from the river but either it is sea sand or from an area of river frequently affected by tidal water near the sea.
- Hold some dry sand and drop it. If the Sand adheres to your palm, then it has Clay.

Lime

- Lime is obtained from LIMESTONE.



- Pure limestone is **$CaCO_3$ (calcium carbonate).**
- Impurities like $MgCO_3$, Al_2O_3, SiO_2, etc may be present.
- The slaking process can produce dry lime hydrate powders or, if excess water is used, lime putty.
- Lime mortars, plasters, and renders are manufactured by mixing aggregate with a lime product, either quicklime, lime hydrate powder, or lime putty, adding water if required.

Production of Lime

• Excavation of limestone

• Crushing

• Grading

• Calcination to obtain *quicklime*

Lime is formed by burning limestone between 850°C and 1200°C, driving off carbon dioxide & water to form calcium oxide (CaO, quicklime). This process is called as calcination. The solid product that remain after the removal of carbon dioxide in the calcium carbonate is called as the quicklime.

• Pulverize

• Mix with water

The calcium oxide is then slaked with water (evolving heat) to form calcium hydroxide (lime, Ca(OH)2). Putty is formed by the addition of a large quantity of water (two to three times its weight). This process promotes a chemical reaction that makes the whole system to boil. A semi-fluid mass is obtained as a stiffened mass on cooling, which is called as the putty. This material after proper screening is used as the material for construction.

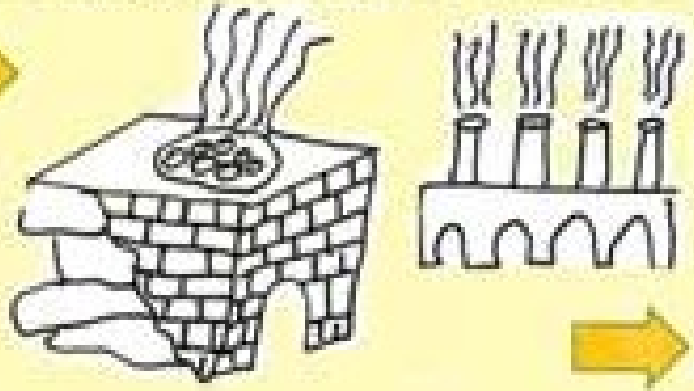
• Dry and pulverize to obtain hydrated lime

• Marketing

limestone ($CaCO_3$)

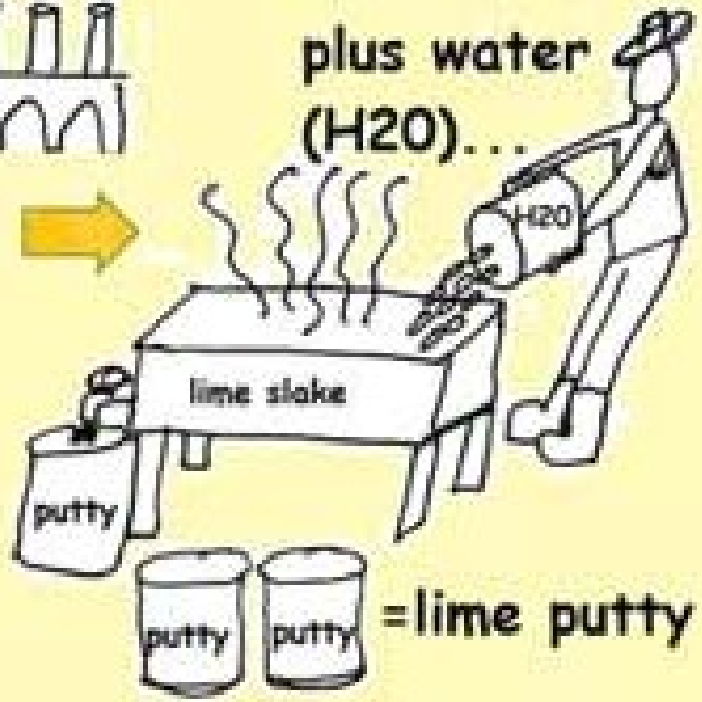


burning gives off H_2O and CO_2



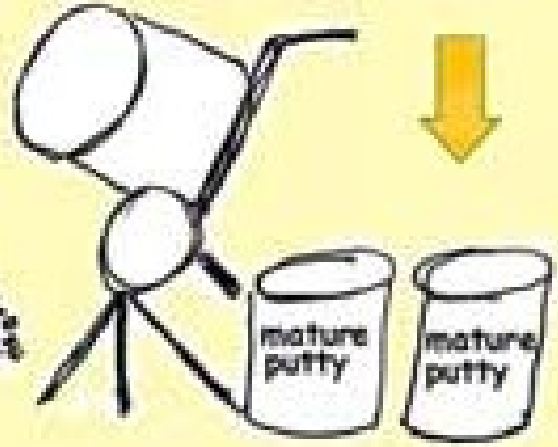
= quicklime (CaO)

plus water (H_2O)...



=lime putty

mature for 3-6 months



mix with sand...



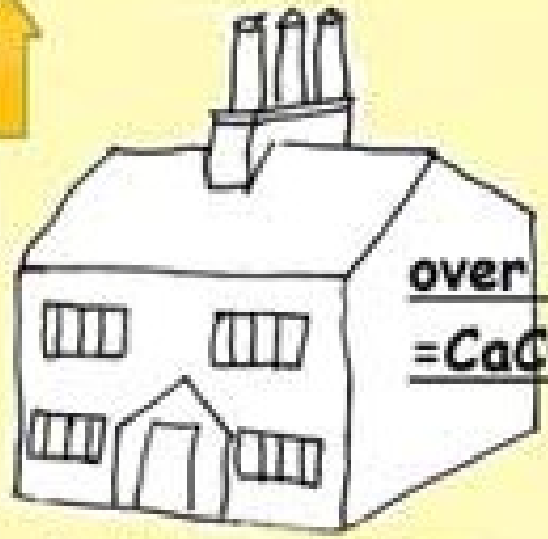
and use as plaster, render and mortar



curing takes on Co_2 and gives off H_2O

over time

$=CaCO_3$



THE LIME CYCLE

Limes classified as

1. non-hydraulic (quick lime, fat lime or white lime)

- it is a Lime made from pure limestone
- sets by drying out and then hardens wholly by absorption and reaction with carbon dioxide, slowly to become calcium carbonate again.

- do not set under water.
- not harden without air being present (e.g. under sea).

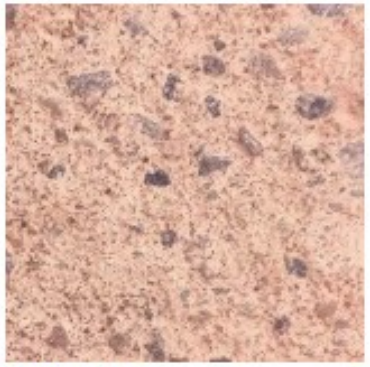
2.Hydraulic

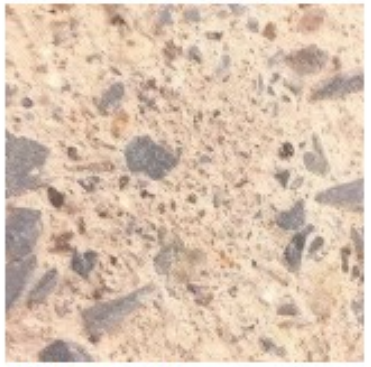
- The raw material for hydraulic lime is limestone with impurities and these are also calcinated.
- sets under water

Special Color Mix Mortars for Matching Historic Lime Pointing.









Advantages of Lime in Construction

- **Provides building breathing property**– This material let the building to be vapor permeable, thus allowing to breathe so that it reduces the chances of trapped moisture and the damage of the building.so that it renders comfortable environment by absorbing moisture and stabilizes internal humidity.
- **Ecological Benefits**– energy conservation than cement, small scale production of lime is possible
- **Protection of adjacent materials**– Porous texture of lime handle the moisture movement, without affecting the adjacent materials
- Provides good workability
- Durability is high
- Beautiful finish for buildings
- **Self-healing properties**– Any movement of the building made of lime, creates micro-cracks. Presence of moisture make the free lime active to precipitate and heal these micro cracks.

Properties of Lime for Use in Construction

The white powdered slaked lime has a wide range of applications in construction. The properties of lime are:

- **Cementing capability**– This is obtained by their carbonation with carbon dioxide. Lime is used as lime mortar for brick masonry construction.
- Have a **higher acid resistance**– due to its alkaline nature
- **Sealing of micro cracks**– This is done by the precipitation made by the calcium carbonate when carbon dioxide passes through the lime mortar mix.
- It has good workability.
- It stiffens quickly.
- It has low shrinkage.
- It has good resistant to moisture.
- Lime possesses good plasticity.

Applications of Building Lime in Construction

- **Masonry Construction-** For the construction of the monument, retaining walls. Also, used in load bearing walls.
- **Structural Applications** like canopies, arches, domes of different size and form
- Used for **construction of wall structures** like wells, fountains and water channels
- Used for **plastering purposes**– For different types like decorative, plain plastering
- Used to **make intricate patterns** as well as geometrical profiles
- Used **for finishing works**







uses of lime

- Lime is uses in the treatment of water and waste water.
- It is used as lime mortar for masonry work of buildings.
- It is used for plastering and white washing of buildings.
- It is used as lime concrete to make water proof structures.

Concrete

Concrete is basically a mixture of

- Water,
- Cement: to bind the coarse and fine aggregate)
- Sand/ fine aggregate : of filling all the open spaces in between the coarse particles. This way the porosity of the final mass is decreased.
- gravel /crushed stone/ coarse aggregate: to act as the main load-bearing component of concrete.

- Plain concrete is weak in tension and good in compression.
- The common method of expressing the proportions of ingredients of a concrete mix is

e.g., a concrete mix of proportions 1:2:4 means the mix contains one part of cement, two parts of sand/fine aggregate and four parts of coarse aggregate. The proportions are either by volume or by mass. The water-cement ratio is usually expressed in mass.

Properties of *fresh concrete*

The most important property of fresh concrete is its workability or flow ability, because this determines the ease with which it can be placed. It is determined using a slump test, in which a standard truncated metal cone form is filled with fresh concrete . The mold is then lifted vertically, and the resulting loss in height of the concrete cone, or the slump value, is indicative of the concrete’s workability. For very liquid mixes, the flow test is performed, which is similar to the slump test, except that the mean diameter of the cake formed by the fresh concrete (or mortar)



Concrete slump test

Properties of *hardened concrete*

By far, the most important property of hardened concrete is its compressive strength. The strength is determined 28 days after casting by loading standardized test for compressive strengths, test cubes are often used.



- The standard cube size is **15*15*15 cm** and for cylinder it is **15 cm diameter and 30 cm height.**

- The concrete mix ratio refers to the proportional relationship between the constituent materials in the concrete.

Basic requirements for designing concrete mix ratios:

- Meet the strength grade of concrete design.
- Concrete and workability to meet construction requirements.
- To meet the durability requirements of concrete use.
- Meet the above conditions to save cement and reduce concrete costs.

- Concrete is divided into several strength grades according to strength, and the strength grade of concrete is strongly divided by compression. The strength of concrete is divided into twelve grades such as C5, C10, C15, C20, C25, C30, C35, C40, C45, C50, C55 and C60.
- The grade of the concrete means the concrete compression resistance after 28 days. It is done in Nektons per square millimeter. A concrete of Grade C15 means that the concrete will have a compression resistance (withstanding a compression) of 15 N/mm2 (Newton per square millimeter) in 28 days.
- Proportions for different grades: Cement : Sand : Gravel

1 : 2 : 5 for grade C15 (general purpose concrete)

1 : 2 : 4 for grade C25 (strong)

1 : 2 : 3 for grade C30 (very strong)

- C10 Concrete: used for non-structural construction elements like courtyard slabs and pathways.
- C15 Concrete : Used for pavement Curb

- C20 Concrete : for domestic floors
- C25 Concrete : used for commercial and domestic construction sites.
- C40 Concrete: is a strong grade of concrete that is mostly used on commercial construction sites,

Types of concretes

- Plain or Ordinary Concrete
- Reinforced Concrete
- Precast Concrete
- Light – Weight Concrete
- High-Density Concrete
- Fiber-reinforced concrete
- Polymer Concrete
- Rapid Hardening Concrete:
- Glass Concrete
- High-Strength Concrete
- High-Performance Concrete
- Self – Consolidated Concrete
- Lime Concrete
- Asphalt Concrete
- Roller Compacted Concrete
- Rapid Strength Concrete

- ***Plain or Ordinary Concrete:*** the most commonly used types of concrete. Essential constituents are cement, sand and coarse
- ***Reinforced Concrete:*** steel in various forms is used as reinforcement to give very high tensile strength.
- ***Precast Concrete***: This term refers to numerous types of concrete shapes that are cast into molds either in a factory or at the site.
- ***Glass Concrete:*** recycled glass is used as an aggregate in the concrete. & it provides better thermal insulation and also have a great appealing look as compared to other types.

- ***Rapid Hardening Concrete:*** This type of concrete is mostly used in under water construction and in repairing of roads. Because its hardening time is very less.
- ***Self Consolidated Concrete:*** These types of concrete are compacted by its own weight, mean by the process of consolidation. There is no need of using a vibrator or doing manual compaction.
- ***Ready Mix Concrete:*** This concrete type is prepared in concrete plants and transported by truck mounted transit mixtures.
- ***Lime Concrete:*** lime is used as a binding material with the aggregates. Before the invention of cement, the mostly used concrete was lime concrete.
- ***Asphalt Concrete:*** Asphalt concrete is a combination of aggregates and asphalt. It is also known as Asphalt. They are vastly used in the highways, airports, as well as in the embankments.

Concrete Admixtures

Admixtures are ingredients in concrete that are added to the mixture immediately before or during mixing.

• ***The major reasons for using admixtures are***:

– To reduce the cost of concrete construction

– To achieve certain properties in concrete more effectively than by other means

– To maintain the quality of concrete during the stages of mixing, transporting, placing, and curing in adverse weather conditions

Admixtures can be classified by function as follows:

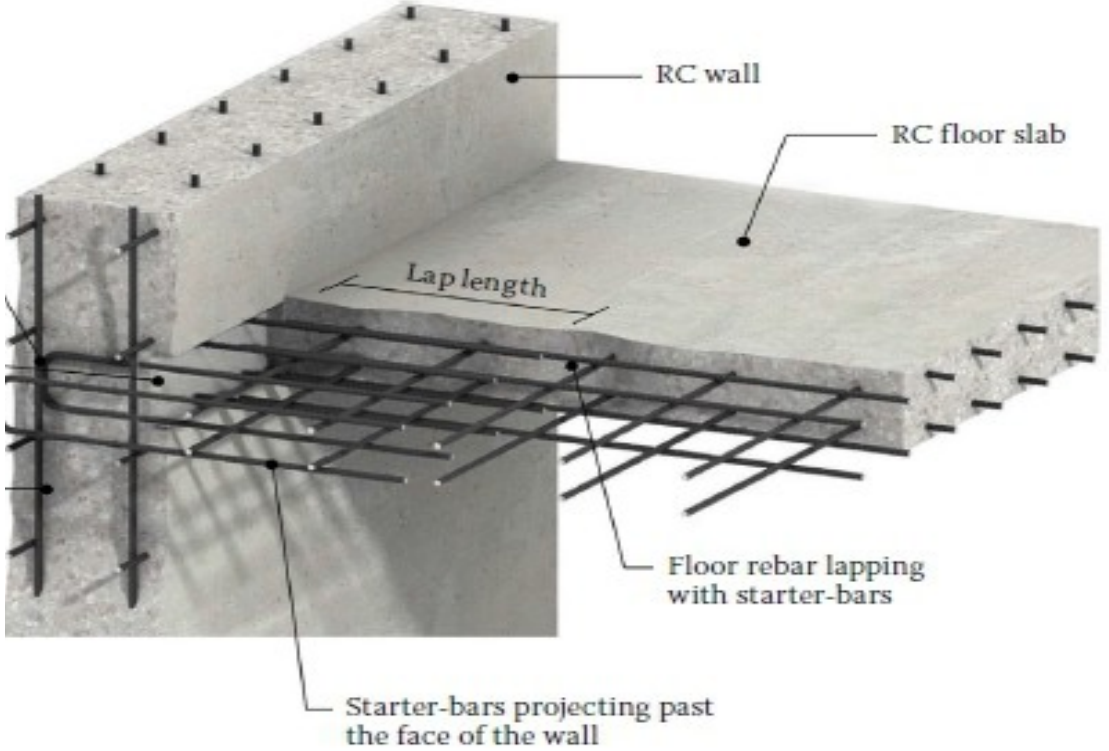
- Water-reducing admixtures
- Plasticizers
- Accelerating admixtures
- Retarding admixtures
- Hydration-control admixtures
- Corrosion inhibitors
- Shrinkage reducers
- Alkali-silica reactivity inhibitors
- Coloring admixtures
- Miscellaneous admixtures
- Air-entraining admixtures
- Fiber

- Plasticizers – this makes the mixed concrete more workable and free-flowing. Ideal if it needs to be laid quickly.
- Retardants – these additives slow down the curing process of concrete, giving you more time to work.
- Accelerants – these additives speed up the curing process, ensuring the concrete begins to cure much faster than normal.
- Fibers – these can increase the concrete’s strength and help prevent cracking.

inforced concrete

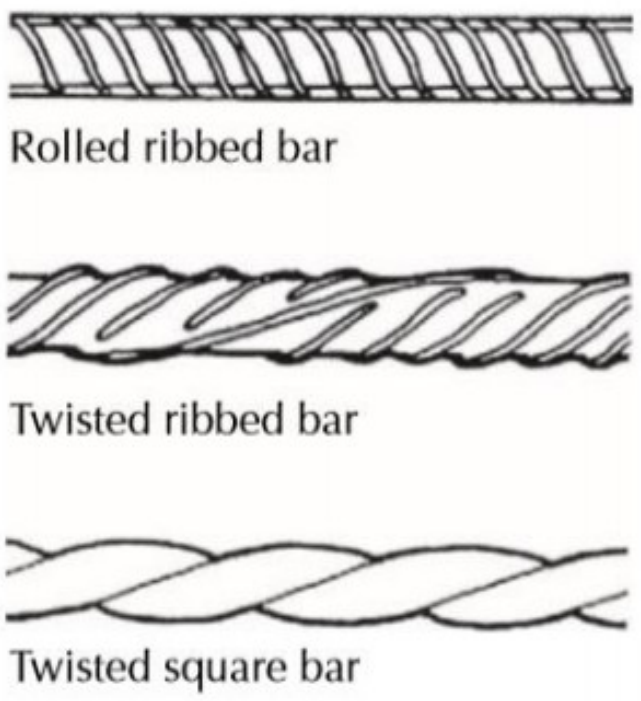
- Reinforced Concrete (RC) is made by combining Concrete with reinforcing steel.
- used as reinforcement to give very high tensile strength.
- Reinforcing schemes are generally designed to resist tensile stresses in particular regions of the concrete that might cause cracking & structural failure
- the combined action of plain concrete (having high compressive strength) and steel (having high tensile strength). it is very necessary to ensure proper bond between the concrete and the reinforcement. This bond will control the strength and the durability factors of the concrete

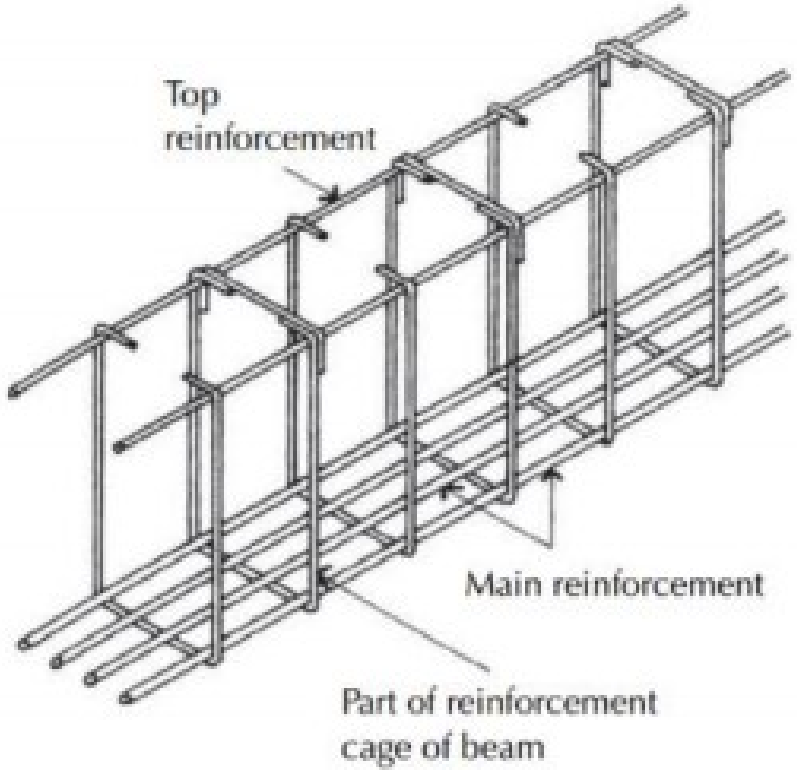


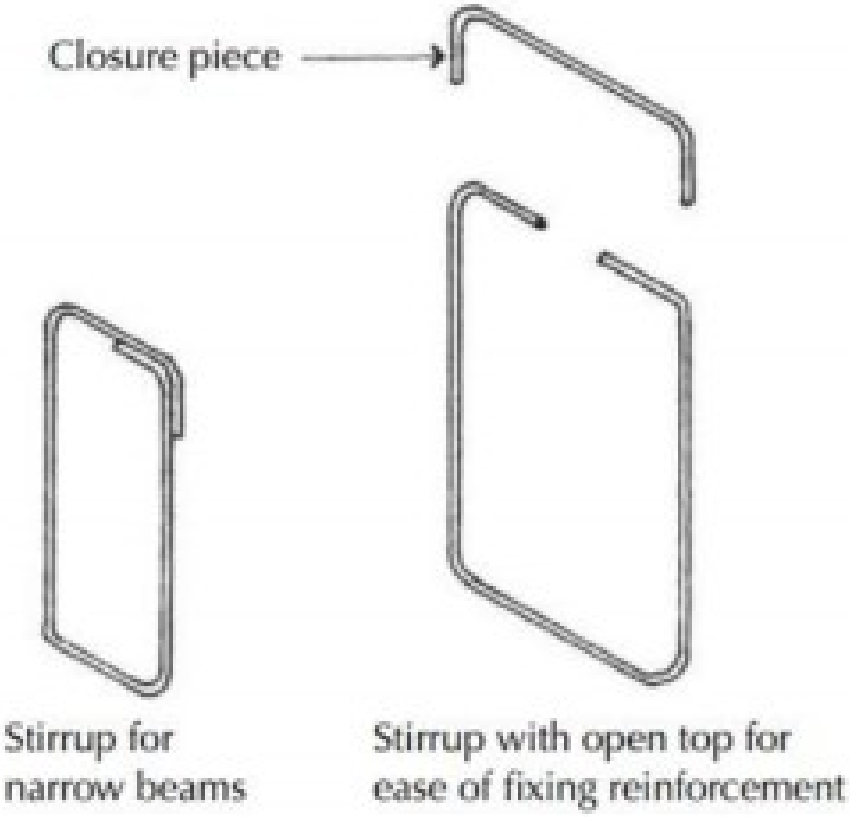


Deformed Reinforced Steel

it is common to use deformed bars that have projecting ribs or are twisted to improve the bond to concrete.







For a strong, ductile and durable construction the reinforcement needs to have the following properties at least:

- High relative strength
- High toleration of tensile strain
- Good bond to the concrete, irrespective of pH, moisture, and similar factors
- Thermal compatibility, not causing unacceptable stresses (such as expansion or contraction) in response to changing temperatures.
- Durability in the concrete environment, irrespective of corrosion or sustained stress

The Concrete Construction Process

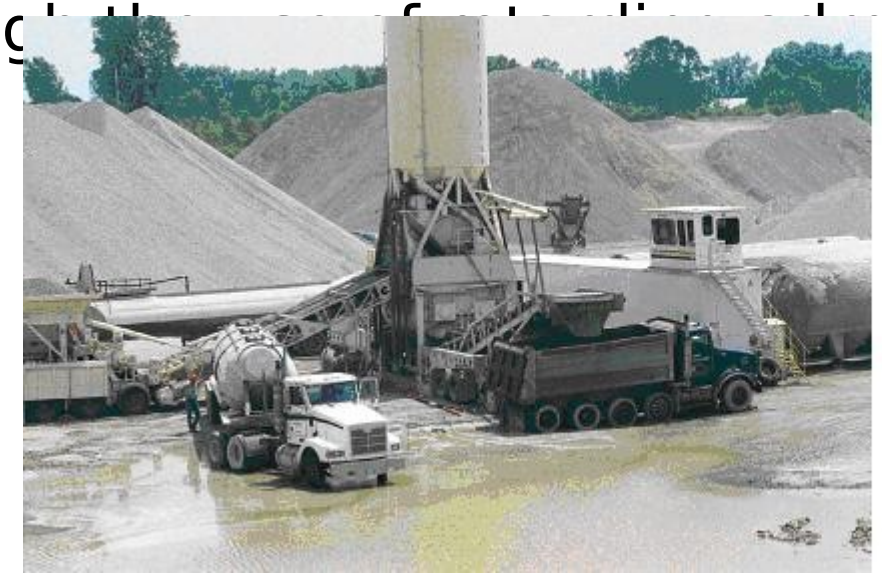
- *Designing the concrete mix* :
- *Mixing*
- *Placing*
- *Consolidation/Compacting*
- *Curing*

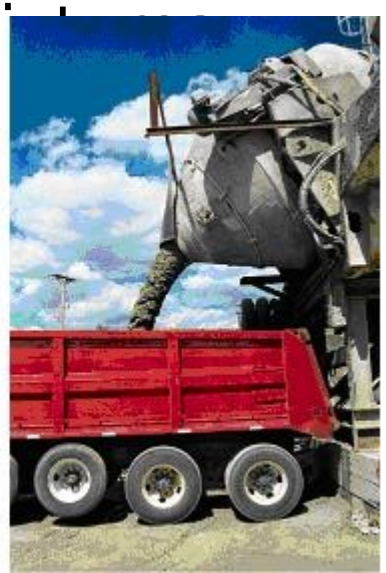
***Designing the concrete mix* :**

- determine the ingredients that will make up the concrete and their proportions.
- cement type, aggregate size and type, amount of water, and mineral and chemical admixtures should be considered.
- In Large projects the responsibility for the final mix design falls to a licensed civil engineer.

Mixing: Mixing distributes the aggregate evenly throughout the cement paste, ensures that all of the cement has been fully saturated in water, and removes large air voids.

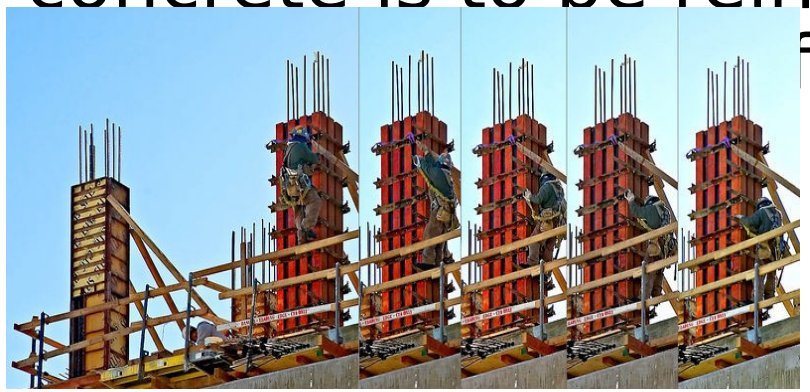
- Most concrete is batched and mixed in a central location called a ready-mix plant and then trucked to the desired location
- Concrete mixing trucks can be used to transport already-mixed concrete, or the mixing can actually be performed by the truck as it is traveling to the site.
- One potential disadvantage of ready-mixed concrete is that the time required to transport the concrete to the site may use up too much of the early period of good workability. This can generally be handled throug





Placing

Once the concrete has been adequately mixed, it must be placed into the formwork that defines its final position and shape. If the concrete is to be reinforced, the rebar must already be in place flow around it







Consolidation/Compacting

Once the concrete is in place, it should be consolidated to remove large air voids developed during placement and to make sure that the concrete has flowed into all of the corners and nooks of the formwork. This process is also called compacting

Curing

- Hydration of cement, as the word itself implies, involves reaction with water. To cure properly, the cement paste must be fully saturated with water
- To keep fresh concrete moist, it can be covered with plastic or damp fabric to prevent evaporation, or sprayed periodically with water. Spraying is particularly helpful when the w/c of the concrete is low, because the original mix water is not enough for the cement to hydrate fully.
- Pools of water should not be allowed to form on the surface, however, as this will leach and degrade the concrete underneath.
- The weather plays an important role in the curing process. Hot windy weather leads to rapid evaporation and thus particular care must be taken to keep the concrete moist. Cold weather causes the concrete to harden much more slowly than hot weather. This delays the construction process, but leads to better concrete in the long run, because the hydration .

- **Masonry Constructions using stone, bricks, blocks**