Engineering Materials

Important terms:

* **Brick:** A brick is an artificial kind of stone made of clay whose chief characteristics are a plasticity when wet and stone like hardness after being heated to high temperature.

* **Lime:** Lime is a more or less impure calcium oxide (CaO) and obtained by the calcination of calcium carbonate ($CaCO_3$).

$$CaCO_3 \longrightarrow CaO + CO_2\uparrow$$

* **Cement:** Cement is a binding material manufactured from calcareous substances (compounds of calcium and magnesium) which is used in construction works.

* **Concrete:** Concrete is an artificial stone manufactured from a mixture of binding materials and inert materials with water.

Concrete = Binding materials (cement) + Inert materials (aggregate) + water.

Components:

i) Binding materials – Cement, Lime.
ii) Inert materials — CA, FA
iii) water.

Bricks

* What factors affect the quality of a brick?

Ans: i) Chemical properties of clay used.
ii) preparation of clay.
iii) process of drying.
iv) Different degrees of burning.

* What are the constituents and chemical composition of brick?

Ans: The constituents of brick are (i) a mixture of pure clay and sand, (ii) water.

Chemical composition:

Silica	55%	This composition is used for 1st class brick.
Alumina	30%	
Iron oxide	8%	
Magnesia	5%	
Lime	1%	
organic matters	1%	

* Harmful constituents of brick-clay

Ans: i) Iron Pyrites ii) Alkalies iii) Stone particles iv) vegetation & organic matter v) Lime.

* If lime present in excess amount in brick-clay, what happens?

Ans: If lime present in excess causes the brick to fuse too readily and the shape is lost.
↑ গলে যাবে

* What is the standard size and weight of a brick?

Ans: Size: According to PWD 9.5" x 4.5" x 2.75"

After using mortar 10" x 5" x 3"

Weight: 6 lbs (about 30N) or 2.7 kg.

* Types of kiln

Ans: 3 types.

i) Bull's trench kiln ii) Hoffman's kiln iii) Tunnel kiln

(বাংলাদেশে বেশি use হয়)

*Write a short note on Field test of brick.

Ans:

- Take a brick and try to make mark on the surface by nail. If you can make it, it is not a good brick. If no, it is very hard and compact.
- If brick gives clear ringing or metallic sound after strike it with hammer, it is a good brick.
- Take two brick and form tee (T) and drop from a height of 6 feet on a solid surface. If they break, they are not good bricks.

\# The crushing/compressive strength of a common building brick should not be less than 3.5 N/mm².

\# Water absorption percentage $\left(= \frac{W_s - W_d}{W_d} \times 100\%\right)$ should not exceed 20% of the weight of dry brick. (1/5 th of own weight).

\# Compressive strength of brick ~~1500 to 4000~~ 2500 psi.

$\frac{W}{A}$ W → Load, A → Area

*(5000-8000 psi এখন হয়েছে)

* What is efflorescence? Why it is found in a brick?

Ans: The process of deposition of whitish powder on the surface of bricks is called efflorescence.

causes: efflorescence is found in brick if
i) soluble salts is present in the bricks
ii) the clay used for making brick contains pyrite.
iii) the water used for tempering clay contains gypsum.

from air (done by pug mill)

* The strength of bricks decrease by about 25% when soaked in water.
* Specific gravity of brick = 2.
* Crushing / compressive strength of
  - 1st class brick = 10.5 N/mm²
  - 2nd class brick = 7 N/mm²
  - 3rd class brick = 5 N/mm²
* Write down the different test of brick?
  - Water absorption test
  - Crushing strength test
  - Hardness test
  - Soundness test
  - Efflorescence test.
* What is formwork? Write down the characteristics of a good formwork?

Ans: Formwork is a temporary construction for cast in situ concrete in a particular shape.

Characteristics:
i) Smooth Surface
ii) Appropriate level
iii) Self Supported
iv) Water tight

Lime

* What is calcination?

Ans: Calcination means heating a substance in air to red heat which is applied to ores in order to bring about a decomposition or removal of volatile fraction.

* What are the sources & constituents of limestone?

Ans: Source: i) Hilly areas ii) Bed of river
iii) Shells of marine animals.
iv) Below ground level as kankar.

constituents: i) clay (<30%) ii) Soluble silicates
iii) Sulphates iv) Iron
v) Magnesium Carbonate
vi) Iron prites vii) Alkalies.

* What are the uses of lime?

Ans: - It is used to prepare mortar for masonry works.
- It is used for white washing.
- It is used in plastering purposes.
- It is used in the manufacturing of paints.
- It is used as a stabilizer for soils.

Cement

*Classify the cement.

Ans: Natural cement: This type of cement can be obtained by burning limestone containing 25-40% clay, the remainder being the carbonate of lime.

Artificial Cement: This cement is obtained by burning the mixture of calcareous (having lime) and argillaceous (having clay) material to a high temperature.

*Classify Artificial cement.

Ans: (1) portland cement;

i) Ordinary portland Cement.
ii) Rapid Hardening cement.
iii) Low heat cement.

(2) Special cement:

i) Quick setting cement
ii) High Alumina Cement.
iii) Blast furnace cement.
iv) Sulphate resistant cement.
v) Super sulphate cement.
vi) White cement.

*Write mineral constituents (composition) of portland cement.

Ans: Tri-calcium Silicate, C_3S ($3CaO, SiO_3$) — 45-55%
Di-calcium Silicate, C_2S ($2CaO, SiO_3$) — 20-30%
Tri-calcium Aluminate, C_3A ($3CaO, Al_2O_3$) — 9-13%
Tetra-calcium Aluminoferrite, C_4AF ($4CaO.Al_2O_3.Fe_2O_3$) — 8-20%
calcium Sulphate, $CaSO_4$ — 2-6%
other Compounds — 2-8%.

* Acid and Alkaline constituents of portland cement

Ans:

Average value

CaO	— 60 to 67%	K_2O	— 0·3 to 1%
MgO	— 0·1 to 4%	Na_2O	— 0·3 to 1%.
SiO_2	— 17 to 25%	Alkalies	— 0·4 to 1·3%
Al_2O_3	— 3 to 8%	loss on ignition	— 1·8 to 2%
Fe_2O_3	— 0·5 to 6%	Insoluble residue	— 0·3 to 0·5%
SO_3	— 1 to 3%		

* What are the raw materials of portland cement?

Ans: Calcareous components:

- Limestone
- marly limestone
- Chalk
- marble
- Coral limestone
- shell deposits.

Argillaceous components:

- Clay
- Shale
- Calcareous marl
- marl
- marly clay
- slate
- glass

* portland cement:

Lime - 63%, Silica - 22%, Alumina - 6%, Iron oxide - 3%, Magnesium oxide - 2·5%, sulphur trioxide - 1·5%, Loss on ignition - 1·5% & Alkalies - 0·5%.

* Why gypsum is added to clinker?

Ans: The reaction of true C_3A with water is very ~~violent~~ violent and leads to immediate stiffening of paste known as flash setting. To prevent this flash setting, gypsum ($CaSO_4 . 2H_2O$) is added to cement clinker during grinding. Gypsum and C_3A react to form insoluble Calcium Sulpho-aluminate

which does not hydrate.

$C_3A + 6H_2O \xrightarrow[(3-4\%)]{\text{Gypsum}} 3C_3A.3CaSO_4.31H_2O \longrightarrow C_3A.H_2O$

(tricalcium aluminate hydrate) — (sulpho) — (tricalcium aluminate hydrate)

*What is clinker? *intimately → ঘনিষ্ঠভাবে.

Ans: The manufacture of cement consists of grinding of raw materials (calcareous & argillaceous stones containing silica, alumina & iron oxide) and mixing them intimately in a certain portion. It is then burnt in a large rotary kiln at a temp. about 1500°c. Then the materials fuse into balls (0.3 to 2.5 cm dia), known as clinker.

Composition of clinker:

①	C_3S	45–55%	Ultimate strength.
②	C_2S	20–30%	
③	C_3A	9–13%	initial setting time
④	C_4AF	8–20%	

* write a short note on setting of cement.

Ans: The term 'setting' is used to describe the stiffening of the cement paste. It refers to change of cement paste from a fluid to a rigid state.

Cement	Initial setting time	Final setting time
ordinary portland cement	≥ 45 minutes	≤ 10 hours
rapid hardening portland cement	≥ 45 minutes	≤ 10 hours
low heat portland cement	≥ 60 minutes	≤ 10 hours
aluminous cement	≥ 2 hours	≤ 2 hours

Initial setting: It occurs when the paste begins to stiffen considerably. It corresponds to a rapid rise in temp.

Final setting: It occurs when cement has hardened to the point at which it can sustain some load. It corresponds to the peak temperature.

False setting: False setting is the name given to the abnormal premature stiffening of cement within a few minutes of mixing with water. No appreciable heat is evolved and the remixing cement paste restores plasticity without addition of further amount of water.

Causes of false setting: The dehydration of gypsum when interground with too hot clinker, semihydrates ($CaSO_4 \cdot \frac{1}{2}H_2O$) or anhydrate ($CaSO_4$) are formed and when the cement is mixed with water these hydrate to form gypsum. Thus plaster set takes place with a resulting stiffening of the paste.

* How you identify good cement in the field?

Ans: 1) The colour of the cement should be uniformly greenish grey.

2) It should feel smooth when rubbed in between fingers.

3) When hand is thrusted into a bag of cement, it should feel cool.

4) A handful of cement it thrown into a bucket of water, it floats and if sinks, it contains impurities.

5) If lump present in cement, it should be powdered by pressing between the thumb.

*Write down the quality of good cement.

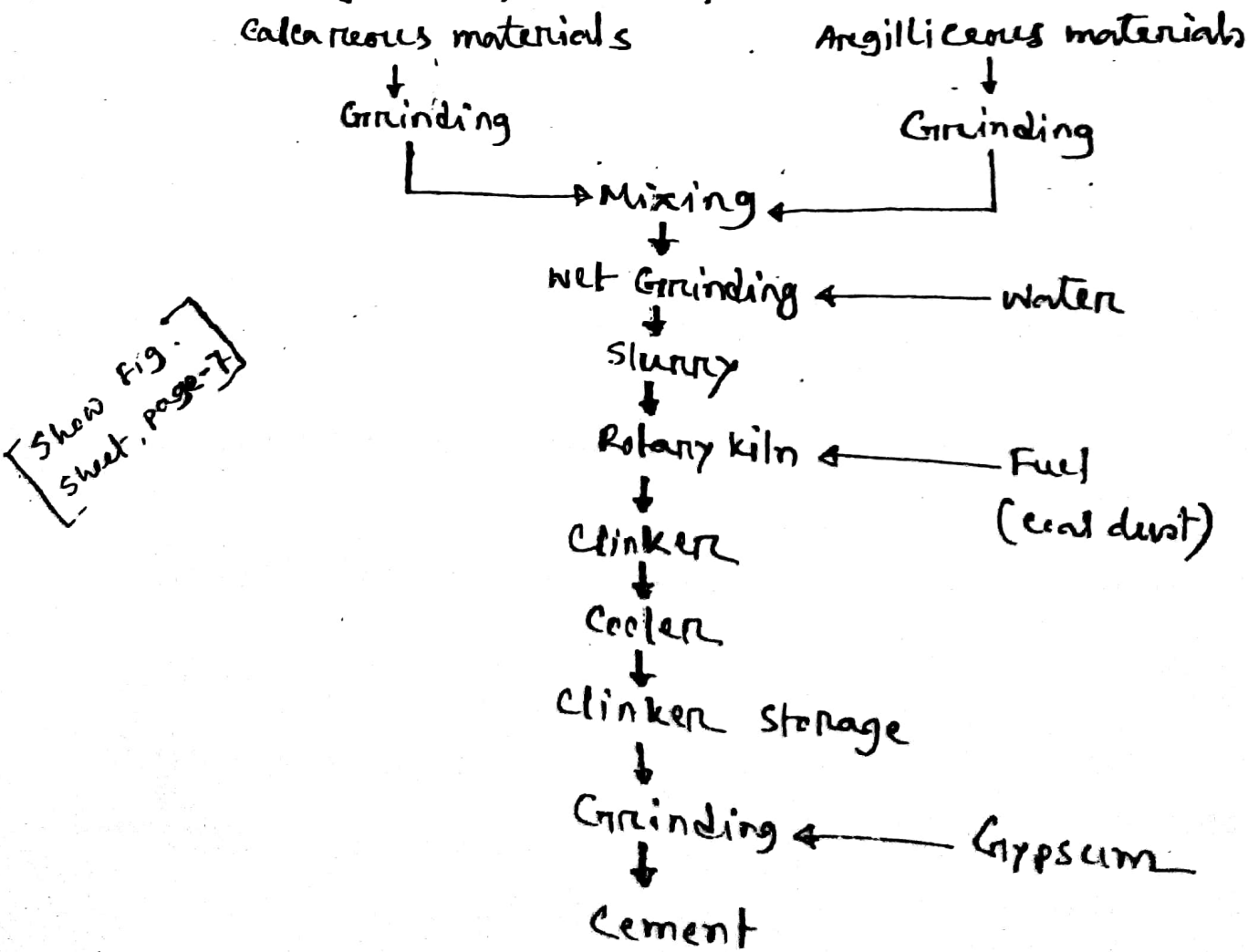
Ans: The answer of the previous question.

*Comparison between cement & lime.

Ans:

Cement	Lime
1) Greenish grey colour.	1) White greyish colour.
2) sets rapidly when mixed with water.	2) sets slowly when mixed with water.
3) possesses more strength.	3) possesses less strength.
4) Does not slake when wetted with water.	4) slakes when wetted with water.
5) Most suitable for engineering purposes.	6) Less suitable for engineering purpose.

* Wet process of manufacture of cement.



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* What are the factors that affects setting time of cement?

Ans: Cement fineness, w/c ratio, gypsum content and admixtures.

* What is the difference between hardening & setting?

Ans: The term 'hardening' refers to gain strength of a cement paste. But in setting, the cement paste aquires some strength.

* Define normal consistency?

Ans: The amount of water content that brings the cement paste to a standard condition of ~~wett~~ wetness is known as normal consistency. It is about ~~22-30%~~ 26-33% of the weight of dry cement.

* What are the tests involved with cement?

Ans: 1) Normal consistency test } → Vicat's apparatus (↳ portland cement)
2) Setting time test

3) Compressive strength test.

4) Tensile strength test.

5) Soundness test. 6) Fineness test.

* What is admixture? Why it is used?

Ans: The materials which are added in cement mortar or concrete to improve their quality is called admixture.

purpose: - Improve the workability.
- Retard setting action of mortar and concrete.
- Increase bond strength between reinforcement and concrete.
- Reduce shrinkage during setting of mortar or concrete.

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- Improve the water proofing properties of mortar or concrete.
- Reduce bleeding & segregation effect of concrete.

* portland composite cement (PCC).

PCC = (Clinker + Gypsum + fly ash + lime + slag)

* M 10 — compressive strength 10 MPa (1:3:6)
  M 15 — " " 15 MPa (1:2:4)
  M 20 — " " 20 MPa (1:1.5:3)
  M 25 — " " 25 MPa (1:1:2)

* What do you mean by Heat of Hydration?

Ans: The chemical reaction between water and cement compounds is known as hydration. During hydration of the cement, sufficient heat is generated which is known as heat of hydration.

* Under which conditions cement is superior to lime?

Ans:

i) For Construction of structures in wet places and under water.

ii) Where high strength and durability of structures are required.

iii) In Construction of water tight structures.

iv) Where mortar or plaster has to set quick and attain desirable strength.

v) For decorative ornamental and painting works.

* Gypsum ($CaSO_4 \cdot 2H_2O$) acts as a retarder.

'Concrete'

* Ingredients of concrete.

Ans: - Binding agent (cement/lime)
- Coarse aggregates
- Fine aggregates
- water.

Lime concrete = Lime + surki + khoa + water

Cement concrete = Cement + sand + khoa + water.

* What is the function of water in concrete?

Ans: - To develop adhesion because the cement paste adheres quickly to the wet surface of aggregates.
- To prepare a plastic mixture to impart workability to concrete.
- water is needed for the hydration of the cementing to set and harden during the period of curing.

* What is the function of aggregate in concrete?

Ans: It gives volume to the concrete, around the surface of which the binding material adheres in the form of a thin film.

* Write down the name of different types of concrete.

Ans: Based on unit weight

i) normal wt concrete – 2400 kg/m^3
ii) Light wt concrete – 1800 kg/m^3
iii) Heavy wt concrete – 3200 kg/m^3

Based on Compressive strength

i) Low Strength concrete – <3000 psi (20 MPa)
ii) Moderate " " – 3000 to 6000 psi (20 to 40 MPa)
iii) High " " – >6000 psi (>40 MPa)

* physical properties of concrete –

a) Strength
b) Elastic properties
c) Fatigue
d) Durability
e) Impermeability
f) workability

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* Define segregation. Write down the causes of segregation.

Ans: The separation of the constituents materials of concrete is known as segregation. A good concrete is one in which all the ingredients are properly distributed to make a homogeneous mixture.

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Causes:

- Badly proportioned mix where sufficient matrix is not there to bind the aggregates.
- If concrete is mixed with excess water content.
- Dropping of concrete from heights such as column.
- When concrete is discharged from a badly designed mixer.

* Write a short note about Bleeding.

Ans: Bleeding is a particular form of segregation, in which some of water from the concrete comes out to the surface of the concrete.

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Causes:

- If concrete is mixed with high amount of water, then bleeding occurs.
- Due to badly proportioned and insufficiently mixed concrete.

* What is Laitance?

Ans: Due to bleeding, water comes up and accumulates at the surface. Sometimes, along with this water, certain quantity of cement also comes to the surface. This formation of cement paste at the surface is known as laitance.

* manipulate = ম্যানিপুলেট

* Workability: According to ASTM - "property determining the effort required to manipulate a freshly mixed quantity of concrete with minimum loss of homogeneity" is called workability.

* Necessity of sufficient workability:-

Ans: Concrete must have workability such that compaction to maximum density is possible with a reasonable amount of work. The work done is used to overcome the friction between the individual particles in the concrete and also between the concrete and the surface of mould or of the reinforcement. So, workability can be best defined as the amount of useful internal work necessary to produce full compaction.

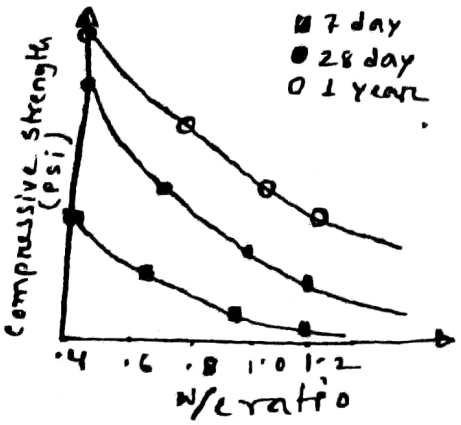
* Write down the factors affecting workability?

Ans:
- Water content → more water, more workable.
- Mix proportions → higher aggregate/cement ratio, less workable.
- Size of Aggregates → bigger aggregate, higher workability.
- Shape of Aggregates → Rounded aggregate, high workable.
- Surface Texture of aggregate → smooth or glassy textured aggregate, more workable.
- Grading of aggregate → Better grading, less void, high workability.
- Use of admixtures → adding admixture, increase workability.

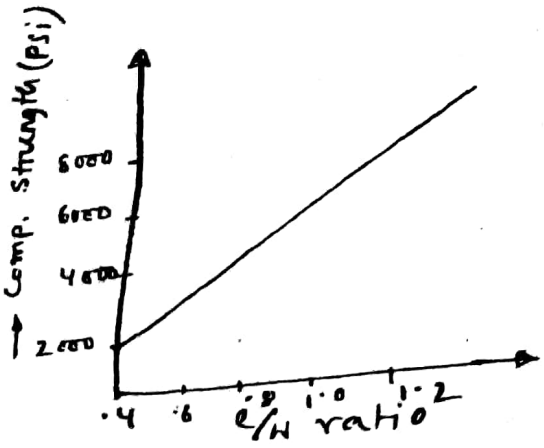
* Fatigue - थकान

* Define W/c ratio. relationship between strength & w/c ratio.

Ans: The proportion between the amount of water and cement used in a concrete mix is termed as the W/c ratio.



- strength decreases with increase in W/c ratio

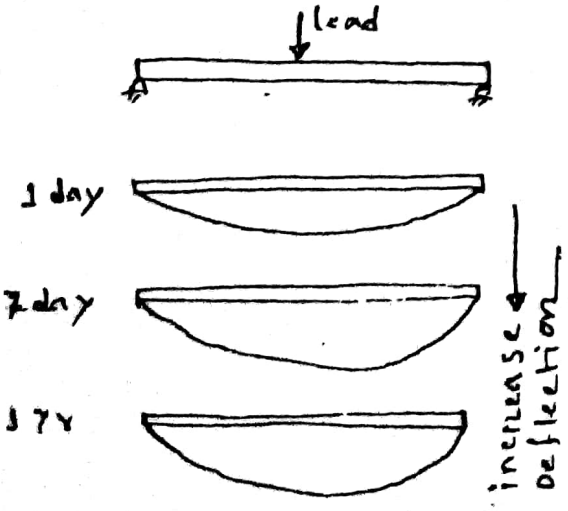


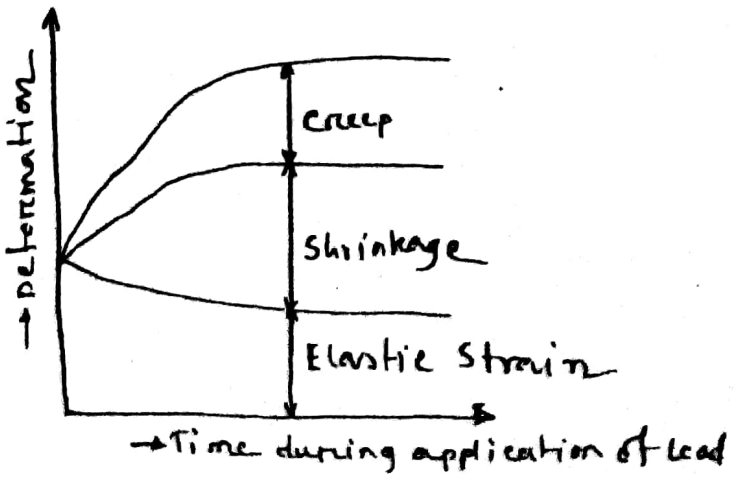
- strength increases with increase in c/w ratio.

* Fatigue of concrete: plain concrete when subject-ed to flexure, it exhibits fatigue.

* Define creep of concrete.

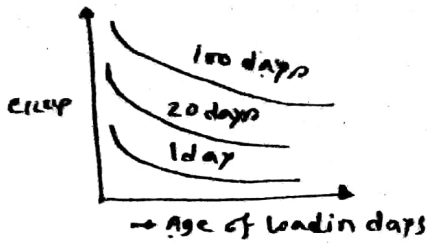
Ans: Creep can be defined as the increase in strain under a sustained stress after taking into account other time-depended deformations not associated with stress viz. shrinkage, swelling & thermal deformation.





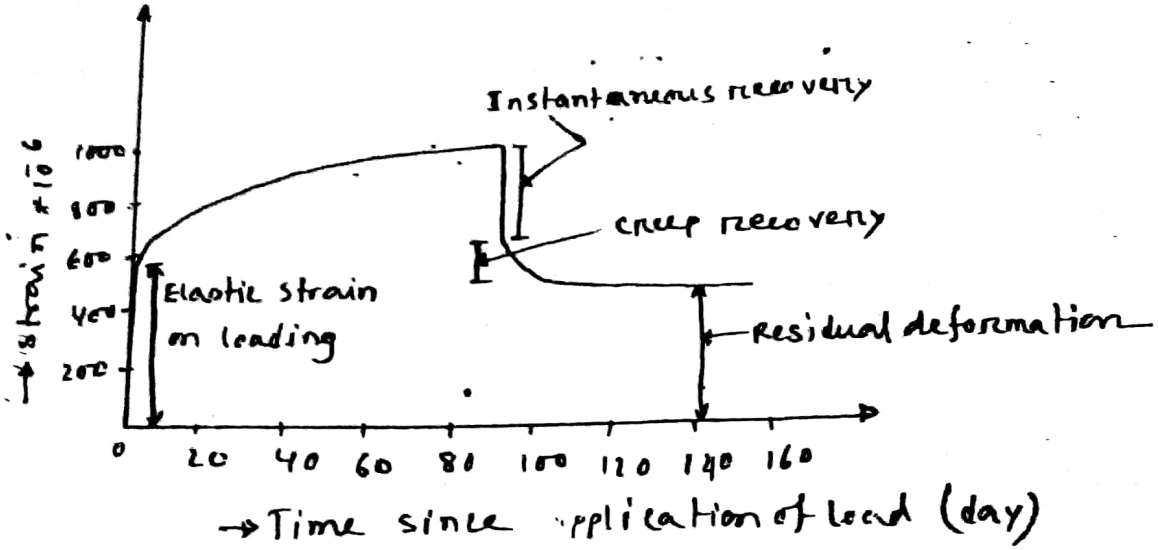
*write down the factors influencing creep.

Ans: i) Relative Humidity (↑), Creep (↓)
ii) shrinkage (↑), Creep (↑)
iii) Strength (↑), Creep (↓)
iv) W/c ratio (↑), Creep (↑)
v) Type of cement. vi) Age & maturity.



*Explain the term creep recovery with necessary figure.

Ans:



If a sustained load is removed, the strain decreases immediately by an amount equal to the elastic strain (generally lower than the elastic strain on loading). This instantaneous recovery is followed by a gradual decrease in strain, called creep recovery.

* Why cylinder specimen is more preferable than cube?

Ans: Cylinder specimens given uniform results because -

i) Failure is less affected by the end restraint of the specimen.

ii) strength is less influenced by the properties of the coarse aggregate used in matrix.

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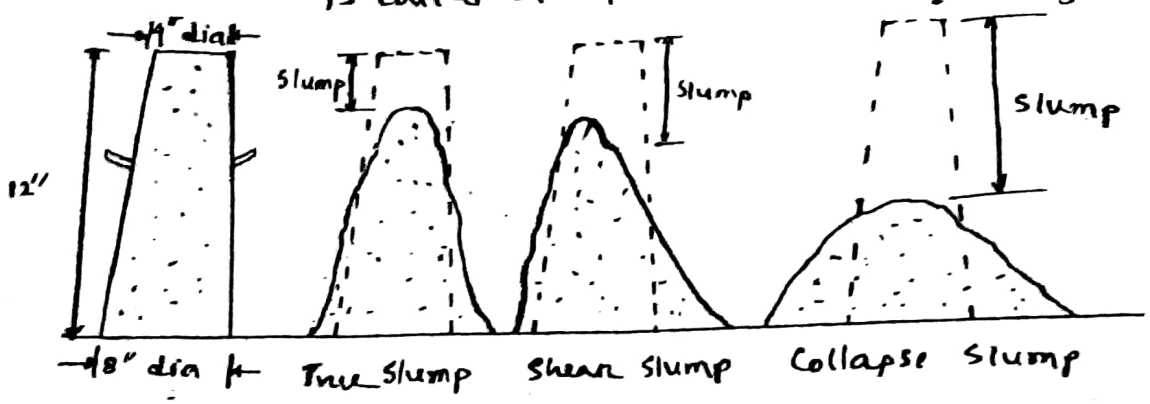
iii) Stress distribution on horizontal plane in a cylinder is more uniform than square cross section.

* what are the tests, used for measuring consistency and workability?

Ans: Slump test, Compacting factor test, Flow test, Remolding test, etc. (GSTR-14)

Slump test: Test used for measuring workability in field is called Slump test. mould → 9" dia (top), 8" dia (bottom) 12" height.



Workability	Slump (mm)	Used for
Very low	5 – 10	Roads.
Low	15 – 30	Roads, foundations.
Medium	35 – 75	flat slab, reinforced concrete.
High	80 – 155	For sections with congested reinforcement.
very high	160 ~ Collapse	Flow table test.

* Ordinary portland cement concrete gains 70 – 75% strength within 28 days and 90 ~ 95% within one year.

* 28 days strength is assumed 1.5 times of 7 days strength.

* Tensile strength of concrete is about 7-10% of the compressive strength.

* What is curing of concrete? What are the methods of curing?

Ans: Curing is the name used for promoting the hydration of cement and consists of control of temperatures and of the moisture movement from and into the concrete.

Methods:

a) structures with small surface volume ratio: curing may be done by oiling and wetting the formworks before casting.

b) Large surface of concrete: Curing can be done by spraying or flooding with water or covering the concrete with sand.

* Recommended slumps for various types of construction

Types of construction	Slump value (mm)
Foundation walls, footings, caissons and substructure walls	25 ~ 75
Beams & columns	25 ~ 100
pavements & slabs	25 ~ 75
Mass concrete	25 ~ 50

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The combined fineness modulus of fine aggregate (sand, $F_f = 2.85$) and coarse aggregate (stones, $F_c = 6.77$) was found to be 5.30. If 8.49 cft of combined and well packed aggregate is required, determine the volume of fine aggregate is required, determine the volume of fine and coarse aggregate mixed initially. Take shrinkage factor to be 0.75.

Soln: The ratio of the fine aggregate to be mixed with CA is, $F = \frac{F_c - F_{com}}{F_{com} - F_f} = \frac{6.77 - 5.30}{5.30 - 2.85} = 0.6$

$\therefore V_f / V_c = 60/100$ | $V_f \rightarrow$ vol^m of fine Aggregate, $V_c \rightarrow$ vol^m " coarse "

Total volume, $V = V_f + V_c = \frac{8.49}{0.75} = 11.32$ cft [shrinkage-এর পূর্বে vol^m বের করা হচ্ছে initial vol^m বের করা হবে]

$\therefore V_f = \frac{60}{60+100} * 11.32 = 4.25$ cft.

$V_c = \frac{100}{60+100} * 11.32 = 7.07$ cft } Ans

Calculate No. of bricks required for 100 Sq.ft BFS.

Soln: Size of brick = 9.5" x 4.5" x 2.75"

After using mortar = 10" x 5" x 3"

∴ The brick area in BFS = $\frac{10 \times 5}{144} = 0.347$ Sft.

∴ Nos of brick req^d for 100 Sft BFS = $\frac{100}{0.347} = 288$ Nos.

5% additional brick is req^d due to wastage.

∴ Total Nos. of bricks = 288 + 5% of 288

$\simeq$ 300 Nos. Ans

Calculate Nos. of brick reqd for 100 cft brick works.

Soln: Size of brick = 9.5" x 4.5" x 2.75"

After using mortar = 10" x 5" x 3"

Volume of single brick = $\frac{10 \times 5 \times 3}{12 \times 12 \times 12}$

= 0.087 cft

∴ Bricks reqd for 100 cft brick work = $\frac{100}{0.087}$ = 1152 Nos.

5% additional reqd for wastage.

Total Nos. = 1152 + 5% of 1152

≃ 1200 Nos.

Ans

Calculate the amount of mortar reqd for 100 cft brickwork.

Soln: Brick size = 9.5" x 4.5" x 2.75"

After using mortar = 10" x 5" x 3"

Mortar volume in 100 cft brick work = $100 - \frac{9.5 \times 4.5 \times 2.75}{12 \times 12 \times 12} \times 1152$

≃ 22 cft.

10% additional mortar reqd for forgmark filling, ~~50% reqd~~

∴ volume = 22 + 10% of 22

= 24 cft.

50% additional mortar reqd due to shrinkage.

Wet volume = 24 + 50% of 24

= 36 cft.

25% additional mortar reqd due to use of brick bats.

∴ volume = 36 + 25% of 36

= 45 cft Ans

Calculate nos. of bricks for 100 cft brick khoa.

Soln: Brick size = 9.5" x 4.5" x 2.75"

Vol^n of single brick = $\frac{9.5 \times 4.5 \times 2.75}{12 \times 12 \times 12}$

= 0.068 cft.

∴ Brick reqd = $\frac{100}{0.068}$ = 1470 Nos.

42% voids is present when bricks are broken.

∴ Brick reqd = 1470 - 42% of 1470

= 850 Nos.

Ans

* 1 bag cement = 1.25 cft = 50 kg.
* 1 cft brick khoa - এ brick লাগে = 8.5 টি.
* 1 cft steel = 490 lb.
* 1 sft BFS needs 3 nos. brick.
* 1 cft Brick work needs 12 Nos. of brick.

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Calculate the amount of materials reqd for 100 sft of cement plaster.

Soln: Let, Thickness of plaster = $\frac{1}{2}$"

Cement, sand ratio = 1:4

Net vol^m of mortar = $100 * \frac{1/2}{12}$

= 4.16 cft.

Dry vol^m = 1.5 * 4.16

= 6.25 cft [50% add for shrinkage]

$\therefore$ Cement = $\frac{1}{1+4} * 6.25$

= 1.25 cft = 1 bag

Sand = $\frac{4}{1+4} * 6.25$

= 5 cft

Ans

Calculate the ingredients reqd for cement concrete with mix proportion 1:3:6 also W/C ratio.

Soln: Let, wet vol^m of CC = 100 cft.

$\therefore$ Dry vol^m of CC = (1.5 x 100) cft

= 150 cft.

$\therefore$ Cement = $\frac{1}{10} * 150$ = 15 cft = 12 bags

Sand = $\frac{3}{10} * 150$ = 45 cft.

Coarse agg. = $\frac{6}{10} * 150$

= 90 cft.

1 cft = 8.5 brick

= 90 * 8.5 $\simeq$ 765 Nos brick

Water = 30% of cement + 5% of (FA + CA)

= 30% of 15 + 5% of (45 + 75)

= 11.25 cft

$\therefore$ W/C = $\frac{11.25}{15}$ = 0.75

Ans

Calculate the amount of materials & reinforcement (1.5%) reqd for RCC with mix proportion 1:3:6.

Ans: Let, wet vol^m of RCC = 100 cft

$\therefore$ Dry volume of RCC = 1.5 x 100

= 150 cft.

$\therefore$ Cement = $\frac{1}{10} * 150$ = 15 cft

= 12 bags

Sand = $\frac{3}{10} * 150$ = 45 cft.

Brick khoa = $\frac{6}{10} * 150$

= 90 cft.

= 90 * 8.5 = 765 Nos.

Steel = 1.5% of 100

= 1.5 cft.

= (1.5 * 490) lb

= 735 lb $\simeq$ 330 kg.

* Determine the number of bags of cement required to cast 40' long span beam if the beam section is 12"x15" and mix ratio 1:2:4.

Soln: wet volume = $40 \times \frac{12}{12} \times \frac{15}{12} = 50$ cft.

Meghna-ITT

Dry volume = $1.5 \times 50 = 75$ cft

Cement required = $\frac{1}{7} * 75 = 10.714$ cft

$= \frac{10.714}{1.25} = 8.576 \simeq 9$ bags Ans.

* For a building construction, total beam length is 1650 m is required 5-20mm dia plain bars. Unit wt of plain bar is 7850 kg/m^3 and cost is TK 48000 per metric ton. Make the cost estimate for the steel bars.

Soln:

Volume occupying by bars = $\frac{\pi}{4} * \left(\frac{20}{1000}\right)^2 \times 5 \times 1650$

$= 2.592$ m^3

Bivet

wt. of plain bar = 2.592×7850

$= 20345.74$ kg

$= 20.35$ tons.

Total cost = $20.35 \times 48000 = 976595.5$ TK

Ans.

* The estimated batch quantities per cubic metre of concrete for SSD condition of aggregates are: cement = 306 kg, CA = 1152 kg, FA = 870 kg, Water = 161 kg. If fine aggregate contains 5% surface moisture and CA absorbs 10% of water. Workout field adjustment.

Soln:

Water required for CA = $\frac{10}{100} \times 1152 = 115.2$ kg

Water required for FA = $\frac{5}{100} \times 870 = 43.5$ kg

Total water requirement for adjustment

$= 115.2 + 43.5 + 162$

$= 320.9$ kg

Ans.

* Design a concrete mix by the minimum void method for the following data, voids of C.A is 40%, voids of F.A is 30%, size of C.A is ¾" to 1", size of F.A is ¾" to ¼". Allow an excess of 10% for cement & 7% for F.A.

Soln: Let, volume of coarse aggregate = 100 cft.

∴ F.A = 40% × C.A × (1+7%) = 0.4×100×1.07 = 42.8 cft

Lowest C.A-এর voids F.A দ্বারা পূরণ হবে।

Cement = 30% × F.A × (1+10%) = 0.3 * 42.8 * 1.10 = 14.14 cft.

Lowest F.A-এর void cement দ্বারা পূরণ হবে।

∴ Cement : Sand (F.A) : C.A = 14.14 : 42.8 : 100 = 1 : 3 : 7 Ans

* Calculate the number of bricks reqd for making a room of 8' width, 10' long, 9' height with 10" wall.

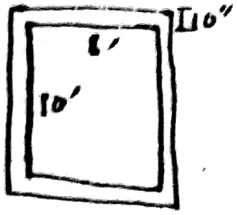
Soln: Brick reqd for Brick Flat Soling (BFS) = 10×8×3 (প্রতি sft-এ 3টা brick লাগে)

Brick size mentain করা হয়েছে = 240 Nos.

Brick work:

Total length = $2\left(10+\frac{10}{12}\right)+2\left(8+\frac{10}{12}\right)$ [c/c length]

= 39.33 ft.



width = $\frac{10}{12}$ = 0.833 ft, height = 9'

∴ volume of brick work = 39.33 * 0.833 * 9

= 295 cft.

∴ Brick reqd = $295 * \frac{1200}{100}$ = 3540 Nos.

Total reqd brick = 3540 + 240 = 3780 Nos

* The durability of concrete is proportional to cement-aggregate ratio. Ans
* Strength of concrete increases with the increase in the size of aggregate.
* Shrinkage of concrete increases with the increase in % of concrete.

Md. Miraj Gazi

* Design a concrete mix by the minimum void method for the following data, voids of C.A is 40%, voids of F.A is 30%, size of C.A. is $\frac{1}{4}$" to 1", size of F.A. is $\frac{3}{16}$" to $\frac{1}{4}$". Allow an excess of 10% for cement & 7% for F.A.

Soln: Let, volume of coarse aggregate = 100 cft.

$\therefore$ F.A = 40% × C.A × (1+7%) = 0.4×100×1.07 = 42.8 cft

↳ মোট C.A - এর voids F.A. দ্বারা পূরণ হবে।

Cement = 30% × F.A × (1+10%) = 0.3 * 42.8 * 1.10 = 14.14 cft.

↳ মোট F.A. এর void cement দ্বারা পূরণ হবে।

$\therefore$ Cement : Sand(F.A) : C.A = 14.14 : 42.8 : 100 = 1 : 3 : 7 Ans

Calculate the number of bricks reqd for making a room of 8' width, 10' long, 9' height with 10" wall.

Soln: Brick reqd for Brick Flat Soling (BFS) = 10×8×3 [1 sft-এ 3টা brick লাগে]

↳ Brick size mortar এর জন্য যোগ করে = 240 Nos.

Brick work:

Total length = $2\left(10+\frac{10}{12}\right)+2\left(8+\frac{10}{12}\right)$ [c/c length]

= 39.33 ft.

width = $\frac{10}{12}$ = 0.833 ft, height = 9'

$\therefore$ volume of brick work = 39.33 * 0.833 * 9

= 295 cft.

$\therefore$ Brick reqd = $295 * \frac{1200}{100}$ = 3540 Nos.

Total reqd brick = 3540 + 240 = 3780 Nos Ans

* The durability of concrete is proportional to cement-aggregate ratio.
* Strength of concrete increases with the increase in the size of aggregate.
* Shrinkage of concrete increases with the increase in % of concrete.

*Write down the properties of Engineering materials on concrete.

Ans: 1. Physical properties:

- specific gravity, specific heat, Elasticity, porosity, plasticity, size, shape, density.

2. Mechanical properties:

- strength, Hardness, Toughness, Brittleness, Ductility, Creep & slip, Fatigue.

#Estimate the yield produced of concrete per bag of cement for concrete mix proportion 1:3:6.

Soln: Thumb Rule: *yield → volume

Volume of one bag cement = 1.25 cft = 0.0354 m^3

∴ Yield of concrete per bag of cement = $\frac{2}{3}$ (.0354*1 + 0.0354*3 + 0.0354*6) = 0.236 m^3 Ans

Absolute volume method.

Yield of concrete per bag of cement = volume of (cement + Sand + C.A + Water)

$= \frac{50}{3150} + \frac{3*.0354*1600}{2650} + \frac{6*.0354*1500}{2650} + \frac{25}{1000}$

* Unit weight of some materials.

Ans:

Materials	Unit weight	Materials	Unit weight
Asphalt/Bitumen	66 lb/ft³	Stone	150 lb/ft³
Bricks	69 lb/ft³	Mild steel	490 lb/ft³
Brick chaps	80-110 lb/ft³	Water	62.4 lb/ft³
Cement	90 lb/ft³	Sand (dry to wet)	100-120 lb/ft³
cement concrete	140 lb/ft³	RCC	150 lb/ft³

* What is Sulphate Resisting portland cement? (SR)

* Write down the FM range of construction materials.

Sand / Fine Aggregate	Range
Fine Sand	2.2 ~ 2.6
Medium Sand	2.6 ~ 2.9
Coarse Sand	2.9 ~ 3.2
Coarse Aggregate	6.5 ~ 8.0

* FM > 3.2 is not used for making good concrete.
* FM > 1.6 is suitable for plastering.

Aggregate

* What is aggregate?

Ans: The important constituents which occupy 70-80% of the volm of concrete is called ~~concrete~~ aggregate. Coarse aggregate (Brick khoa/stone chips) and fine aggregate (Sand / Surki) are used to make concrete.

* Define CA & FA.

Ans: The particle having diameter from 75 mm to 4.75mm is called CA i.e. 75mm passing & 4.75mm retained.

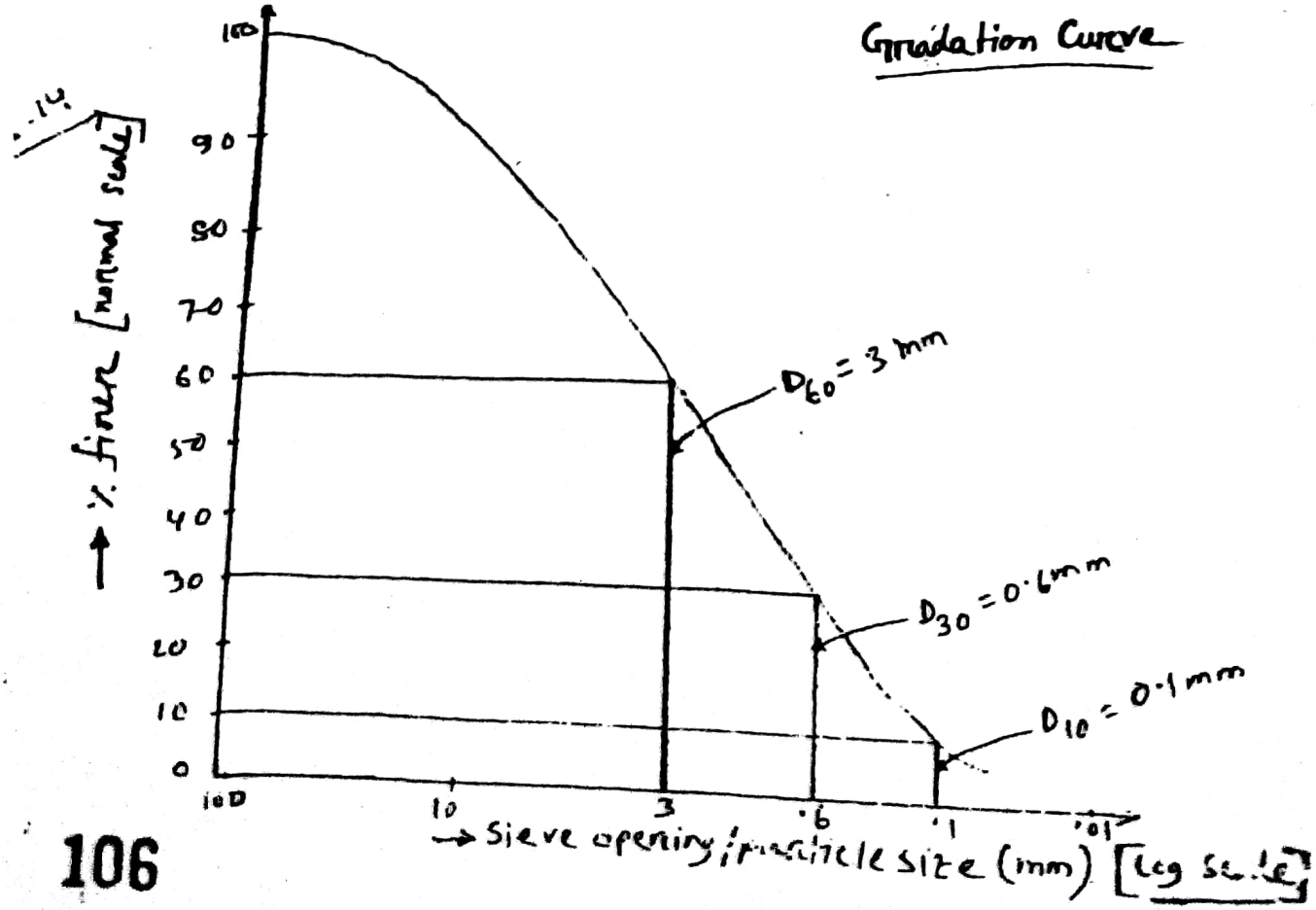
The particle having diameter ~~from~~ less than 4.75 mm and more than 0.075 mm is called F.A. i.e. 4.75 mm passing and 0.075 mm retained.

* Standard sieve.

Ans: 3", $1\frac{1}{2}$", $\frac{3}{4}$", $\frac{3}{8}$", $\frac{3}{16}$" (4.75mm or #4), #8, #16, #30, #50, #160.

C.A. | F.A.

* Relation between % finer and sieve opening / particle size.



* D_{10} → particle size (diameter) corresponds to 10% finer.

D_{60} → " " " " " 60% finer.

D_{30} → " " " " " 30% finer.

* Co-efficient of uniformity, $C_u = \frac{D_{60}}{D_{10}}$

↳ 1 এর কাছাকাছি হলে sample কে uniform বলে।

* Why desert sand is not used for construction?

Ans: Because of -

i) The extended weather effect of desert sand are finer & smoother particle compared to ordinary construction sand.

ii) These sand particles are so small, the slurry would slip and given poor strength.

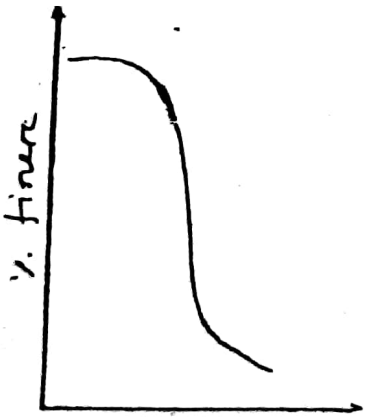
iii) The poor strength of concrete is prohibited to construction works.

* Gradation curve.

i) Well graded

↓

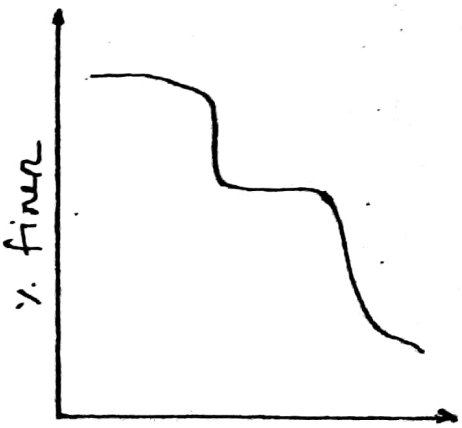
When soil sample has good representation of particles of all sizes.



ii) Uniformly graded

↓

When soil sample has an excess of certain particles and deficiency of others. (poorly graded)



iii) Gap graded.

↓

A soil sample in which some intermediate size particles are missing is known as gap graded or skip graded.

* Define Bulking of sand/volume expansion of sand.

Ans: The increase in the volume of a given weight of sand due to the presence of moisture is called bulking of sand. For upto 5 to 8% of moisture by weight of sand, there is a steady increase in volume to about 20% to 30%.

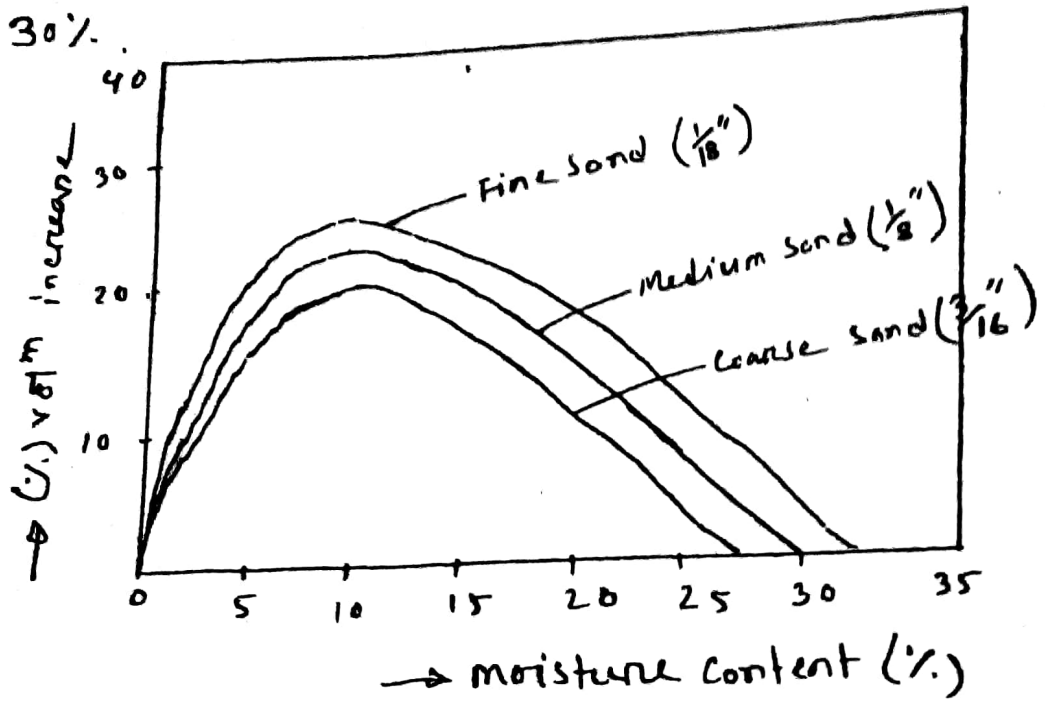


Fig: Bulking of sands with different moisture content.

* Define Fineness Modulus (F.M.).

Ans: Fineness modulus is an empirical factor obtained by adding the cumulative percentages of aggregate retained on each of the standard sieves 3", 1½", ¾", ⅜", #4, #8, #16, #30, #50 and #100 and dividing the sum by 100. FM value should not be less than 2.30 and not more than 3.10.

* The sedimentary rock formed due to gradual deposition of materials like Sand, clay etc.

910 — 970 —

$\Sigma = 970 gm$

- FM value of ⇒ followi

→ #4 #8 #16 #20 #3

→ 10 60 90 110 130

Wt retained (gm)	Cumulative Wt retained (gm)
10	10
60	70
90	160
110	270
130	400
70	470

Determine FM for sand in which 100% sample retaining on #30 sieve?

Soln: Let, Total weight of sample = 100 gm.

sieve size	Wt retained (gm)	cumulative wt retained (gm)	cumulative wt retained (%)	FM
#4	0	0	0	$\frac{300}{100} = 3$
#8	0	0	0	
#16	0	0	0	
#30	100	100	100	
#50	0	100	100	
#100	0	100	100	
#200	0	100	x	
pan	0	100	x	
		$\Sigma = 300$		

Compute the FM value of following data -

sieve size →	3"	$1\frac{1}{2}$"	$\frac{3}{4}$"	$\frac{3}{8}$"	#4	#8	#16	#30	#50	#100
% cum. retained →	0	0	0	0	0	0	10	30	100	100

Soln: $FM = \frac{10 + 30 + 100 + 100}{100} = 2.40$ Ans

Compute the combined FM value of two samples having total weight of 1250 gms.

sieve size →	3"	$1\frac{1}{2}$"	$\frac{3}{4}$"	$\frac{3}{8}$"	#4	#8	#16	#30	#50	#100
cum. wt retained → (Sample-1)	0	0	0	0	50	200	360	650	1120	1150
cum. wt retained → (Sample-2)	0	0	0	0	0	50	250	400	615	1250

Soln:

Sieve size	(Sample-1) % Cum. retained	(Sample-2) % Cum. retained
#4	$\frac{50}{1250} * 100 = 4$	0
#8	$\frac{200}{1250} * 100 = 16$	4
#16	24	20
#30	52	32
#50	89.6	50
#100	92	100
	Sum = 277.6	= 206

$\therefore F_1 = \frac{277.6}{100} = 2.78$, $F_2 = \frac{206}{100} = 2.06$

$\therefore F_{com} = \frac{m_1F_1 + m_2F_2}{m_1 + m_2}$ $[m_1 = m_2 = 1250\,gm]$

$= \frac{1250*2.78 + 1250*2.06}{1250+1250} = 2.42$ Ans

Two samples of sand having fineness modulus of 2.84 and 2.24 were mixed together to get a combined FM of 2.54. Determine the ratio in which they were mixed?

Soln: $F_{com} = 2.54$, $F_1 = 2.84$, $F_2 = 2.24$

$\therefore$ Desired ratio $R = \frac{F_1 - F_{com}}{F_{com} - F_2} = \frac{2.84 - 2.54}{2.54 - 2.24} = 1:1$

OR

Let, $m_1 + m_2 = W$

$\Rightarrow m_2 = W - m_1$

$m_1 \rightarrow$ Amount of sample 1

$m_2 \rightarrow$ " " " 2

$W \rightarrow$ total weight

$F_{com} = \frac{m_1F_1 + m_2F_2}{m_1 + m_2} \Rightarrow 2.54 = \frac{2.84\,m_1 + 2.24\,m_2}{W}$

$\Rightarrow 2.54W = 2.84m_1 + 2.24(W - m_1) \Rightarrow 0.3W = 0.6m_1$

$\Rightarrow m_1 = 0.5W \quad \therefore m_2 = 0.5W$.

So, $\frac{m_1}{m_2} = \frac{.5W}{.5W} = 1:1$ Ans

Three different types of sand A, B and C have the FM values 3·15, 2·20 and 2·40 respectively. To prepare a concrete mix of 20kg sand having FM = 2·80 is required. What are the possible ways to get the regd mix? Also, calculate the amount of each varieties of sand.

Soln: possible ways:

i) A+B+C ii) A+B iii) A+C [B+C ALT. $F_B/F_C < 2·80$]

(i) $m_A + m_B + m_C = 20$ kg

$F_{com} = \frac{m_A F_A + m_B F_B + m_C F_C}{m_A + m_B + m_C}$

Let, $m_A = 11$ kg

$\therefore m_B + m_C = 9$

$\Rightarrow m_B = 9 - m_C$

$\therefore F_{com} = \frac{11*3·15 + (9-m_C)*2·2 + 2·4m_C}{m_A + m_B + m_C}$

$\Rightarrow 2·8 * 20 = 59·45 - 2·2m_C + 2·4m_C$

$\Rightarrow m_C = 7·75$ kg.

$\therefore m_B = 1·25$ kg Ans

(ii) $m_A + m_B = 20$ kg

$\Rightarrow m_B = 20 - m_A$

$F_{com} = \frac{m_A F_A + m_B F_B}{m_A + m_B}$

$\Rightarrow 2·80 = \frac{m_A * 3·15 + (20-m_A) * 2·2}{20}$

$\Rightarrow m_A = 12·63$ kg.

$\therefore m_B = 7·37$ kg.

Ans

(iii) Solve As (ii)

Combined FM of two types of soil is 2·75 and whose total weight 100gm. First fineness modulus of soil is 2·65 with a mass 60gm. Find FM and mass of 2nd soil mass.

Soln. Here, $m_1 + m_2 = 100$gm $\Rightarrow m_2 = 100 - 60 = 40$gm Ans

$F_{com} = \frac{F_1 m_1 + F_2 m_2}{m_1 + m_2} \Rightarrow 2·75 = \frac{2·65 * 60 + F_2 * 40}{100}$

$\Rightarrow F_2 = 2·9$ Ans

The combined FM of FA ($F_f = 2.85$) & CA ($F_c = 6.77$) was found to be 5.3 & 8.49 cft of combined and well packed agg. is reqd. Determine the vol^m of CA & FA mixed initially. Take shrinkage factor to be 0.75.

Ans: ~~Desired Ratio, R = Fcom~~

Desired Ratio, $R = \frac{F_c - F_{com}}{F_{com} - F_f}$

$= \frac{6.77 - 5.3}{5.3 - 2.85} = 0.6$

Here,
Compact $V = 8.49$ cft

Initial vol^m $= 8.49/0.75$
$= 11.32$ cft

we get, $\frac{V_f}{V_c} = 0.6 = \frac{60}{100}$

∴ vol^m of F.A, $V_f = \frac{60}{100+60} * 11.32$
$= 4.25$ cft.

vol^m of CA, $V_c = \frac{100}{100+60} * 11.32$
$= 7.07$ cft.

Ans

Design a concrete mix for $f'_c = 3000$ psi in 28 days. Slump = 2", CA = $\frac{3}{4}$", FA = $\frac{1}{16}$ to $\frac{3}{16}$", $F_{CA} = 6.27$, $F_{FA} = 2.85$. Shrinkage factor 0.75. Moisture content in CA & FA is 5% & 29.5%.

Ans: Let, $F_{com} = 5.3$

Compacted vol^m = 3.75

∴ Loose vol^m $= 3.75/0.75$
$= 5$ cft.

Ratio of FA & CA

$= \frac{F_{CA} - F_{com}}{F_{com} - F_{FA}} = 0.4$

∴ $\frac{V_f}{V_c} = \frac{40}{100}$

∴ vol^m of F.A, $V_f = \frac{40}{100+40} * 5$
$= 1.43$ cft.

vol^m of C.A., $V_c = \frac{100}{100+40} * 5$
$= 3.57$ cft.

∴ Mix ratio = 1 : 1.43 : 3.57

moisture দেওয়া থাকলে 5% ও 29.5% vol^m বাড়বে তাই এতটুকু vol^m extra add করতে হবে। → In field,

$V_f = 1.43 * 1.295 = 1.85$ cft

$V_c = 3.57 * 1.05 = 3.75$ cft

∴ mix ratio = 1 : 1.85 : 3.75

Ans

Mortar, plaster, Timber, paint,

* What is mortar? write down the uses of mortar.

Ans: Mortar is a paste made by mixing binding material and inert material with water.

Mortar = Binding material (Lime / cement) + inert material (Sand / surki) + water.

uses:

- To bind the building units (bricks, stones, etc) into a solid mass.
- To carray out pointing or plastering works on exposed surface of masonry.
- To form an even and soft bedding layer for building units.
- To improve the appearance of structure.
- To hide the open joints of brick works.

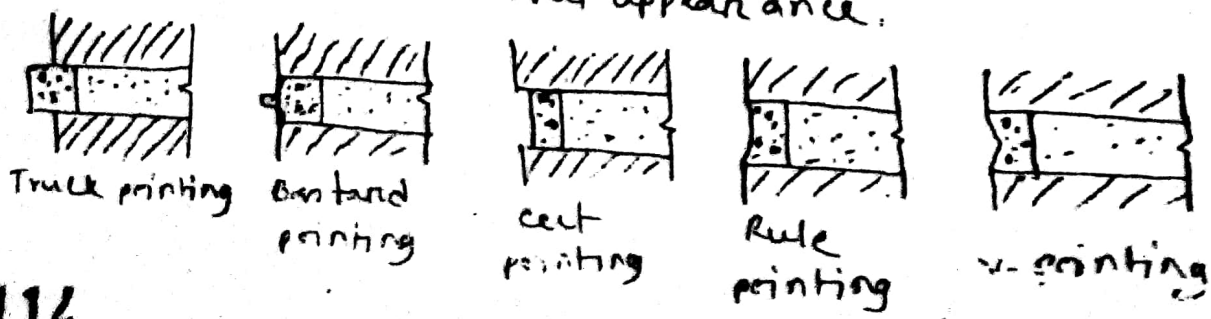
* What is plaster? uses of plaster.

Ans: plaster is a thin coat of mortar which is appled on both external and internal faces of walls, ceilings, beam, column, etc.

uses: - To give a smooth and finished surface to the works.
- To cover joints and defective workmanship.
- To protect surface from the action of weathering.
- To provide a ground for decoration or ~~wite~~ White/color washing.

* What is pointing?

Ans: pointing is the finishing off (with the trowel) the mortar in the rough brick joints of walls to give the surface a beautiful appearance.



* Draw the structure of a timber.

*Trunk → खोड

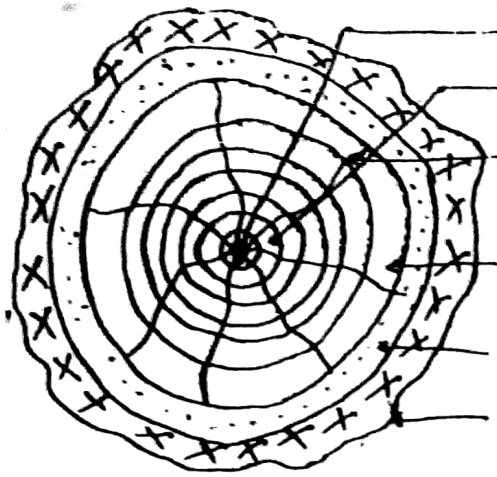


Fig: Transverse section of the trunk of an exogenous tree.

* What is the seasoning of timber?

Ans: The process of reducing moisture or sap present in a timber/tree, is called seasoning of timber.

① Natural/Air seasoning → simple, cheap & slow process. 2 to 3 yrs reqd for removing moisture content.

② Artificial seasoning → Drying of timber by exposure for a limited period to high temp. requires about 6-12 days.

* What is Geotextile?

Ans: The ASTM (1994) defines geotextiles are permeable textile materials used in contact with soil, rock, earth or any other geotechnical related material as an integral part of civil engineering works.

12·5	125		
9·75	100	100	$\frac{100}{200} \times 100 = 50$
2·36	50	150	75
1·18	20	170	85
·6	10	180	90
·3	10	190	95
·15	4	194	97
·075	4	198	x
pan	2	200	x

"Sessional On Engineering Materials"

Exp-1: Determination of unit weight, voids, moisture content, specific gravity and absorption of coarse/fine aggregate.

* Unit weight of aggregate, $\gamma_{bulk} = \frac{G - T}{V}$ in kg/m^3

Where, G = mass of aggregate + measure, kg

T = mass of measure, kg

V = vol^m of measure, $m^3 = \frac{W_W}{\gamma_W}$

* void content (%) $= \frac{G_s\gamma_W - \gamma_{bulk}}{G_s\gamma_W} \times 100$

Where, G_s = Bulk specific gravity.

γ_W = Unit weight of water.

* Moisture content $= \frac{W}{A} \times 100\%$.

Where, W = Wt of water present in aggregate, gm

A = Wt of dry aggregate, gm

* Bulk dry specific gravity, $G_{sb} = A/(B-C)$

Bulk SSD specific gravity, $G_{sb}(SSD) = B/(B-C)$

Apparent specific gravity, $G_{sa} = A/(A-C)$

Where, A = oven dry weight

B = SSD weight.

C = weight in water.

* Absorption (%) $= \frac{B-A}{A} \times 100\%$.

B = SSD weight

A = oven dry weight.

* For which type of aggregate the value of unit weight and void is greater? Explain why?

Ans: Unit wt of C.A. > Unit wt. of F.A. because of having higher density (for coarse aggregate).

Voids in C.A > voids in F.A because of having more spaces among the particles of coarse aggregate.

* Absorption (%) is important for determining the net water - cement ratio in concrete mix.

* Sp. gr. of C.A > Sp. gr. of F.A.

* Absorption in F.A > Absorption in C.A.

Exp-2: Resistance to degradation of small - size coarse aggregate by abrasion and impact in the Loss angeles machine.

* Write the table of grading of the test sample.

Ans:

Grading	No. of spheres	weight of Charge. gm
A	12	5000 ± 25
B	11	4584 ± 25
C	8	3330 ± 20
D	6	2500 ± 15

* L.A. Abrasion Loss (%) = $\frac{A-B}{A} * 100$

where, A = Mass of original test specimen

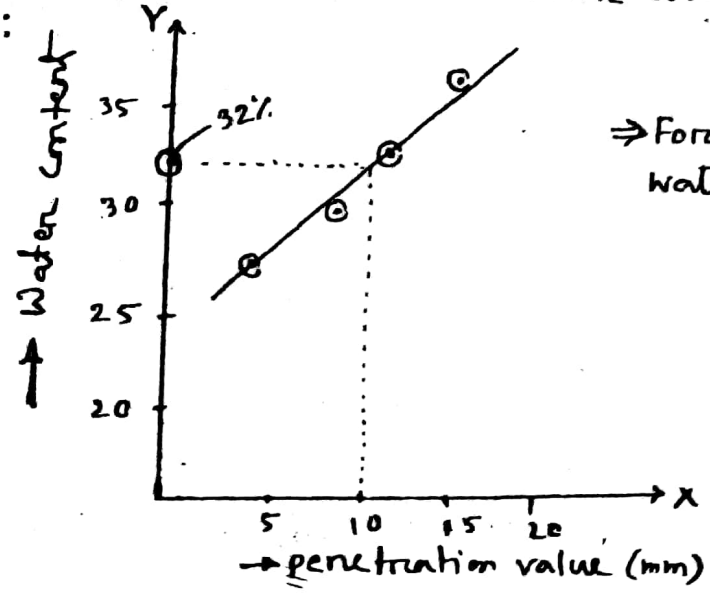
B = Mass retained on the 1.70mm sieve after the specified nos. of revolution

* According to ASTM-33, max^m abrasion loss is 50%.

Exp-3: Normal consistency of cement by vicat apparatus.

* Diameter of vical needle is 1mm & length 50 mm.
* Normal Consistency = $\frac{\text{Amount of water for 10 mm penetration}}{\text{Amount of cement.}} * 100$
* How we determine the water content for 10mm penetration?

Ans:



⇒ For 10mm penetration, the water content is 32%.

Exp-4: Compressive and absorption test of brick specimen.

* Compressive Strength = $\frac{\text{Load, W}}{\text{Area, A}}$
* Water Absorption, % = $\frac{W_s - W_d}{W_d} * 100$

Where, W_s = Saturated wt. of brick specimen.

W_d = Dry wt of brick specimen.

Exp-5: Compressive/Tensile strength of hydraulic cement mortar.

*Minimum compressive and tensile strength according to ASTM C150.

Age (Days)	Min^m Comp. strength psi (MPa)	Min^m tensile strength psi (MPa)
3	1800 (12.4)	150 (1.034)
7	2800 (19.3)	275 (1.896)
28	4000 (27.6)	350 (2.413)

*The range of temperature for curing is 23°c to 27°c.

Exp-6: Compressive strength of cylindrical/cubical concrete specimen.

*Cubical specimen (6"x6"x6"), 3 layers each mold, temping 35 times.

*Cylindrical specimen (6"x12"), 4 layers each mold, temping 25 times.

*Write down the types of failure in cylindrical specimen.

Ans:

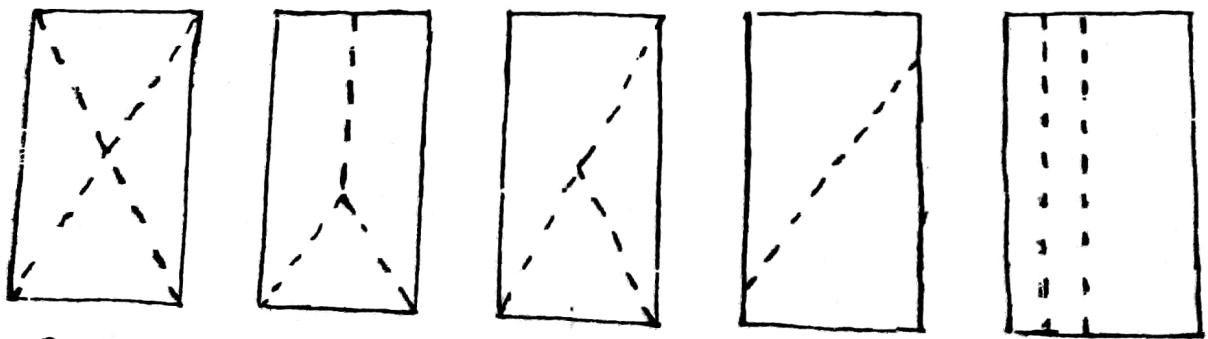


Fig: Types of concrete fracture

* Define true slump, Shear Slump, Collapse slump.

Ans: True slump: In a true slump the concrete simply subsides, keeping more or less to shape.

Shear slump: In a shear slump the top portion of the concrete shears off and slips sideway.

Collapse slump: In a collapse slump the concrete collapse completely.

+ Figure (From concrete chapter)

~~* What is admixture? Why is it used?~~

~~Admixture:~~

* Consisteney of concrete: In the case of concrete, consisteney is sometimes taken to mean the degree of wetness, within limits, Wet concrete are more workable than dry concrete but concrete of the same consisteney may vary in workability.

* Workability of concrete can be improved by -

1) $CaCl_2$ 2) Fly Ash 3) Hydrated lime

* For a coarse aggregate sample air dry wt. of sample is 1790 gm, wt. when it is immersed in water is 1180 gm and SSD wt. is 1850 gm. Calculate the bulk specific gravity, Apparent specific gravity and % absorption.

Soln: A = 1790 gm, B = 1850 gm, C = 1180 gm

Bulk sp. gravity = $\frac{B}{B-C}$ = 2.76 (SSD basis)

Bulk sp. gravity = $\frac{A}{B-C}$ = 2.67 (Dry basis)

Apparent sp. gravity = $\frac{A}{A-C}$ = 2.93

Absorption = $\frac{B-A}{A} \times 100$ = 3.35 %.

* Dry weight of a sample is 1206 gm & SSD weight is 1226.4 gm. The volume of water occupying the same volume excluding excluding the pores is 440.6 cm^3. Find bulk sp. gravity, apparent sp. gravity & % absorption.

Soln: Wt. of water = 1226.4 - 1206 = 20.4 gm

volume of water = $\frac{20.4}{1}$ = 20.4 cm^3

Bulk sp. gravity = $\frac{1206}{440.6 + 20.4}$ = 2.62

Apparent sp. gravity = $\frac{1206}{440.6}$ = 2.74

% Absorption = $\frac{20.4}{1206} \times 100$ = 1.7 % Ans.

"Details of Construction"

*Building: A building is a structure consisting of walls, floors and roofs, erected to provide covered space for different uses such as residence, education, business, storage, etc.

*Types of Building: (According to BNBC)

1. Residential Buildings
2. Educational Buildings
3. Institutional Buildings
4. Business Buildings
5. Assembly Buildings
6. Industrial Buildings
7. Storage Buildings
8. Hazardous Buildings

*Foundation: Foundation is the lowest part of a structure which provides a base for the super-structure which transmit the load of the structure to the underlying soil.

*purpose of Foundation:

- To distribute the weight of the structure to the underlying soil.
- To prevent the unequal settlement.
- To take the structure deep into the ground and hence increase stability, preventing overturning.

*Frog: These are depressions provided in the face of the brick. The frogs are provided for two reasons-

i) To form a key with mortar to prevent sliding of bricks on their beds.

ii) To reduce the weight of bricks and hence economy in the cost of transport.

*Arch: The mechanical arrangement of wedge-shaped blocks of stones or bricks mutually supporting each other and supported at the end by piers or abutments, is called arch.

*DPC: The treatment given to keep the walls, floors and basement dry is called damp-proofing. A DPC is a layer usually laid below all masonry walls, floors & basement. Plastic sheeting, butyl rubber, lead sheet, asphalt, impervious bricks, stones, etc are commonly used as DPC.

*Shoring: The temporary structure required to support an unsafe structure, is termed as shoring.

*Scaffolding: It is a temporary rigid structure having platforms raised up as the building increases in height.

*Underpinning: This term is applied to the building of new work underneath an existing structure without disturbing its stability. It is necessary when defective foundation is replaced by new foundation.

*DPC is provided at plinth level of the building to check the rise of moisture from ground to super-structure.

* Write five examples of business & mercantile building.

Ans:

Business & mercantile
- offices.
- Small shops & markets.
- Large shops & markets.
- Garages & petrol stations.
- Essential services (police station, fire stations).

JUNE 14