

CEL 774
IIT DELHI
Construction pRACTICES

(Lecture 1-3)
Concrete: Production
B. Bhattacharjee

CIVIL ENGINEERING DEPARTMENT
IIT DELHI



DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

General Outline

❖ Concrete Production.

⚙ Production Process

⚙ Batching.

⚙ Mixing.



What is CONCRETE?

- ***Ordinarily concrete is made by mixing an inorganic material known as cement with water together with natural sand or stone dusts and natural stones which may be uncrushed or crushed.***



Cement



Sand/
Fine Aggregate



Stone /
Coarse Agg.



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

CEMENT

- *Most commonly used cement is called Portland Cement patented in 1824 in England, when mixed with water, hardens, hence hydraulic cement .*
- ❖ *Basic raw materials used in the manufacture of cement are calcium carbonate found in lime Stone or chalk, and silica, alumina and iron oxide found in clay or shale.*



AGGREGATES



Cement-sand
Mortar

Aggregate

✎ Aggregates forms
the skeleton matrix
60-75% by volume.
25-40% Paste
1-2% Voids.

➤ **Aggregate shall be inert and strong.**



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

ADMIXTURES

- ❖ *Chemical Admixture: Used for specific Property/performance enhancement.*
- ❖ *Mineral Admixture: Used for improvement of long term strength and durability performance.*
- ***Using above admixtures together, high Strength and high performance concrete Materials can be designed.***



ADVANTAGES AND DISADVANTAGES OF CONCRETE

- ❖ *Lower life cycle cost*
 - ❖ *Mould-ability*
 - ❖ *Robustness.*
 - ❖ *Can be designed for desired property*
 - ❖ *Low tensile strength.*
 - ❖ *Lower ductility (brittle)*
- **Concrete is most popular construction material.**



CONCRETE & COMPOSITES

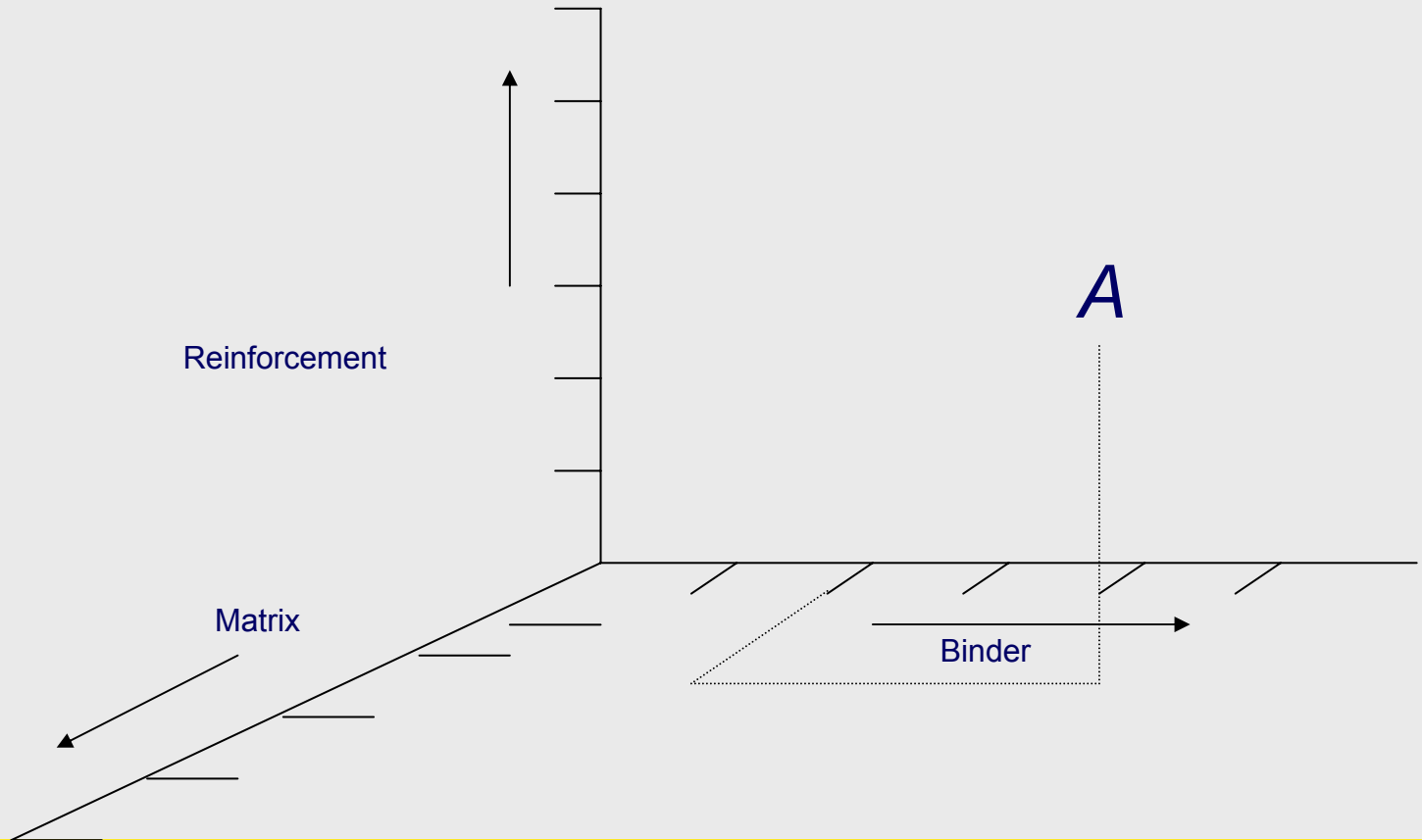
- ❖ *Normal strength Concrete*
- ❖ *High strength/performance concrete*
- ❖ *Ultra high strength concrete*
- ❖ *Fiber Reinforced Concrete.*
- ❖ *Densified with small particle (DSP)*
- ❖ *Macro Defect Free (MDF) Matrix*
- ❖ *Reactive Powder Concrete (RPC)*
- ❖ *Polymer Concrete (PC)*
- ❖ *Polymer cement concrete*



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

CONCRETE COMPOSITES



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

DESIGNATION OF NORMAL STRENGTH CONCRETE

- Concrete is designated through 28 day Standard cube compressive strength.
- ❖ In Indian Standard Code of practice (IS 456) a concrete is designated by its characteristic cube compressive strength at 28 days, the cube being cast, cured and tested in a standard manner.
- ❑ Concrete is designated as M25 has a 28 day Characteristic standard cube strength of 25 MPa.



PERFORMANCE OF CONCRETE

- ❖ *Normal strength concrete: $\leq 60\text{MPa}$*
 - ❖ *High strength concrete: $60 \leq f_c \leq 120\text{MPa}$.*
 - ❖ *Ultra High strength concrete: $\geq 120\text{MPa}$.*
 - ❖ *Performance at fresh state: Self Compacting*
 - ❖ *Long term durability performance.*
- **Concrete is a versatile construction material.**



SUMMARY

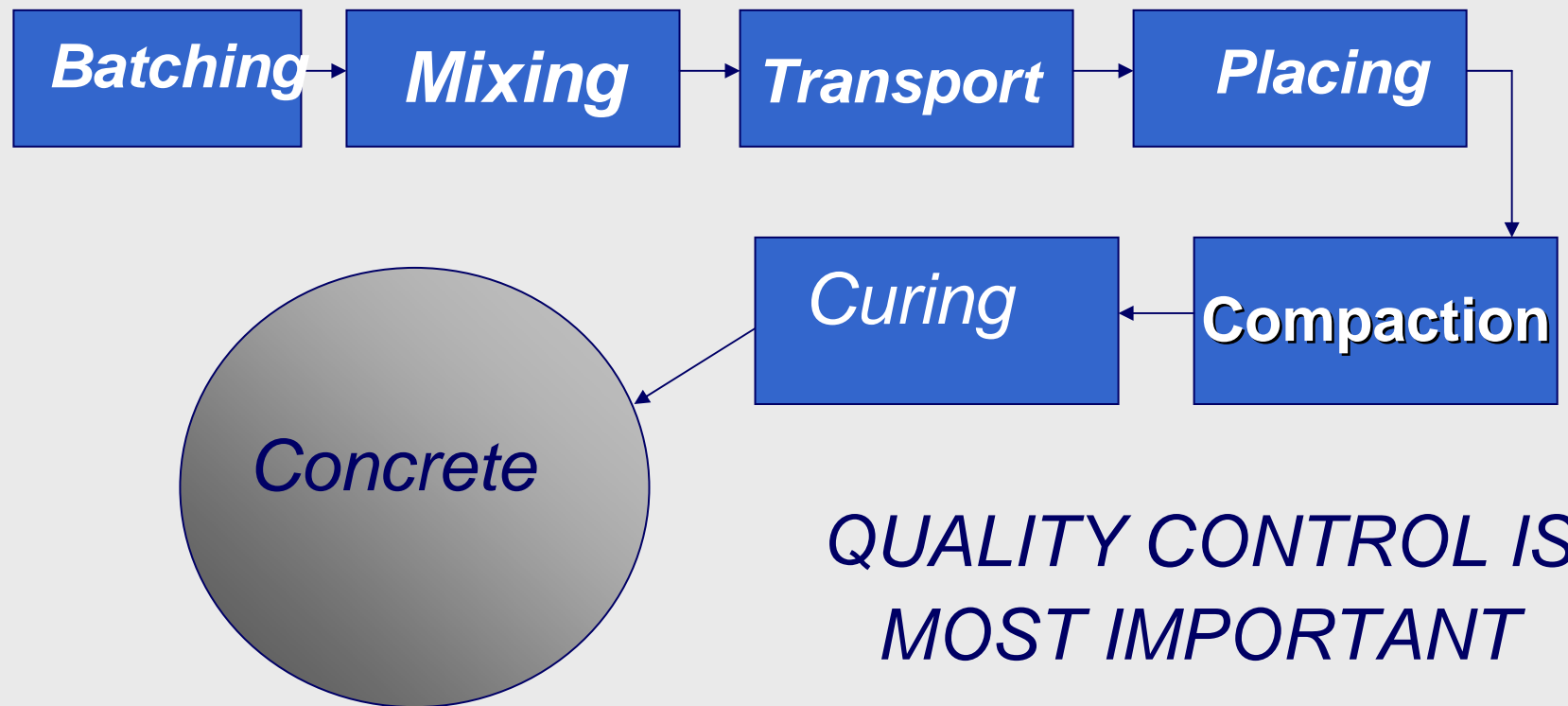


Concrete Material.

- ❁ Natural aggregates, cement or cementitious and water and also admixtures.
- ❁ Concrete composites.
- ❁ Concrete is designated by characteristics 28 day cube compressive strength.
- ❁ Performance of concrete at fresh, hardening and hardened state.



Production Process



Batching

- **Batching** is the process of measurement of specified quantities of cement, aggregates, water and admixture, i.e., ingredients of concrete in correct proportion.
- **Batching Process**
 - ❑ 1) Volumetric batching .
 - Not desirable except for small non engineered jobs
 - ❑ 2) Weigh Batching (Mass basis, IS456:2000)



Batching Process

- *Batching by mass (weights) as reproducibility of loose volume is inadequate and is not economical .*
- *Control and storage of materials
Aggregate bins for storing aggregate. Silos for storing cement and cementitious materials*



Batching Plant

- **Components of a Batching Plant**
 - A) Aggregate bins for various types of aggregates.
 - B) Feeding mechanisms such as scrappers, conveyors or hoists etc. to transfer aggregate to scales (balances).
 - C) Balance and measuring system.

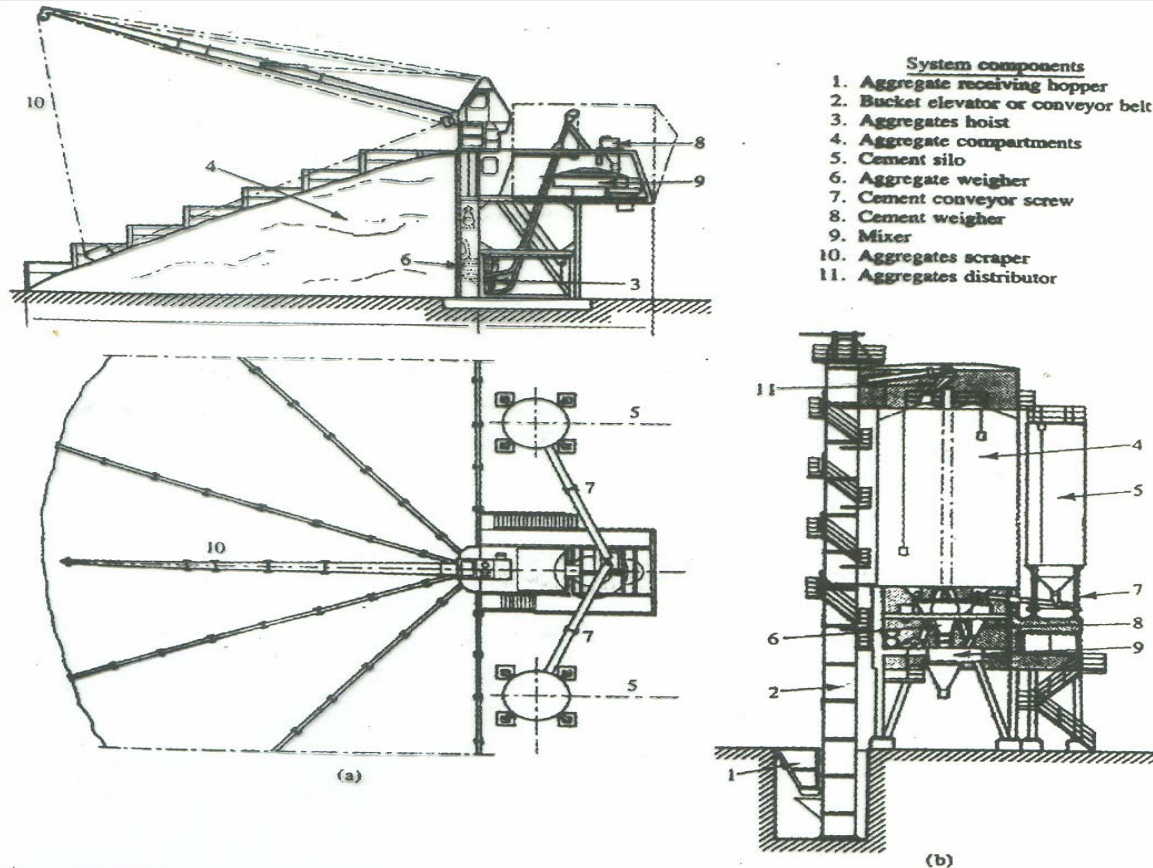


Batching Plant

- ***Components of a Batching Plant***
 - *D) Cement silos and a conveyor screw or bucket conveyor .*
 - *E) The storage tank for water and water measuring system .*
 - *F) Dispenser for chemical (liquid) admixture.*



Batching Plant



TYPICAL CONCRETE MIXING CENTERS
a- star type ; b- tower type



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

BATCHING PLANT

Scraper
Fly ash silo
Cement Silos
Aggregate bins



DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

BATCHING PLANT

Screw Conveyors

Control Room

Mixer



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

BATCHING

- *Plant Type can be cyclic or continuous.*
- *Plant Type can be automatic or manual*
- *Accuracy:*

Recommendation of IS 456 is $\pm 2\%$ for the quantity of cement measured and $\pm 3\%$ for the quantity of aggregate, water and admixture being measured.



PLANT CAPACITY

– ***Capacity depends on***

- ❖ *1) size of the job;*
- ❖ *2) required production rate; and*
- ❖ *3) required standard of batching performance.*

➤ *Capacity of the material handling system, bin size, batcher size and; mixture size and number controls the capacity*
 $Q = \min(Q_1, Q_2, Q_3, Q_4, \dots)$



INSTRUMENTATION AND MEASUREMENTS

- *mechanical lever system, load cells etc for measurements of mass.*
- *Controlling the discharge from storage and weigh hoppers is through gates operated by compressed air cylinders.*
- *Presetting of desired batch weights can be done by devices such as punched cards, digit switches or rotating dials and computers.*



INSTRUMENTATION AND MEASUREMENTS

- *Electrical or microwave moisture gauges can be used as aggregate moisture meters .*
- *Water is most commonly measured through flow meters, although in some plants water is also weighed .*
- *With the need of adequate calibration, frequent regulatory routine and specialist's checks of weighing process are required without too much difficulty .*



TOLERANCES

(individual Batch IS 4925)

Ingredient	Batching tolerances (%)
Cement and other cementitious materials	± 1
Water (by volume or weight),%	± 1
Aggregates, %	± 2
Admixture (by volume or weight),%	± 3



TOLERANCES (individual Batch)

tolerances applies to:

Minimum weight (kg) =

$[0.3 \times \text{scale capacity (kg)}] / \text{Weigh tolerance (\%)}]$
as in table

- Uniform concrete exhibits less variation.
- Variation depends on variation in proportions
 - e.g., higher ΔC and ΔW , *the **errors in cement & water** measurements will result in higher variation in strength.*
- Proper Batching ensures better quality



MIXING

- *Thorough mixing is essential for production of uniform quality concrete.*
- *Equipment and method should be capable of effectively mixing concrete material containing largest specified aggregate to produce uniform mixtures of the lowest slump practical for the work.*

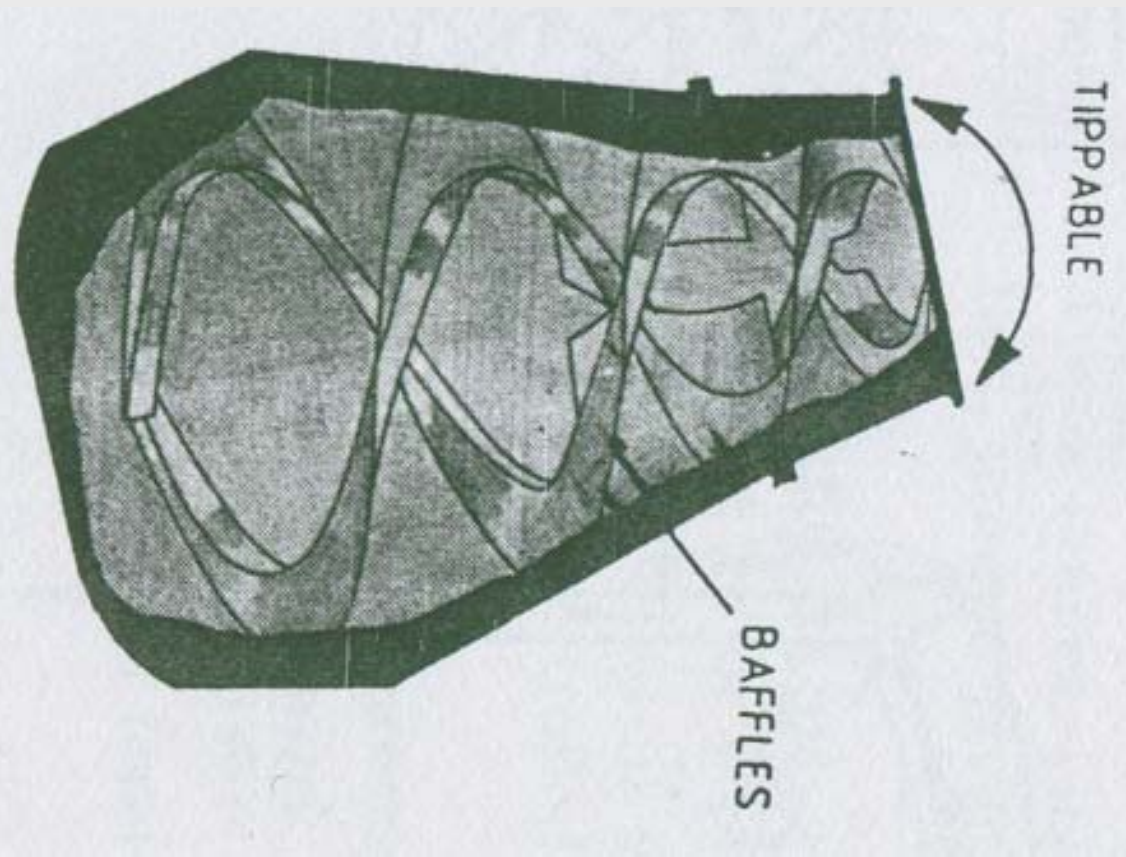


MIXING

- *cyclic or batch mixers, and continuous mixers. .*
- *gravity mixers or mixers with forced movements*
 - *They can be tilting or Non-tilting*
- *Counter-flow mixer or open-pan mixers*



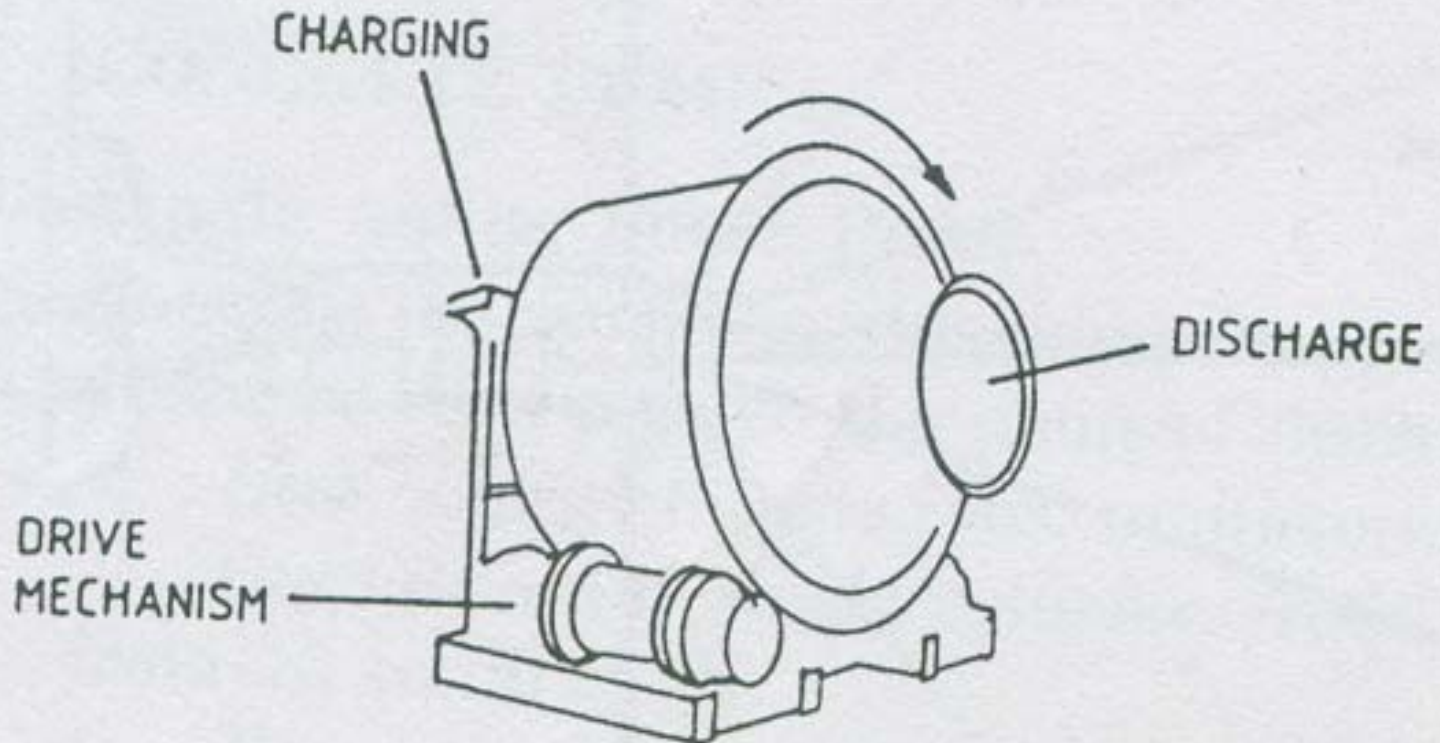
TILTING DRUM MIXER



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

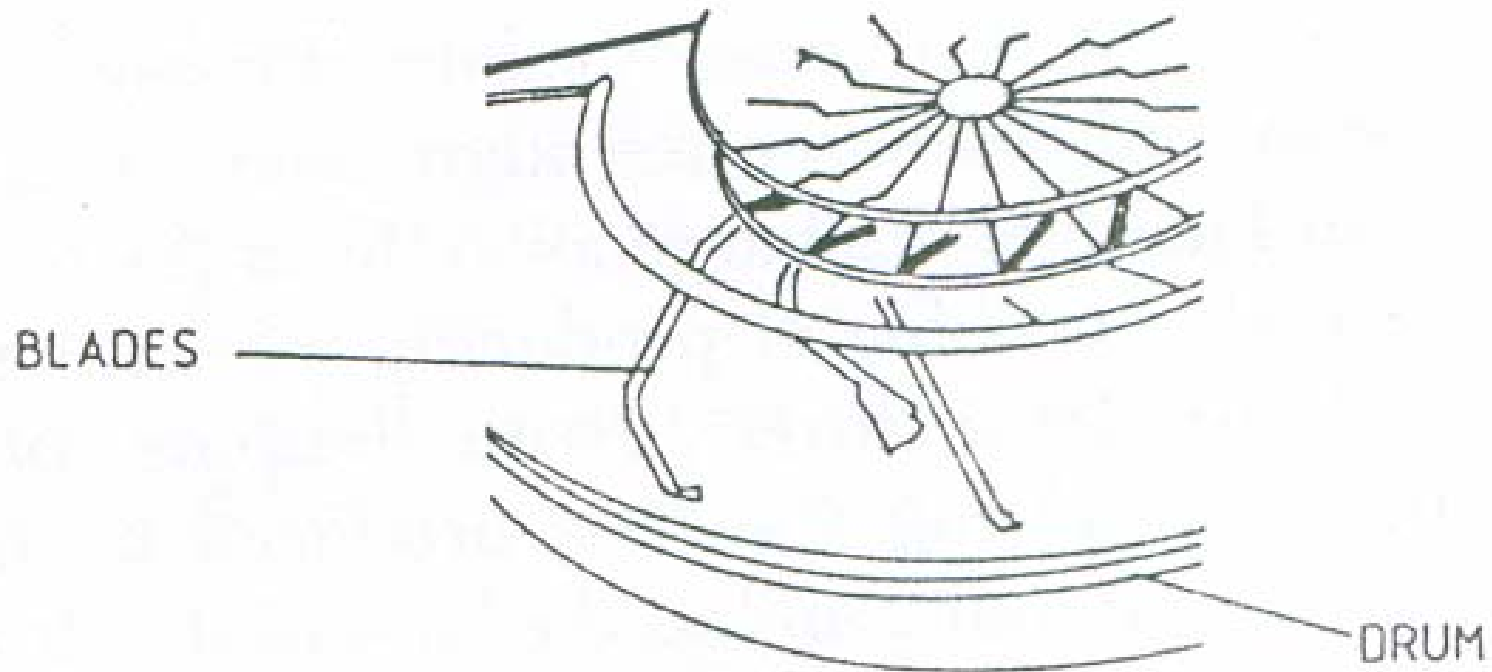
NON-TILTING DRUM MIXER



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

PAN MIXER



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

PAN MIXER



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

MIXING

- *uniformity tests on samples of fresh concrete collected from the mixer at different stages of its discharge from a given batch. .*
- *Charging: pre-blending and ribboning effect*
- *Mixing Time: 1minute is required for 0.75 m³ capacity mixer and 0.25 minute is required for each additional 0.75 m³ capacity*



MIXING TIME

– IS guide lines

■ *IS 4925-1968 “mixing time for each batch of materials, except the full amount of water, provided that all the mixing water shall be introduced before one-fourth the mixing time elapsed” shall be 1½, 2 and 2½ minutes respectively for mixer capacity up to 2 m³, 3 m³ and 4 m³ respectively. IS 456 : 2000 guidelines specifies a overall minimum mixing time of 2 minutes*



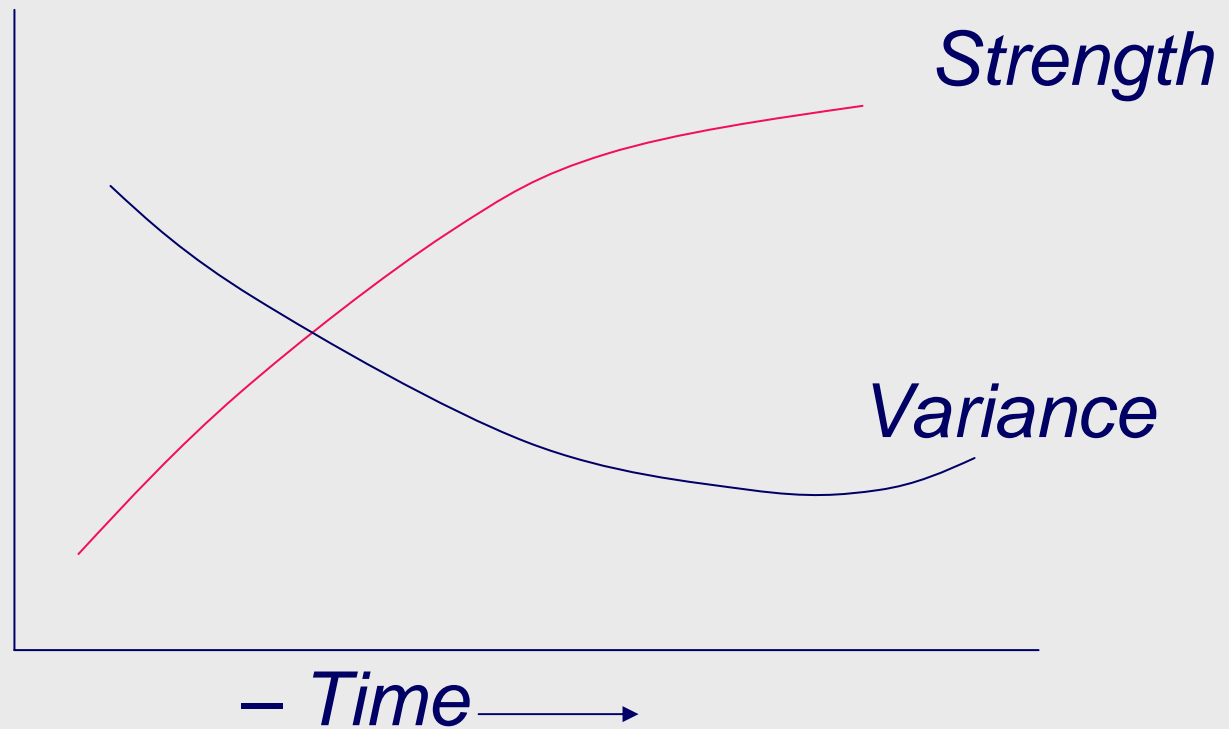
MIXING TIME

- increasing mixing time may result in more uniform distribution of hydration product resulting in higher compressive strength*
- prolonging the mixing process too long may not increase the strength proportionally and may result in a decrease in some cases.*
- over grinding of the material and in some cases may increase the proportion of fines. Quite often excessive mixing leads to segregation in case of leaner concretes.*



MIXING TIME

– Strength & Variance



B. Bhattacharjee

DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

SUMMARY

- Concrete production process***
- Batching process and its importance in producing quality concrete***
- Mixing process for producing uniform quality concrete***



***THANK YOU
FOR HEARING***



DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI