CONCRETE

ACHINTYA

Ph. D. (Engg.), F.I.E.

PRINCIPAL, DCE, DARBHANGA & BCE, BHAGALPUR

FORMER PRINCIPAL, M I T, MUZAFFARPUR

FORMER PRINCIPAL, S I T, SITAMARHI

FORMER DEAN OF ENGG., A K U, PATNA

drachintya@rediffmail.com

drachintya@rediffmail.com

- **Concrete is one of the most commonly used construction materials in the world today.**

- Conventional concrete sometimes needs to be modified for special circumstances and unusual applications and to meet stringent and demanding specifications.

- **There has been tremendous use of concrete EVEN in marine structures such as construction of bridges, breakwaters, docks, oil wells, oil storage tanks, etc.**

drachintya@rediffmail.com

RELEVANT CODES OF CONCRETE DESIGN

- **Bureau of Indian Standards, New Delhi**
  - **IS: 456 – 2000** Code of practice for plain and reinforced concrete (fourth edition)
  - **IS: 10262 – 2009** Indian standard Guidelines for concrete mix design proportioning
  - **SP: 23-1988** Handbook on concrete mixes (based on Indian Standards)

- **Ministry of Shipping, Road Transport & Highways**
  - MOSRTH Handbook - 5th Revision, April 2013

drachintya@rediffmail.com

- **CONCRETE =**

  Cement

+ Fine Aggregate (Sand)

+ Coarse Aggregate (Stone Chips)

+ Water

+ Some Admixture {if any}

drachintya@rediffmail.com

CONCRETE INGREDIENTS

+

+

+

drachintya@rediffmail.com

CONCRETE INGREDIENTS

Concrete has bypassed the stage of **FOUR COMPONENT SYSTEM** to a combination of ingredients from as many as **TEN MATERIALS**.

CEMENT + SAND + COARSE AGGREGATES + WATER

+

- **FLY ASH**
- **SLAG (GGBS)**
- **SILICA FUME**
- **METAKAOLIN**
- **RICE HUSKASH**

} **Mineral Admixtures**

- **SUPERPLASTICIZER** → **Chemical Admixtures**

drachintya@rediffmail.com

- **CEMENT** IS USED AS **BINDING MATERIAL** IN MAKING THE CONCRETE
- HENCE CALLED **CEMENT CONCRETE**

Normally known as **CONCRETE**

drachintya@rediffmail.com

CONCRETE INGREDIENTS - CEMENT

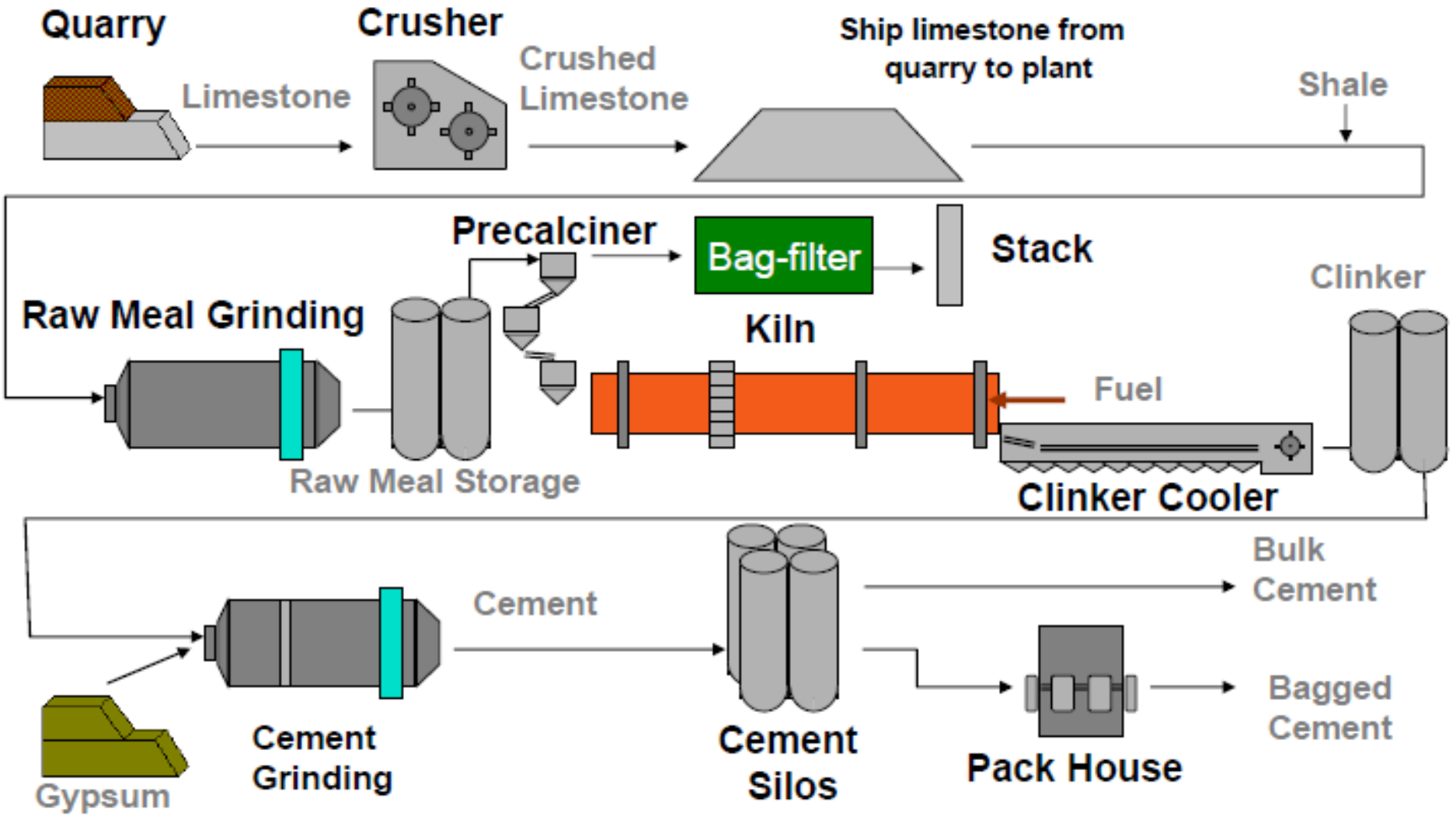
CEMENT is the basic binding ingredient in concrete.

Cement + water —**Hydration**→ **Cement paste (gel)**

- **Strength of the concrete depends upon the *physical characteristics of the cement* paste.**
- ***Hydration* causes the cement to harden and develop strength.**

drachintya@rediffmail.com

Flow Chart – Cement Manufacturing Process

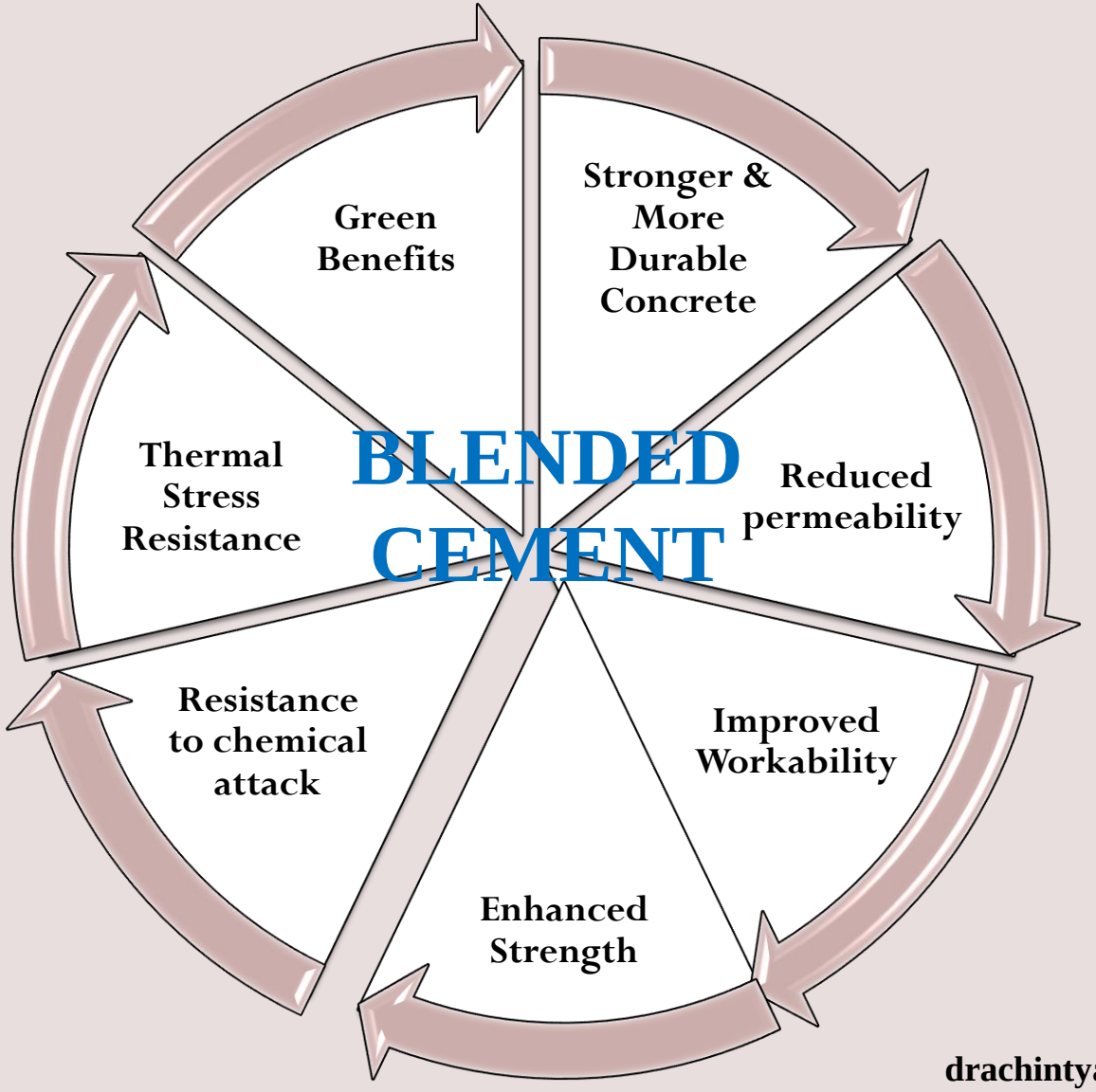


drachintya@rediffmail.com

Clinker & Cement

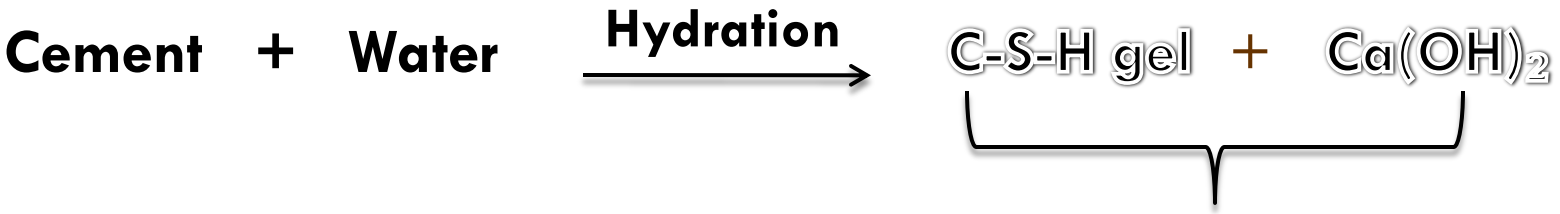
drachintya@rediffmail.com

Performance of Blended Cement



drachintya@rediffmail.com

HYDRATION OF CEMENT



Formation of hydration products over time leads to:

- Stiffening (loss of workability)
- Setting (solidification)
- Hardening (strength gain)

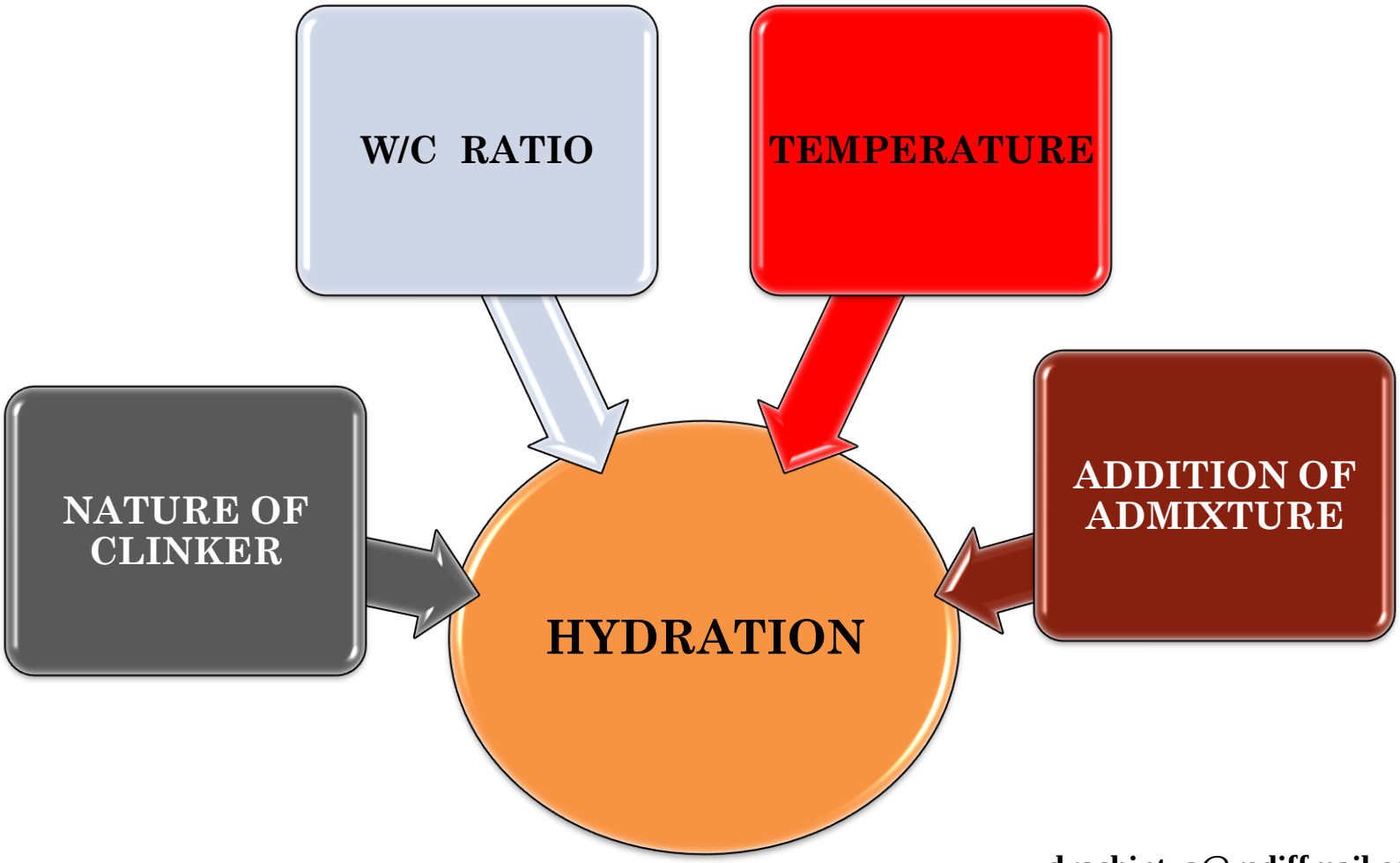
drachintya@rediffmail.com

FUNCTIONS OF CEMENT PASTE

- Lubricates coarse aggregates, leading to good compaction of fresh concrete.
- Imparts binding and fills the small voids of fine aggregates, coats the coarse aggregates and imparts binding.
- Provides a plastic mass
- **Provides strength and water tightness to concrete in hardened state.**

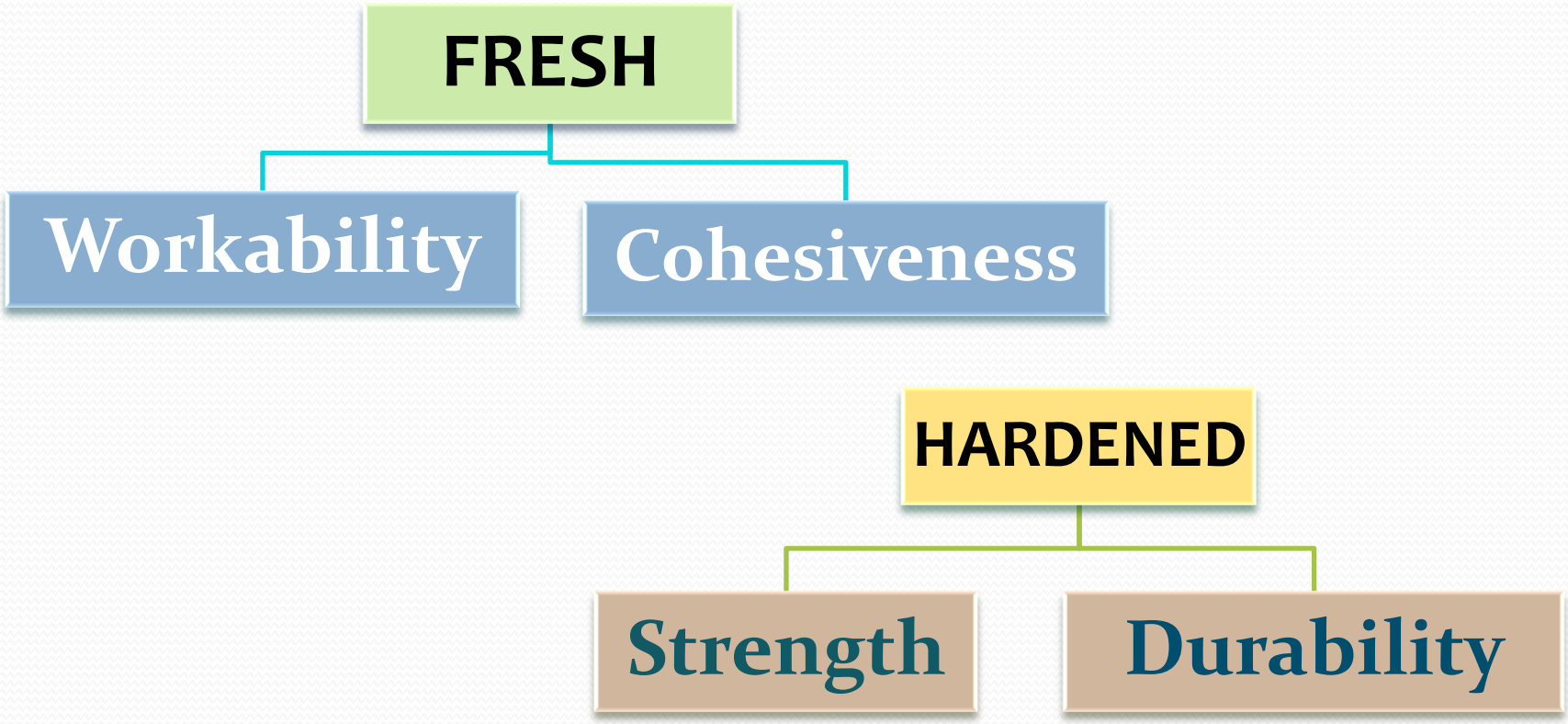
drachintya@rediffmail.com

FACTORS INFLUENCING HYDRATION OF CEMENT ON CONCRETE



drachintya@rediffmail.com

PROPERTIES OF CONCRETE



drachintya@rediffmail.com

TESTS OF INGREDIENTS

- Comp. Strength, Fineness, Standard consistency and Soundness of cement
- **Sp. Gr. Of cement, coarse aggregate and fine aggregate**
- **Crushing strength, Av. Impact value, Los Angeles' abrasion and Flakiness Index of stone chips.**
- **Sieve Analysis of sand and stone chips which will give away gradation of Aggregates and sand zones.**

drachintya@rediffmail.com

QUALITY OF RAW MATERIALS

FINE AGGREGATES

- **Natural or river sand -** Natural disintegration of rock due to flow of water in rivers.

- **Crushed stone sand -** Crushing hard stone.
- **Crushed gravel sand -** Crushing natural gravel.

Crushed stone sand is gaining momentum as an alternative to natural sand due to scarcity of natural sand.

IS 383 permits silt content of 15% by weight for crushed stone sand and 3% by weight for natural sand

drachintya@rediffmail.com

Sieve Analysis conforming sand's Quality and so, Sand Zones

Testing of Fine aggregates (sand) by Sieve Analysis Method

Quality of sand, stone-chips & bricks

Sieve Analysis

Coarse Sand

Medium Sand

drachintya@rediffmail.com

QUALITY OF RAW MATERIALS
COARSE AGGREGATES

- **Crushed gravel or stone** - Mechanically crushing of gravel or hard stone.
- **Uncrushed gravel or stone** - Natural disintegration of rock.
- **Partially crushed gravel or stone** - Blending of crushed and uncrushed gravel.

For most of the RCC work, crushed gravel or stone aggregates having maximum size of 20 mm are used.

drachintya@rediffmail.com

QUALITY OF RAW MATERIAL

Quality of Coarse Aggregates (Stone Chips)

Angular Aggregate

Flaky Aggregate

Elongated Aggregate

Angular Aggregate is best suited for Concreting work

drachintya@rediffmail.com

CONCRETE INGREDIENTS – WATER

- **Important ingredient** used to produce concrete.
- Required **initially for hydration** of cement.
- Provides **fluidity to concrete** in fresh state.
- Should be **Potable – Clean and free** from impurities.
- **Sea water** (3.5% salinity) **is not recommended** to use.
- Presence of **Sugar or tannic acid retards the setting time** at least by four hours.
- **Silt or suspended particles interfere** with setting, hardening and bonding characteristics.

drachintya@rediffmail.com

Alkali Aggregates Reaction

To minimize the risk of alkali – silica reaction the following precautions are recommended.

- Prevent contact between the concrete and external source of moisture.
- Use Portland Pozzolana Cement with minimum 25% of fly ash. The silica present in the fly ash minimize the harmful effect of the alkali – silica reaction.
- Use the combination of aggregate which is judge to be potentially safe.

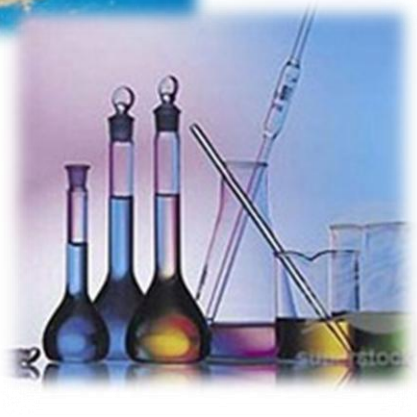
drachintya@rediffmail.com

Better Resistance to Sulphate attack & Chloride attack

drachintya@rediffmail.com

CONCRETE INGREDIENTS – ADMIXTURES

- Material other than Cement, water, Sand and Coarse aggregates.
- Added immediately before or during mixing.
- Modifies one or more properties of concrete in fresh and hardened state.



Admixtures may be Chemical or Mineral/ Pozzolanic

Mineral/Pozzolanic materials – Fly Ash, Slag, Rice husk ash, Metakaolin, Silica fume etc.

Chemical Admixtures – Plasticizers, Super Plasticizers, Retarders, etc.

drachintya@rediffmail.com

water-cement ratio vs. WORKABILITY

WATER - CEMENT

IMPROVES

SLUMP

STRENGTH

w/c > Limiting value for Durability

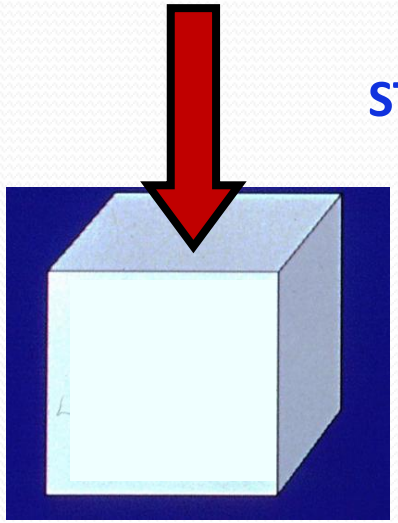
drachintya@rediffmail.com

FACTORS INFLUENCING STRENGTH

HIGH w/c

REDUCES

STRENGTH



w/c v/s Strength

drachintya@rediffmail.com

WRONG METHOD OF ADDING WATER

POOR WORKMANSHIP

- Segregation & Bleeding of Concrete Due to use of excess Water during mixing

- Bleeding and Segregation leads to formation of Honeycomb and Blowholes in the concrete

drachintya@rediffmail.com

Curing of Concrete Cast

- Why Curing ? – Replenishment of loss of moisture
- Importance of curing – Strength gain, secondary reaction
- Ways of curing – ponding, covering with Hessian clothes, curing compound
- Early curing during hot and windy weather
- Problems due to inadequate curing - poor strength and corrosion.

drachintya@rediffmail.com

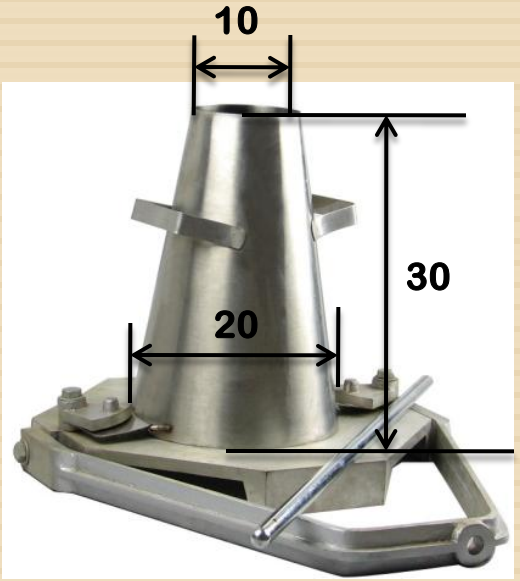
Experimental Results

Slump Test : Record Slump

SLUMP TEST - as per IS -1199

SLUMP CONE TEST

- Most extensively used at site.
- Helps in finding the variations in the uniformity of a mix.



Slump Test Apparatus

drachintya@rediffmail.com

Methods of Measuring- WORKABILITY

1. Fill the mould with concrete in four layer, each appx. 7.5cm height.

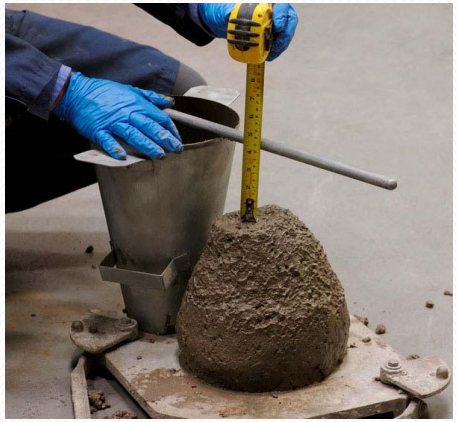
2. Tamp each layer with 25 stokes using the Tamping rod

3. After the top layer has been rodded, struck the concrete off level with a trowel or the tamping rod

drachintya@rediffmail.com

Methods of Measuring- WORKABILITY

SLUMP TEST - as per IS -1199



4. Immediately remove the mould from concrete by raising it slowly and carefully (without disturbing).

5. Eventually Concrete will subside.

6. Measure the slump immediately.

Variation in Slump by 25mm → 3 % change in water content → strength by 2N/mm²

drachintya@rediffmail.com

Methods of Measuring- CRUSHING STRENGTH (COMP. STRENGTH)TEST

CONCRETE CUBE TEST

1. Fill the mould in three layers, each being 1/3rd the height of the mould.

2. Tamp each layer with 35 stokes using a tamping rod.

3. Flush the top surface with the edges of the mould and finish it using a trowel.

Presence of 1% Voids → 5% Strength ↓

drachintya@rediffmail.com

CONCRETE CUBE TEST

4. Keep the moulds aside in room temperature. Demould the cube after 24hrs.

5. Store the specimen in water for curing – 3/7/28 days as per the requirement.

6. Test the cubes in Compression testing machine.

RATE OF LOADING to be included

drachintya@rediffmail.com

Compressive Strength Test

- Three no. of moulds of 150mm cube of concrete should be scheduled to undergo the requisite compressive strength tests.
- 7 – day and 28 – day Compressive strength of should be obtained to justify the requirement of Grade of Concrete.

And finally,

- **Calculate Quantities required per bag of cement used in one cubic metre of concrete (as per requirement of Concrete Design).**

drachintya@rediffmail.com

THANK YOU

drachintya@rediffmail.com