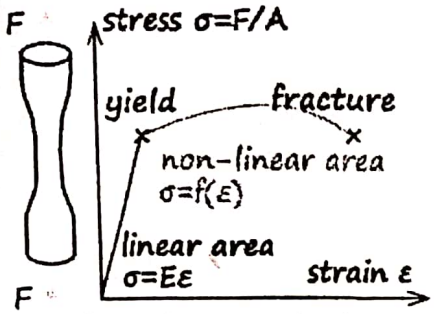
Engineering Materials

Engineering Materials

The following are the important engineering materials that are commonly used in bangladesh. Stones, brick and other structural clay products, lime, cement, sand, concrete, iron, steel, ferrous alloys, non-ferrous metals and alloys, timber and timber products, bamboos, soils, bituminous materials, glass, Plastic, paints and varnishes, rubber etc.

Some property of materials:

Strength: It is the property of material that represents its ability to resist internal forces or stresses. Therefore strength defines capacity of a material to carry loads.



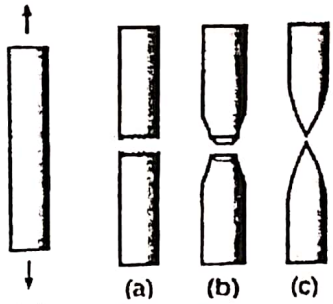
Ductility: Ductility indicates the ability of a material to deform in the plastic range without breaking, which may be expressed as percent elongation or percent area reduction from a tensile test.

Percent elongation, or engineering strain at fracture, can be written as:

$$\%EL = \frac{\text{final gage length} - \text{initial gage length}}{\text{initial gage length}} = \frac{l_f - l_0}{l_0} \times 100$$

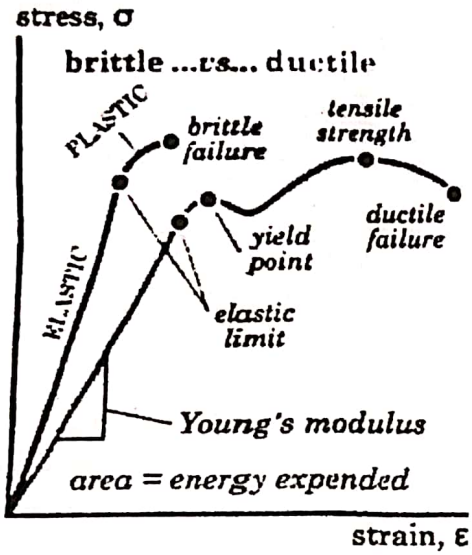
Percent reduction in area can be written as:

$$\%RA = \frac{\text{change in area}}{\text{original area}} = \frac{A_0 - A_f}{A_0} \times 100$$



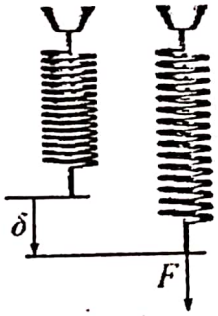
(*a*) Brittle fracture
(*b*) Ductile fracture
(*c*) Completely ductile fracture

Brittleness: Brittleness is the tendency of a material to break before it undergoes plastic deformation.

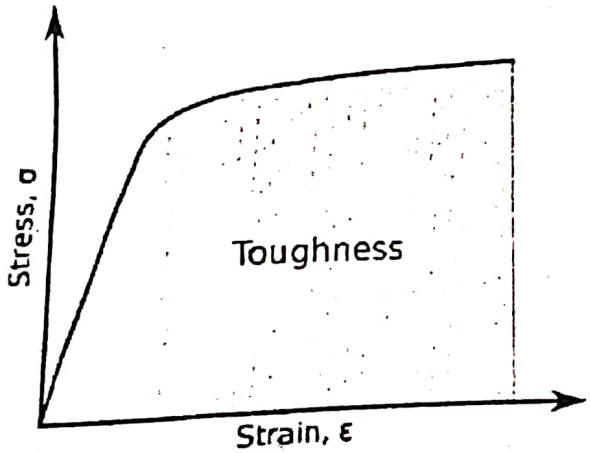


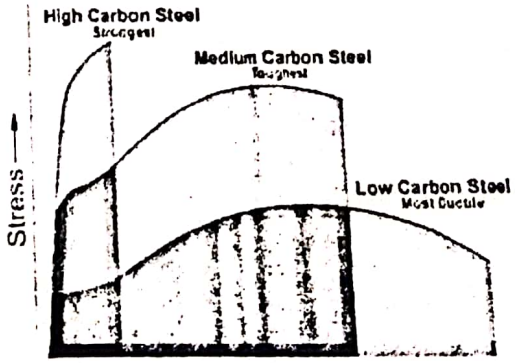
Stiffness: The term stiffness designates the resistance of a material to deformation in the elastic range.

$$k = \frac{F}{\delta}$$

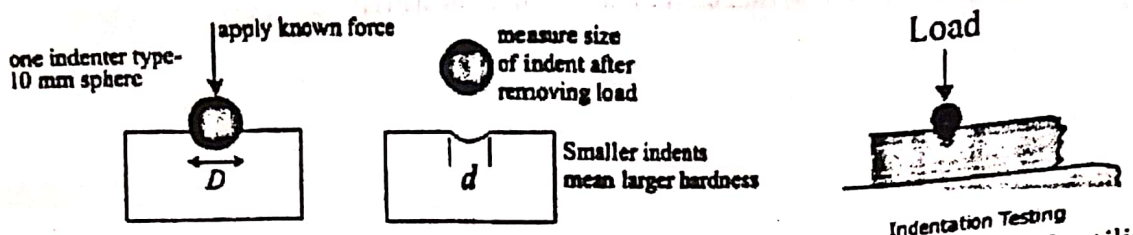


Toughness: property of a material where it can absorb energy before actual fracture.



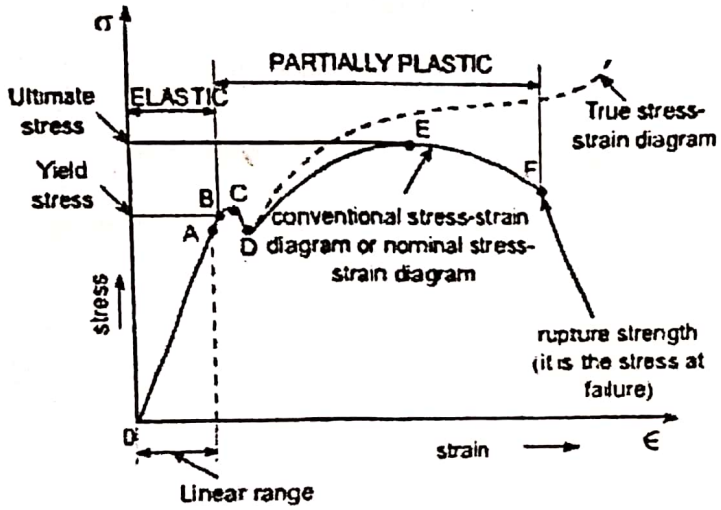


Hardness: hardness is the resistance of a material to permanent deformation of its surface.



Question: Draw the mild steel stress-strain diagram with all point and how the ductility of mild steel is determined? (BWDB-2018)

Solution:



Ductility indicates the ability of a material to deform in the plastic range without breaking, which may be expressed as percent elongation or percent area reduction from a tensile test. Two measures of ductility are elongation and reduction of area. The conventional means by which these measures are obtained is by pulling a specimen in tension until fracture.

Percent elongation or engineering strain at fracture can be written as:

$$\%EL = \frac{L_f - L_o}{L_o} \times 100$$

Percent reduction in area can be written as:

$$\%EA = \frac{A_f - A_o}{A_o} \times 100$$

Question: Write four physical and four mechanical properties of engineering materials. (TGTDCL – 2014)

Solution:

Physical properties: Size, Shape, Density & Porosity.

Mechanical properties: Elasticity, Plasticity, Stiffness, Ductility, Hardness & Brittleness.

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

Bricks –advantages over Stone:
- Bricks have greater fire resistance than stone or concrete masonry
- its size enables easy handling and placement in walls
- It can be easily adapted to small-scale and large-scale structures to give pleasing appearance and texture.

Composition of bricks: Chemical analysis of good brick clay should give the following chemical composition.

Compounds	Percentage
Silica	55%
Alumina	30%
Iron oxide	8%
Magnesia	5%
Lime	1%
Organic matters	1%
Total	100%

Question: Describe the field test of first class bricks / characteristics of first class brick.
(PMO – 2015, Army – 2014, BSEC – 2014, BHP – 2017, EED – 2015)

Solution:

The following field tests are to be performed in order to determine if a brick is good:

1. A good brick should be of proper shape and standard specified size.
2. The color of a good brick should be copper red color.
3. When a brick is struck by a hammer or against another brick, it should emit a clear metallic ringing sound, it should not be dull.
4. The structure should be homogeneous, compact and free from any defects.
5. If a brick is dropped from about a height of 1m on a hard ground or on another brick, it should not break.
6. When a brick is scratched with finger nail it should not leave any impression on the brick.
7. A good brick (1st Class) should not absorb water by not more than 20% of its own dry weight when immersed in water for a period of 24 Hours.
8. Standard size of brick = 9.5" x 4.5" x 2.75"

Bricks Test: It is necessary to check the quality of brick before using it in any construction activities. There are some field tests that we can conduct in the field in order to check the quality of bricks. These tests are as follows.

- Water Absorption
- Visual inspection
- Efflorescence

- Dimension
- Hardness
- Soundness
- Structure

Question: As per PWD, what is the standard size of Brick in Bangladesh, Write the name of the test for testing brick in Field. (EED – 2019)

Solution:

PWD approved bricks size without mortar is 9.5" x 4.5" x 2.75" or 25 cm x 11.5 cm x 7 cm
Test for testing brick in Field:

- Water Absorption
- Visual inspection
- Efflorescence
- Dimension
- Hardness
- Soundness
- Structure
- Color

Question: In a half brick test the maximum compressive load 15 ton and area of brick 21.5 in^2. Determine the compressive strength and also classify the brick.
(BIFPCL– 2015, BEPZA – 2019)

Solution:

Load, $P = 15 \text{ ton} = 15 \times 1000 = 15000 \text{ kg}$

Area, $A = 21.5 \text{ in}^2 = 21.5 \times 2.52 \times 2.52 = 136.53 \text{ cm}^2$

Compressive strength of brick $= \frac{\text{Load}}{\text{Area}} = \frac{15000}{136.53} = 109.86 \text{ kg/cm}^2$

Minimum compressive strength of brick-

(a) 1st class brick = 105 kg/cm^2

(b) 2nd class brick = 70 kg/cm^2

(c) Common building brick = 35 kg/cm^2

So, the bricks are 1st class brick.

Cement:

Cement is a mixture of compounds consisting mainly of silicates and aluminates of calcium formed out of silica, calcium oxide, aluminum oxide and iron oxide. Cements are popular as building materials with adhesive and cohesive properties. Used to bind the fine & coarse aggregate together and to fill voids in between fine & coarse aggregate particle form a compact mass.

Portland cement: Material made by heating a mixture of limestone and clay in a kiln at about 1400 to 1600 degrees C, then grinding to a fine powder with a small addition of gypsum. Portland cement is the most common type of cement.

Constituents of cement

Lime (CaO)
Silica (SiO_2)
Alumina (Al_2O_3)
Iron Oxide (Fe_2O_3)
Gypsum ($CaSO_4.2H_2O$)

Question: Write the Constitutions of the Cement. (BEPZA – 2019)

Solution:

Main constituents of Portland cement:

- Lime or calcium oxide, CaO : from limestone, chalk, shells, shale or calcareous rock
- Silica, SiO_2: from sand, old bottles, clay or argillaceous rock
- Alumina, Al_2O_3: from bauxite, recycled aluminum, clay
- Iron, Fe_2O_3: from clay, iron ore, scrap iron and fly ash
- Gypsum, $CaSO_4.2H_2O$: found together with limestone

Question: Write the laboratory test of cement. (RAJUK – 2016, BHP – 2017, EED – 2015)

Solution:

Following are the tests to be conducted to judge the quality of cement.

- Consistency test
- Fineness test
- Soundness test
- Initial and final setting time
- Compressive strength test
- Tensile test
- Heat of hydration test
- Chemical composition test.

Hydration of cement:

It's a process of chemical reaction between cement and water. It results first in setting (the concrete become solid) and then hardening (increase of strength and stiffness). Heat is liberated during hydration process. Thus, during the hardening process, the concrete is being continually warmed by internal heat generated.

Question: Under which condition cement is superior to lime? (TGTDCL – 2014)

Solution:

- Contribution of structure in wet place and water.
- Where great strength and durability of structure are required.
- Mortar and plaster has to set quickly and attain quick strength.
- Water tightness of structure.
- Decorative ornaments and pointing work.

Question: What are the functions of alumina (Al_2O_3)in Portland cement? (ISTT – 2015)

Solution:

- Alumina (Al_2O_3) imparts quick setting property to the cement.
- Clinkering temperature is lowered by the presence of the requisite quantity of alumina.
- Excess alumina weakens the cement.

Question: Difference between initial setting time and final setting time? (PGCB – 2017)

Solution:

The time between the water is added to cement till it starts losing its plasticity is called as initial setting time. The time between which water added to cement till it has come in hardened state is called as final setting time. Initial setting time of ordinary Portland cement should not be less than 30 minute and final setting time should not be more than 10 hours.

Question: Define setting time of cement. What are the different types of setting time which is used in cement? (PMO – 2015)

Solution:

Setting time is defined as a specified time required for concrete or mortar to change from liquid state to plastic state and plastic state to solid state so that surface becomes sufficiently rigid. The time between the water is added to cement till it starts losing its plasticity is called as initial setting time. The time between which water added to cement till it has come in hardened state is called as final setting time.

The initial setting time for different types of cements is as follows:

Ordinary Portland cement – 30 minutes
Portland – Pozzolana Cement – 30 minutes
Rapid Hardening Cement – 5 minutes
Low Heat Cement – 30 minutes
High alumina Cement – 30 minutes

Question: Difference between OPC & PPC. Why fly ash is added with cement? (BSEC – 2014)

Solution:

PPC Cement: Pozzolana is a natural or artificial material which contains silica in the reactive form. Portland Pozzolana Cement is cement manufactured by combining Pozzolanic materials. This cement comprises of OPC clinker, gypsum and pozzolanic materials in certain proportions. The Pozzolanic materials include fly ash, volcanic ash, calcined clay or silica fumes. These materials are added within a range of 15% to 35% by cement weight.

OPC Cement: Ordinary Portland Cement (OPC) is manufactured by grinding a mixture of limestone and other raw materials like argillaceous, calcareous, gypsum to a powder. OPC is the most commonly used cement in the world. This type of cement is preferred where fast pace of construction is done. However, the making of OPC has reduced to a great extent as blended cement like PPC has advantages, such as lower environmental pollution, energy consumption and more economical.

OPC	PPC
It has higher strength than PPC in the initial stage.	The strength of PPC is good than OPC in long terms.
It has high heat of hydration making it unfavorable for mass concreting.	The hydration process is slower than OPC resulting low heat of hydration. Therefore, it is suitable for mass concreting.
The presence of sulphates, alkalies, chlorides, etc. is higher and less resistant than PPC	It has low percentage of sulphate alkalis, chlorides, magnesia and free lime in its composition, which makes the concrete durable.
OPC is not favorable in aggressive weather.	Show greater resistance to aggressive weather.
It is slightly costlier than PPC.	Cheaper than OPC.

The use of fly ash in Portland cement concrete (PCC) has many benefits and improves concrete performance in both the fresh and hardened state. Fly ash use in concrete improves the workability of plastic concrete, and the strength and durability of hardened concrete. Fly ash use is also cost effective. When fly ash is added to concrete, the amount of Portland cement may be reduced.

Question: Write the special usage of (a) Low heat cement (b) Quick setting cement (c) Expansive cement (NPCBL – 2017)

Solution:

(a) Usage of Low heat cement: To make the road and workroom surface of factories such as chemical plants and sulphuric acid factories. Majorly used in constructing dam's large footings, large raft slabs, wind turbine plinths.

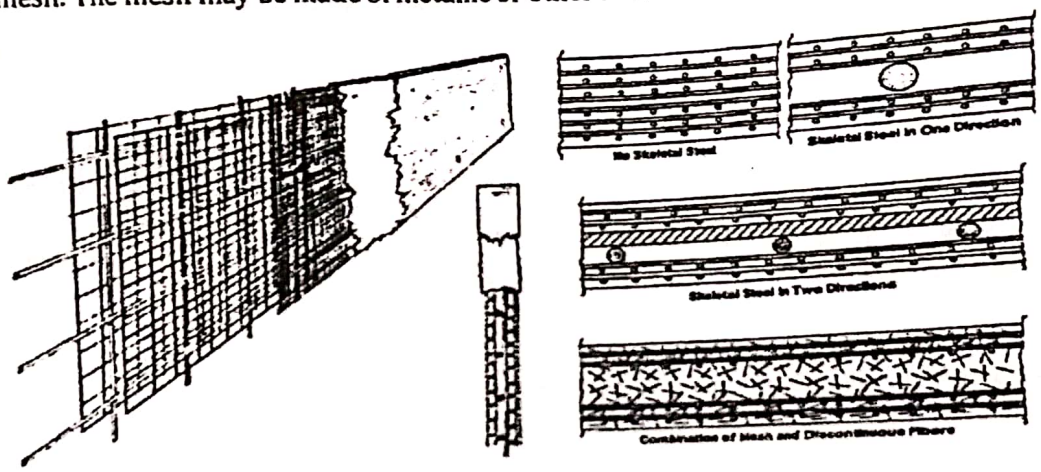
(b) Usage of Quick setting cement: Quick setting cement is used only in very specific situations such as while constructing piers for bridges and other structures in running or standing water.

(c) **Usage of Expansive cement:** This cement is used in large, continuous floor slabs without joints. It work well to fill holes in foundations and to create self-stressed concrete that is stronger than conventional Portland cement concrete. Pre-stressed concrete components for bridges and buildings are made using this material. Used for construction of water retaining structures and also for repairing the damaged concrete surfaces. Used in grouting of anchor bolts.

Question: Sketch typical cross section of Ferro cement. (BB AD – 2018)

Solution:

"Ferro cement is a type of thin wall reinforced concrete, commonly constructed of hydraulic cement mortar, reinforced with closely spaced layers of continuous and relatively small size wire mesh. The mesh may be made of metallic or other suitable materials"

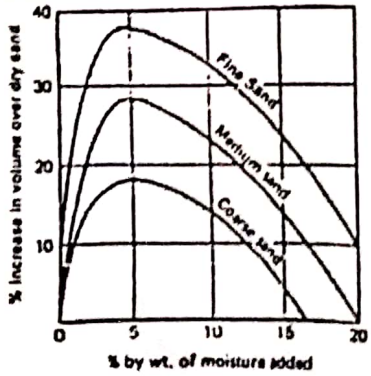


Sand:

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The most common constituent of sand is silica (silicon dioxide or SiO_2) usually in the form of quartz and may be of argillaceous, silicious or calcareous according to its composition.

Bulking of Sand:

Bulking is the increase in total volume of moist fine aggregate over the same dry mass. It happens because of water film around the particles creates a barrier thus increasing the inter particle distance. At certain moisture level the barrier breaks and volume decreases.



Question: Write down the test of sands.

Solution:

The following sand test method performed to molding.

- Moisture content of sand test
- Silt and clay content test
- Strength test
- Permeability test
- Flow ability test
- Mould hardness test
- Buckling of sand
- Fineness modulus

Aggregates:

Aggregate is a collective term for the mineral materials such as sand, gravel and crushed stone that are used with a binding medium (such as water, bitumen, portland cement, lime, etc.) to form compound materials (such as asphalt concrete and portland cement concrete). Aggregate is also used for base and sub-base courses for both flexible and rigid pavements.

Question: Difference between Fine aggregate and coarse aggregate (HED – 2017)

Solution:

Fine Aggregate (sand): Fine aggregates are small size filler materials in construction. Fine aggregate includes the particles that all passes through 4.75 mm sieve and retain on 0.075 mm sieve. The voids between the coarse aggregate are filled up by fine aggregate. Sand, surki, stone screenings, burnt clays, cinders, fly ash, etc are used as fine aggregate in concrete.
Silt: sizes 0.002 – 0.075 mm
Clay: sizes smaller than 0.002 mm

Coarse Aggregate (gravel): Coarse aggregates are larger size filler materials in construction. Coarse aggregate includes the particles that retain on 4.75 mm sieve. Coarse aggregate acts as inert filler material for concrete. Brick chips (broken bricks), stone chips (broken stones), gravels, pebbles, clinkers, cinders etc. are used as coarse aggregate in concrete.

Question: In a sieve analysis the 30% of passing 4.75 mm sieve and 2% passing in the 0.075 mm sieve. Determine the percent of coarse and fine aggregate. (BIFPCL – 2015)

Solution:

Coarse aggregate retains on 4.75 mm sieve
Fine aggregate retains on 0.075 mm sieve

Sieve size	% retained
4.75	100 - 30 = 70%
0.075	30 - 2 = 28%

Percent of coarse aggregate = 70%
Percent of fine aggregate = 28%

Question: Write down the basic ingredients of concrete and briefly describe the functions of each ingredients. (EED – 2015)

Solution:

Concrete is a building material made up of three basic components: water, aggregate (sand, gravel or stone chips) and cement. Cement acts as a binding agent when mixed with water and aggregates. This combination or concrete mix, will be poured and harden into the durable material.

Water :The water in the concrete mix should be clean and free of impurities. The amount of water relative to the amount of cement changes how easily the concrete flows but also affects the final strength of the concrete.

Portland cement: Cement hardens when mixed with water which binds all of the ingredients together. Portland cement is the most common cement used and is composed of alumina, silica, lime, iron, and gypsum.

Aggregates: The majority of a concrete mixture is made up of both coarse and fine aggregates which help increase the strength of the concrete beyond what cement can provide on its own. Sand, gravel and crushed stone are used as aggregates.

Air: The fourth ingredient of concrete is entrained air. While it usually isn't considered an ingredient, the fact is that a concrete mix includes anywhere from 1% to 9% entrained air. Higher quantities of air should be included when the concrete will be exposed to very cold or freezing conditions.

Admixtures: Admixtures accomplish a variety of goals. This can be as simple as adding a pigment to color the concrete. Other admixtures are used for faster curing times in cold weather, creating extremely high-strength concrete, or for increasing the flowable nature of concrete without compromising the strength.

Question: Fineness Modulus (FM) বলতে কি বুঝেন? এটির প্রয়োগ কোথায় এবং কেন?
(HED – 2017, RAJUK – 2016)

Solution:

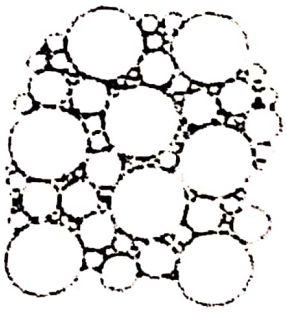
The Fineness modulus (FM) is an empirical figure obtained by adding the total percentage of the sample of an aggregate retained on each of a specified series of sieves and dividing the sum by 100. The sieve sizes are 150μ (No. 100), 300μ (No. 50), 600μ (No. 30), 1.18 mm (No. 16), 2.36 mm (No. 8), 4.75 mm (No. 4), 9.375 mm (0.375 in), 18.75 mm (0.75 in), 37.5 mm (1.5 in), and 75 mm (3 in).

$$F.M. = \frac{\text{Cumulative percentage retained on specified sieves}}{100}$$

Fineness Modulus is used in determining the degree of uniformity of the aggregate gradation. Generally used to get an idea of how coarse or fine the aggregate is. More fineness modulus value indicates that the aggregate is coarser and small value of fineness modulus indicates that the aggregate is finer. A typical fineness modulus for fine aggregate: 2.3-3.0, Coarse aggregate: 5.5-8.0, combined aggregate: 4.0-7.0

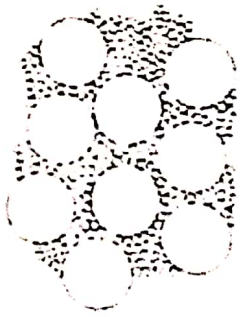
Grading of aggregate:

Aggregate gradation (sieve analysis) is the distribution of particle sizes expressed as a percent of the total dry weight. grading is kept constant during the concreting work; otherwise variable workability results and as this is usually corrected at the mixer by a variation in the water content, concrete of variable strength is obtained.



Well Graded

Poorly Graded



Gap Graded

Question: Write the name of aggregate test. (RAJUK – 2016)

Solution:

Aggregate Test: In order to decide the suitability of the aggregate for use in pavement construction, following tests are carried out:

- Crushing test
- Abrasion test
- Impact test
- Shape test
- Specific gravity and water absorption test
- Bitumen adhesion test

Question: What is meant by 60 grade of Reinforcement? What are the normal test performed for reinforcement for construction works? (EED – 2019)

Solution:

Grade 60 rebar offers a minimum yield strength of 60,000 pounds per square inch or 420 MPa on the metric grading scale.

Different tests for Rebar:

1. Tensile test
2. Bending test
3. Compression test
4. Fatigue test

Question: Write the name of laboratory test for cement, sand, stone chips and reinforcing bars. (RAJUK – 2016)

Solution:

Test for Cement:

1. Fineness Test
2. Consistency Test
3. Setting time Test
4. Soundness Test
5. Strength Test
6. Heat of Hydration Test
7. Specific Gravity Test

Test for Sand:

1. Organic impurities test
2. Silt content test
3. Particle size distribution
4. Bulking of sand site.

Test for Stone chips:

1. Attrition test
2. Crushing test
3. Impact test
4. Laboratory hardness test

Test for Reinforcing bars:

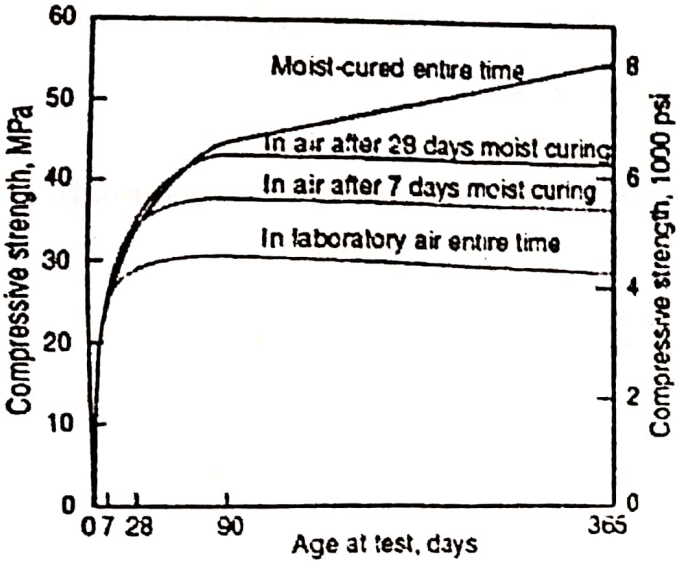
1. Tensile test
2. Bending test
3. Compression test
4. Fatigue test

Concrete:

Concrete is the homogenous mixtures of cement, water, aggregates and sometime admixture. Course aggregate and fine aggregate act as filler material and cement act as a binder material.

Compressive Strength of concrete:

Compressive Strength - is defined as the measured maximum resistance of a concrete or mortar specimen to an axial load, usually expressed in psi (pounds per square inch) at an age of 28-days.



Question: Define the curing of concrete? What are the different methods of curing of concrete? (PMO – 2015)

Solution:

Curing may be defined as the process of maintaining satisfactory moisture and temperature conditions for freshly placed concrete for some specified time for proper hardening of concrete. Curing in the early ages of concrete is more important. Curing for 14 days is very important. Better to continue it for 7 to 14 days more. If curing is not done properly, the strength of concrete reduces and cracks develop due shrinkage. The durability of concrete structure reduces.

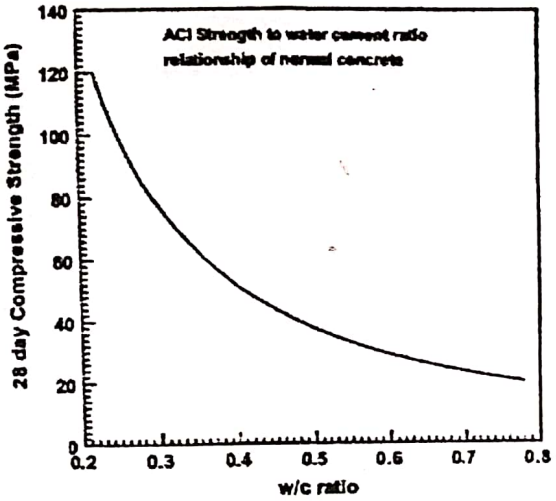
The following curing methods are employed,

(a) Spraying of water
(b) Covering the surface with wet gunny bags, straw etc.
(c) Ponding
(d) Steam curing and
(e) Application of curing compounds.

Question: Describe (*a*) Water cement ratio (*b*) Workability of concrete. (RAJUK – 2016)

Solution:

Water cement ratio: Water cement ratio can be defined as the ratio of the volume of water to the volume of cement used in a concrete mix. Water has a great role on the strength and workability of concrete. After lots of experiments it has been found that for a specific proportion of materials in a concrete mix, there is a certain amount of water that gives maximum strength. A lower ratio leads to higher strength and durability, but may make the mix difficult to work with and form. Workability can be resolved with the use of plasticizer. A w/c ratio of 0.4 means that for every 100 lbs of cement used in the concrete, 40 lbs of water is added.

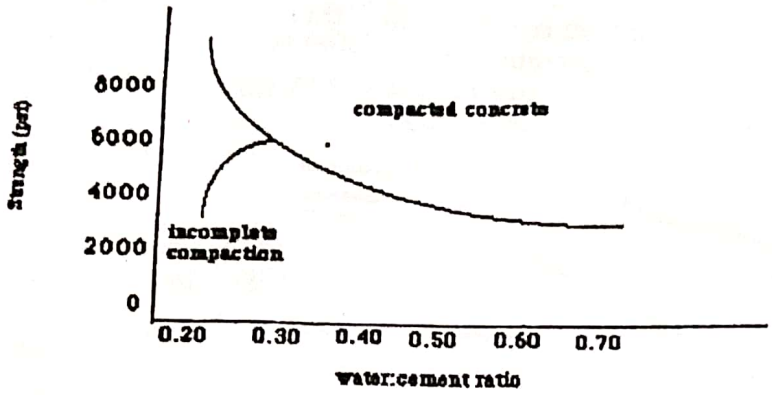


Workability of concrete: Concrete is said to be workable if it is easily transported, placed, compacted and finished without any segregation or bleeding. The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product. Workability is directly proportional to water cement ratio. An increase in water-cement ratio increases the workability of concrete. Workability can be measured by conducting slump test. The workability of concrete depends on many factors which are given below,

- Water content
- Aggregate/cement ratio
- Size of aggregate
- Shape of aggregate
- Grading of aggregate
- Use of admixture

Question: Draw the graph between compressive strength of concrete and water cement ratio. (WASA – 2017, DNCC – 2020)

Solution:



Question: Concrete এর strength কি কি বিষয়ের উপর নির্ভর করে ?(HED – 2020)

Solution:

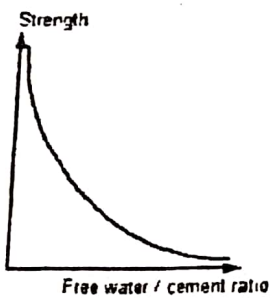
Concrete strength is affected by many factors, such as water/cement ratio, coarse/fine aggregate ratio, age of concrete, compaction of concrete, temperature, relative humidity and curing of concrete.

Cement: Cement affect strength of concrete directly, Appropriate & standard quality of cement should use for proper strength of concrete.

Aggregates: Quality of aggregates, its size, shape, texture, strength etc. determines the strength of concrete. The presence of salts, silt and clay also reduces the strength of concrete.

Water: Quality of the water should be fit for drinking.

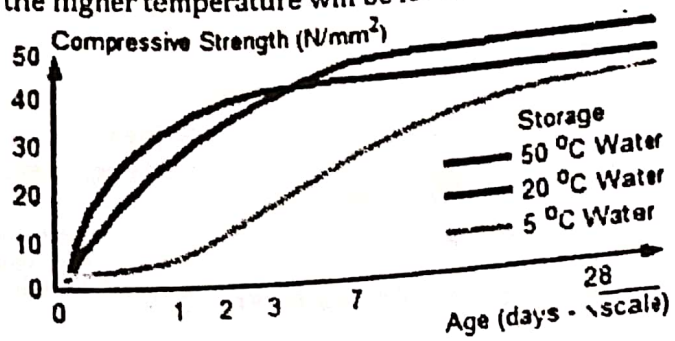
Water/Cement Ratio: The higher the water/cement ratio, strength reduced. But w/c should not be less than 0.5, after that workability will reduce. The relation between water cement ratio and strength of concrete is shown in the plot as shown below.



Age of concrete: The degree of hydration is synonymous with the age of concrete provided the concrete has not been allowed to dry out or the temperature is too low. It is generally accepted that the majority of the strength has been achieved by 28 days.

Compaction of concrete: Any entrapped air resulting from inadequate compaction will lead to a reduction in strength. If there was 10% trapped air in the concrete, the strength will fall down in the range of 30 to 40%.

Temperature: Rate of hydration reaction is temperature dependent. If the temperature increases the reaction also increases. This means that the concrete kept at higher temperature will gain strength more quickly than a similar concrete kept at a lower temperature. But the final strength of the concrete kept at the higher temperature will be lower.



Question: What are the factors affecting workability of concrete mix? State the reasons for cracking. (BKB – 2018)

Solution:

Factors affecting workability of concrete mix
a) Cement content of concrete
b) Water content of concrete
c) Mix proportions of concrete
d) Size of aggregates
e) Shape of aggregates
f) Grading of aggregates
g) Surface texture of aggregates
h) Use of admixtures of concrete
i) Use of supplementary cementitious materials.

Reasons for cracking
a) Excess water in the mix
b) Concrete drying too fast
c) Improper strength concrete poured on the job.
d) Lack of control joints (in concrete slab)
e) Foundations poured in the winter.

Question: Define the following term. Initial Setting time, Soundness test of cement (NPCBL – 2019)

Solution:

Initial Setting time: The time between the water is added to cement till it starts losing its plasticity is called as initial setting time. For OPC it should not be less than 30 minutes.

Soundness test of cement: The ability of cement to retain its volume after it gets hardened is known as Soundness of Cement. That means the cement should be at minimum volume change after it gets hardened. The test used for determining soundness of cement is known as "Le chatelier apparatus test."

Question: Write down the short note on: Quick lime, Fat lime, Hydraulic lime, hydrated lime and Sacked lime (NPCBL – 2019)

Solution:

Quick lime: Quicklime is a compound named calcium oxide which when added with water gives slake lime which is used for whitewashing. Quick lime is prepared by heating calcium carbonate or limestone to a temperature of 1200 celsius in kiln and then it decomposes into calcium oxide and gaseous carbon dioxide.

Fat lime: Fat lime is produced from sea shell, coral deposits etc or from lime stone containing impurities like free sand and soluble silica combined with alumina, magnesium, carbonate etc. Fat lime, therefore, does not possess much strength and is used for plastering walls, while washing etc in exposed positions.

Hydraulic lime: It is also known as water lime. This lime contains clay and some amount of ferrous oxide. It sets under water and hence also known as water lime.

Hydrated lime: Hydrated lime is a dry powder manufactured by treating quicklime with sufficient water to satisfy its chemical affinity for water, thereby converting the oxides to hydroxides.

Sacked lime: It is also known as hydrate of lime. It is obtained by slaking (i.e. chemical combination of quick lime with water) of quick lime. It is ordinary pure lime, in white powder form, available in market. It has got the tendency of absorbing carbonic acid from the atmosphere in presence of water.

Question: Differentiate between segregation and bleeding? (TGTDC – 2014)

Solution:

Segregation can be defined as the separation of the constituent materials of concrete. In case of segregation, the heavy aggregate particles settle down leaving a sand cement mix on top affecting the quality adversely. Fine aggregate could be used to overcome the problem. However, design mix must be such that required strength could be achieved.

Bleeding is the tendency of the water to rise to the surface of freshly laid concrete. This results from inability of the solid material of concrete to hold the all the water mixed for preparation of concrete and during the process of material downward settling.

Question: Write down the causes of segregation of concrete? (BUET M.Sc – 2018, 47 BMA)

Solution:

Use of high water-cement ratio in concrete. This general happens in case of concrete mixed at site by unskilled workers. Excessive vibration of concrete with mechanical needle vibrators makes heavier particles settle at bottom and lighter cement sand paste comes on top. When height of dropping of concrete is more (ex. In case of concreting long column) it will result in segregation.

Question: What is admixture? Why is it used? (RAJUK – 2014, Army – 2014, BHP – 2017)

Solution:

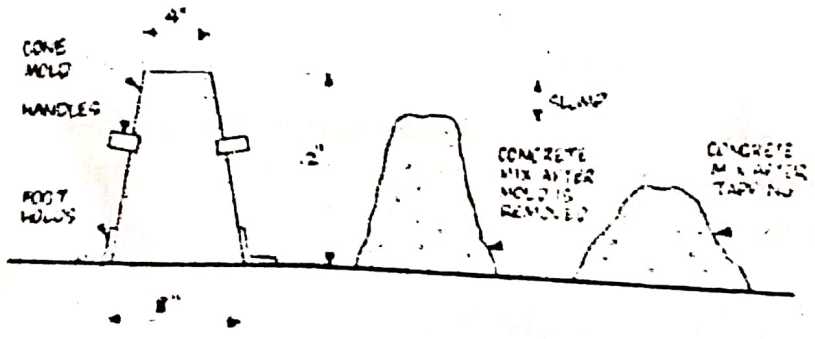
Concrete Admixture is defined as a material other than water, aggregates and hydraulic cement and additives like Pozzolana or slag and fiber reinforcement, used as an ingredient of concrete or mortar and added to the batch immediately before or during its mixing to modify one or more of the properties of concrete in the plastic or hardened state.

- To improve workability of concrete.
- To improve durability by entrainment of air.
- Reduce the rate of slump loss.
- Increase strength (compressive, tensile or flexural).
- To accelerate setting & hardening time.
- To reduce bleeding.
- Reduce segregation.
- Increase bond between existing and new concrete.
- Decrease permeability of concrete.
- Increase bond of concrete to steel reinforcement.

Question: What is slump? Draw a slump cone with dimensions? (TGTDCL – 2014)

Solution:

The concrete slump test is used for the measurement of a property of fresh concrete. The test is an empirical test that measures the workability of fresh concrete and used to determine the consistency of concrete. This test is popular due to the simplicity of apparatus used and simple procedure.



PROCEDURE FOR SLUMP TEST

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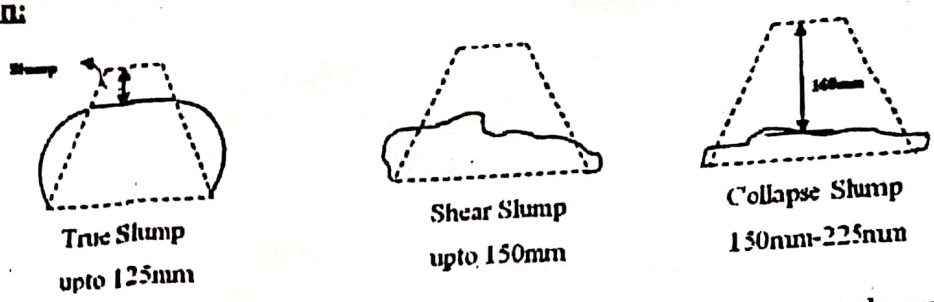
Question: Describe different type of slump & figure? (RAJUK – 2014, DSCC – 2019)

Solution:



True Slump
upto 125mm

Shear Slump
upto 150mm

Collapse Slump
150mm-225mm

There are three types of slump that may occur in slumps test, namely, true slump, shear slump and collapse slump.

(*i*) True slump: In a true slump concrete just subsides shortly and more or less maintain the mould shape. This type of slump is most desirable.

(*ii*) Shear slump: If one-half of the cone slides down in an inclined plane, it is called a shear slump. Shear slump indicates lack of cohesion in the concrete mix. Shear slump may occur in the case of a harsh mix.

(*iii*) Collapse slump: In a collapse slump the concrete collapses completely. A collapse slump will generally mean that the mix is too wet or that it is a high workability mix, for which slump test is not appropriate.

Question: কংক্রিটের কিউরিং এর বিভিন্ন পদ্ধতি বর্ননা করুন। Slump test কি? কংক্রিটের Shear slump এবং Collapse slump কি নির্দেশ করে বর্ননা করুন ?(LGED – 2019)

Solution:

Curing of concrete: Curing may be defined as the process of maintaining satisfactory moisture and temperature conditions for freshly placed concrete for some specified time for proper hardening of concrete. Curing in the early ages of concrete is more important. Curing for 14 days is very important. Better to continue it for 7 to 14 days more. If curing is not done properly, the strength of concrete reduces. Cracks develop due shrinkage. The durability of concrete structure reduces.

There are various methods of curing. The adoption of a particular method will depend upon the nature of work and the climatic conditions. The following methods of curing of concrete are generally adopted.

- Shading concrete work
- Covering concrete surfaces with gunny bags
- Sprinkling of water
- Ponding method
- Membrane curing
- Steam curing

Shading of concrete work: This is adopted mainly in case of large concrete surfaces such as road slabs. Shading may be achieved by using canvas stretched on frames. This method has a limited application only.

Covering concrete surfaces with gunny bags: This is a widely used method of curing, particularly for structural concrete. Expose dsurface of concrete is prevented by covering it with empty cement bags. It should be ensured that the surface of concrete is not allowed to dry even for a short time during the curing period.

Sprinkling of water: Sprinkling of water continuously on the concrete surface provides an efficient curing. It is mostly used for curing floor slabs. Small jobs sprinkling of water may be done by hand. Vertical and sloping surfaces can be kept continuously wet by sprinkling water on top surfaces.

Ponding method: This is the best method of curing. It is suitable for curing horizontal surfaces such as floors, roof slabs, roads and air field pavements. After 24 hoursof placing concrete ,t he area is divided into a number of rectangles. The water is filled between the ponds. The filling of water in these ponds is done twice or thrice a day, depending upon the atmospheric conditions. Though this method is very efficient

Membrane curing: Another method of curing is to cover the wetted concrete surface by a layer of water proof material, Bituminised water proof papers, wax emulsions, bitumen emulsions and plastic films are the common types of membrane used.

Steam curing: Steam curing and hot water curing is sometimes adopted. With these methods of curing, the strength development of concrete is very rapid. These methods used in pre cast concrete work.

Slump Test: The concrete slump test is used for the measurement of a property of fresh concrete. The test is an empirical test that measures the workability of fresh concrete and used to determine the consistency of concrete. The shape of the concrete slumps shows the information on the workability and quality of concrete.

Shear Slump: In a shear slump the top portion of the concrete shears off and slips sideways. Shear slump indicates that the concrete lacks cohesion. It may undergo segregation and bleeding and thus is undesirable for the durability of concrete.

Collapse Slump: In a collapse slump the concrete collapses completely. A collapse slump will generally mean that the mix is too wet or that it is a high workability mix, for which slump test is not appropriate.

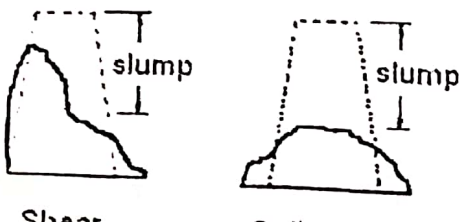
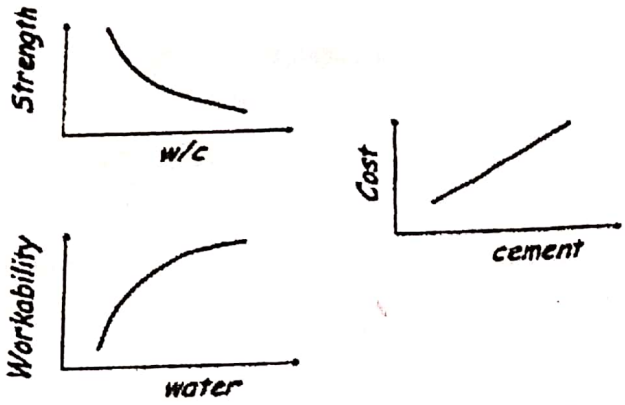


Figure: Shear Slump & Collapse slump pattern

Concrete mix design:

Concrete mix design may be defined as the art of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength & durability as economically as possible. The purpose of concrete mix design is to ensure the most optimum proportions of the constituent materials to fulfill the requirement of the structure being built.



Question: What is seasoning of timber? What are the methods of seasoning? (47 BMA)

Solution:

Seasoning of timber is the process by which moisture content in the timber is reduced to required level. By reducing moisture content, the strength, elasticity and durability properties are developed. A well-seasoned timber has 15% moisture content in it.There are two methods of Seasoning of timber which are explained below,

Natural seasoning: Natural seasoning is the process in which timber is seasoned by subjecting it to the natural elements such as air or water.

Artificial seasoning: Natural seasoning gives good results but takes more time. So, artificial seasoning of timber is developed nowadays. By artificial seasoning, timber is seasoned with in 4-5 days. Here also different methods of artificial seasoning are there and they are as follows.

Question: ভবন কেন Paint করা হয়? আদর্শ Paint এর গুনগুলি বর্ণনা করুন। (HED – 2017)

Solution:

The main function of paint is,

- To provide colorful and decorative appearance to the surface.
- To protect the surface from the weathering effects of the atmosphere.
- To make waterproof of the structure.

Characteristics of an ideal paint

- Paint should form hard and durable surface.
- It should give attractive appearance.
- It should be cheap and readily available.
- It can be applied easily to the surfaces.
- It should dry in reasonable time.
- It should not show hair cracks on drying.
- It should form film of uniform color, on drying.
- It should be stable for a longer period.
- It should not be affected by atmospheric agencies.
- It should have good spreading quality, so as to cover maximum area in minimum quantity.

Question: Plastic Paint এবং Distemper এর পার্থক্য কী? (HED – 2017)

Solution:

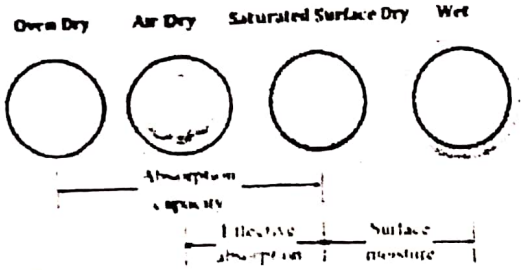
Plastic Paints: The water-based wall paint or plastic emulsion paint is based on acrylic and offer a smooth matte finish to your walls. In addition to being washable and easy to maintain, these paints are exceptionally durable. The plastic emulsion paints are humidity-resistant as well. Being better in quality, emulsions are a little costlier as compared to distemper paints.

Distemper: is also known as cement paint. This is called so because such kind of paint can be applied directly on cement walls without any other coating on them. They are a cheaper option and they stay good for more than 5 years. Distempers are used for both interior and exterior walls. The usually need two coatings.

Coarse Aggregate Specific Gravity and water absorption:

The coarse aggregate specific gravity test measures coarse aggregate weight under three different sample conditions:

Oven-dry (no water in sample).
Saturated surface-dry (SSD, water fills the aggregate pores).
Submerged in water (underwater).



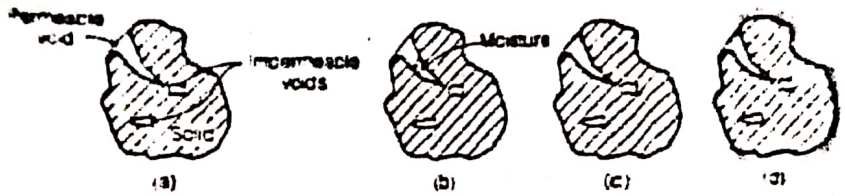


FIGURE 5.9 Voids and moisture absorption of aggregates: (a) bone dry, (b) air dry, (c) saturated surface-dry (SSD), and (d) moist.

Bulk specific gravity: It is defined as the ratio of weight of aggregate to the weight of the water occupying a volume to that of the solid excluding impermeable pores.

$$G_{sb} = \frac{\text{Mass of aggreagte, oven dry}}{\text{Vol of agg. including surface pores}}$$

Apparent specific gravity: It is defined as the ratio of the aggregate weight dried in an oven at 110oC for 24 hours to the weight of water occupying a volume equal to that solid including impermeable pores.

$$G_{sb} = \frac{\text{Mass of aggreagte, oven dry}}{\text{Vol of agg. not including surface pores}}$$

Water absorption ratio: Water absorption refers to the property of absorbing water when materials are exposed to water. It is expressed by the water absorption ratio. The water absorption is the percentage of the increased weight of the aggregate after water absorption.

$$\text{Bulk Dry Sp. Gr.} = \frac{\text{Dry weight}}{(\text{Total praticle volume})\,\gamma_w} = \frac{W_s}{(V_s + V_i + V_p)\,\gamma_w}$$

$$\text{Bulk SSD Sp. Gr.} = \frac{\text{SSD weight}}{(\text{Total praticle volume})\,\gamma_w} = \frac{W_s + W_p}{(V_s + V_i + V_p)\,\gamma_w}$$

$$\text{Apparent Sp. Gr.} = \frac{\text{Dry weight}}{(\text{Volume not accessible to water})\,\gamma_w} = \frac{W_s}{(V_s + V_i)\,\gamma_w}$$

W_s = weight of soilds
V_s = volume of soilds
V_i = volume of water impermeable voids
V_p = volume of water permeable voids
W_p = weight of water permeable voids when the aggregate is in the SSD condition
γ_w = unit weight of water

$$\text{Bulk Dry Sp. Gr.} = \frac{A}{B - C}$$

$$\text{Bulk SSD Sp. Gr.} = \frac{B}{B - C}$$

$$\text{Apparent Sp. Gr.} = \frac{A}{A - C}$$

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

A = dry weight
B = SSD weight
C = submerged weight

Question: For a coarse aggregate sample, air dry weight is 1790 gm, weight when it is immersed in water is 1180 gm and SSD weight is 1850 gm. Calculate the bulk specific gravity, apparent specific gravity and % absorption. (BUET M.Sc. – 2014, ERL – 2017, MPL – 2017, JOCL – 2018)

Solution:

A = Mass of oven dry sample = 1790 gm
B = Mass of SSD sample in air = 1850 gm
C = Mass of SSD sample in water = 1180 gm

$$\text{Bulk specific gravity, } G_{sb} = \frac{A}{B-C} = \frac{1790}{1850-1180} = 2.67$$

$$\text{Apparent specific gravity, } G_{sa} = \frac{A}{A-C} = \frac{1790}{1790-1180} = 2.93$$

$$\% \text{ Absorption} = \frac{B-A}{A} = \frac{1850-1790}{1790} = 3.35\%$$

Question: A dry mass of a sample of aggregate is 1982 g, the mass in saturated surface dry condition is 2006.7 g. The volume of water exerted by the sample is 734.4 cm^3. Find bulk specific gravity, apparent specific gravity and percentage absorption of the sample. (PGCL – 2014)

Solution:

M_D = Dry Mass of the aggregate = 1982 g
M_{SSD} = Mass of aggregate in SSD condition = 2006.7 g
M_W = Mass of absorbed water = 2006.7 – 1982 g = 24.7 g
W = water density = 1 g/cc
Volume of absorbed water = 24.7 cm^3
V_N = Net volume of aggregate excluding water permeable voids (excluding the volume of the absorbed matter) = 734.4 cm^3

V_B = Total volume of aggregate including water permeable voids (including the volume of the absorbed matter) = 734.4 + 24.7 = 759.1 cm^3

$$\text{Apparent Specific Gravity, } G_{sb} = \frac{M_D}{V_N W} = \frac{1982}{734.4 \times 1} = 2.69$$

$$\text{Bulk Specific Gravity, } G_{sa} = \frac{M_D}{V_B W} = \frac{1982}{759.1 \times 1} = 2.61$$

$$\% \text{ Absorption} = \frac{M_w}{M_D} = \frac{24.78}{1982} \times 100 = 1.25\%$$

Question: The air dry wright of a sample aggregate is 120 kg and SSD weight is 152 kg. The weight when it immersed in water is 92 kg. Determine the bulk specific gravity and % absorption. (BCIC – 2017)

Solution:

A = mass of oven – dry sample in air (g) = 120 kg
B = mass of SSD sample in air (g) = 152 kg
C = mass of SSD sample in water (g) = 92 kg
Absorbed water = 152 – 120 = 32 kg

$$\text{Bulk Specific Gravity, } G_{sb} = \frac{\text{Oven dry weight}}{\text{Water include pore}} = \frac{A}{B - C} = \frac{120}{152 - 92} = 2$$

$$\% \text{ Absorption} = \frac{\text{Absorbed water}}{\text{Air dry weight}} \times 100 = \frac{B - A}{A} = \frac{32}{120} \times 100 = 26.66\%$$

Question: Dry weight of a sample is 1206 g, SSD weight is 1226.4 g. The volume of water exerted by the sample is 440.6 cm^3. Find bulk specific gravity, apparent specific gravity and Absorption capacity of the sample. (BPDB – 2016, NPCBL – 2017)

Solution:

M_D = Dry Mass of the aggregate = 1206 g
M_{SSD} = Mass of aggregate in SSD condition = 1226.4 g
M_W = Mass of absorbed water = 1226.4 – 1206 g = 20.4 g
W = water density = 1 g/cc
Volume of absorbed water = 20.4 cm^3
V_N = Net volume of aggregate excluding water permeable voids (excluding the volume of the absorbed matter) = 440.6 cm^3

V_B = Total volume of aggregate including water permeable voids (including the volume of the absorbed matter) = 440.6 + 20.4 = 461 cm^3

$$\text{Apparent Specific Gravity, } G_{sb} = \frac{M_D}{V_N W} = \frac{1206}{440.6 \times 1} = 2.73$$

$$\text{Bulk Specific Gravity, } G_{sa} = \frac{M_D}{V_B W} = \frac{1206}{461 \times 1} = 2.61$$

$$\% \text{ Absorption} = \frac{M_w}{M_D} = \frac{20.4}{1206} \times 100 = 1.69\%$$

Question: Find the Fineness Modulus for the following sieves. (BUET M.Sc. – 2011)

Sieve No.	Soil retained (gm.)
3"	11
1.5"	56
3/4"	71
3/8"	98
#4	100

Solution:

Sieve No.	Mass of soil (gm.)	% Retained	Cum. % retained
3"	11	3.27	3.27
1.5"	56	16.67	19.94
3/4"	71	21.13	41.07
3/8"	98	29.17	70.24
#4	100	29.76	100
#8	-	-	100
#16	-	-	100
#30	-	-	100
#50	-	-	100
#100	-	-	100
Sum =	336		734.52

$$FM = \frac{734.52}{100}$$

$$= 7.34$$

Question: Find the fineness modulus for 25% retain on each sieve #30, #50, #100 & #200. (BUET M.Sc. – 2014, BPDB- 2016, BGFCL – 2017, SGCL – 2017, ERL- 2013)

Solution:

Sieve size	% Retain	Cumulative % retain
#30	25	25
#50	25	50
#100	25	75
#200	25	-
Total		150

$$F.M = \frac{25 + 50 + 75}{100} = 1.5$$

Question: Sieve analysis was performed on a soil in the lab, determine fineness modulus. (BWDB – 2020)

Sieve size	3/8	4	8	16	30	50	100	150	200	Pan
Soil retained (gm)	0	20	10	30	40	30	40	20	10	0

Solution:

Sieve Size	Soil retained (gm)	% Retained	% Cumulative Retained
3/8	0	-	
#4	20	10	10
#8	10	5	15
#16	30	15	30
#30	40	20	50
#50	30	15	65
#100	40	20	85
#150	20	10	-
#200	10	5	-
Pan	0	0	-
Total	200	100	

$$F.M = \frac{10 + 15 + 30 + 50 + 65 + 85}{100} = 2.55$$

Question: Find the value of Fineness Modulus from the following sieves. (DPDC – 2014, WASA– 2014, BCIC – 2017)

Sieve size	#4	#8	#16	#30	#40	#50	#100	#200	Pan
% retained	0	1	3	2	12	4	5	3	1

Solution:

Sieve Size	% Retained	% Cumulative Retained
#4	0	-
#8	1	1
#16	3	4
#30	2	8
#40	12	20
#50	4	24
#100	5	29
#200	3	32
Pan	1	33

$$F.M = \frac{1 + 4 + 8 + 24 + 29}{100} = 0.66$$

Question: Determine the fineness modulus and percent of silt and clay of the sample (DESCO – 2019, BEPZA- 2016, BPDB – 2018, SGFL – 2020, PGCB – 2020, DPDC – 2020)

Sieve size	#4	#8	#16	#30	#40	#50	#100	#200	Pan
% retained	0	1	4	12	13	30	34	4	2

Solution:

Sieve size	Percent retained	Cumulative % retained	% finer
No. 4	0	0	100
No. 8	1	1	99
No. 16	4	5	95
No. 30	12	17	83
No. 40	13	30	70
No. 50	30	60	40
No. 100	34	94	6
No. 200	4	98	2
Pan	2	100	0

$$F.M = \frac{0+1+5+17+60+94}{100} = 1.77$$

% of silt and clay = 2 - 0 = 2%

Question: Find the fineness modulus of fine aggregate. And also determine the percentage of course aggregate and percent of silt & clay content. (WARPO – 2017, JOCL – 2018)

Solution:

Sieve size	Amount retained	% retained	Cumulative % retained	% finer
18.75	175	35	35	65
9.375	125	25	60	40
4.75	100	20	80	20
2.36	50	10	90	10
1.18	20	4	94	6
0.6	10	2	96	4
0.3	10	2	98	2
0.15	4	0.8	98.8	1.2
0.075	4	0.8	99.6	0.4
Pan	2	0.4	100	0
Total	500			

$$\text{Fineness modulus} = \frac{35+60+80+90+94+96+98+98.8}{100} = 6.51$$

Coarse aggregate includes the particles that retain on 4.75 mm sieve.

Percent of course aggregate = 100 - 20 = 80%

% of silt and clay content = 0.4 - 0 = 0.4%

Question: Find the fineness modulus and percentage of silt and clay.
(BPDB– 2015, MPL – 2017, GTCL – 2018)

Sieve size	#4	#8	#16	#30	#50	#100	#200	Pan
% retained	0	1	4	12	43	2	2	4

Solution:

Sieve Size	% Retained	Cumulative % Retained	% of finer
#4	0	-	100
#8	1	1	99
#16	4	5	95
#30	12	17	83
#50	43	60	40
#100	2	62	38
#200	2	64	36
Pan	4	68	32

$$FM = \frac{1 + 5 + 17 + 60 + 62}{100} = 1.45$$

% of silt and clay $= 36 - 32 = 4\%$

Question: Find the fineness modulus (FM) of the following aggregate sample.
(BUET M.Sc. –2017, TGTDCL – 2018)

Sieve size (mm)	Weight retained (gm.)
4.75	10
2.36	12
1.18	18
0.6	20
0.3	102
0.15	205
0.075	30

Solution:

Sieve size (mm)	Weight retained (gm)	% of weight retained	Cumulative % retained	FM
4.75	10	2.51	2.51	$FM = \frac{166.38}{100}$
2.36	12	3.02	5.53	
1.18	18	4.53	10.06	
0.6	20	5.03	15.09	
0.3	102	25.69	40.78	
0.15	205	51.63	92.41	$= 1.66$
0.075	30	7.55	-	
Total	397		166.38	

Question: 25% of a total sand sample is retained on each of 0.60 mm, 0.425 mm, 0.30 mm and 0.15 mm sieves. Find the FM of sand sample. (BGFCL– 2017, ERL – 2017, WASA – 2017)

Solution:

Sieve Size	% Retained	Cumulative % retained
4.75	0	0
2.36	0	0
1.18	0	0
0.6	25	25
0.425	25	50
0.3	25	75
0.15	25	100

$$\text{F.M of sand} = \frac{25 + 75 + 100}{100} = 2$$

Question: Sieve analysis were performed for a coarse sand and it has been found 20% sample retained on each #30, #40, #50, #100 and #200 sieve. Find the F.M of sand. (WASA – 2017, CPGCBL – 2018)

Solution:

Sieve No.	Percent retained	Cumulative % retained
#30	20	20
#40	20	40
#50	20	60
#100	20	80
#200	20	100

$$\text{F.M of sand} = \frac{20 + 60 + 80}{100} = 1.6$$

Question: Combined fineness modulus of two types of soil is 2.75 and whose total mass 100gm. First fineness modulus is 2.65 with mass 60gm. Find the F.M and mass of second sample of soil.

Solution:

$F_{com} = 2.75, F_1 = 2.65, F_2 = ?, M_1 = 60\text{ gm}, M_2 = ?$

Total mass of soil sample, $M = M_1 + M_2$

$100 = 60 + M_2$

$M_2 = 40\text{gm}$

$$\text{Now, } F_{com} = \frac{F_1 M_1 + F_2 M_2}{M_1 + M_2}$$

$$2.75 = \frac{2.65 \text{ x } 60 + F_2 \text{ x } 40}{60 + 40}$$

$F_2 = 2.9$

Question: দুই প্রকার বালুর নমুনা ওজন যথাক্রমে (i) 400 gm & 2.5 (ii) 600 gm & 1.8 এই দুই প্রকার বালু একত্রে মিশ্রিত করলে তাদের FM কত হবে? (HED – 2017)

Solution:

Given, $F_1 = 2.5, F_2 = 1.8, M_1 = 400\ \text{gm}, M_2 = 600\ \text{gm}$

Now, $F_{com} = \dfrac{F_1M_1 + F_2M_2}{M_1 + M_2} = \dfrac{2.5 \times 400 + 1.8 \times 600}{400 + 600} = 2.08$

$F_{com} = 2.08$

Question: Two sample of sand of FM 2.24 and 2.54 are mixed in the proportion of 1:2. Find out the combined FM. (EED – 2019)

Solution:

Given, $F_1 = 2.24, F_2 = 2.54, M_1 = 1, M_2 = 2$

Now, $F_{com} = \dfrac{F_1M_1 + F_2M_2}{M_1 + M_2} = \dfrac{2.24 \times 1 + 2.54 \times 2}{1 + 2} = 2.44$

$F_{com} = 2.44$

Question: Determine the number of bags of cement required to cast 40' long span beam if the beam section is 12" x 15" and mix ratio is 1:2:4.
(BUET M. Sc. – 2014, BGFCL – 2017, ERL – 2017, MPL – 2017)

Solution:

Wet volume $= 40 \times \dfrac{12}{12} \times \dfrac{15}{12} = 50\ \text{cft}$

Dry volume $= 1.54 \times 50 = 77\ \text{cft}$

Quantity of cement required $= \dfrac{1}{(1 + 2 + 4)} \times 77 = 11\ \text{cft}$

No. of bags required $= \dfrac{11}{1.25} = 8.8 = 9\ \text{bag}$

Question: Determine the number of bricks required a 500m^3 masonry wall.
(BIFPCL – 2015, BCIC – 2016)

Solution:

One brick volume with mortar $= 10" \times 5" \times 3" = 150\ \text{in}^3 = \dfrac{150}{12^3 \times 3.28^3} = 2.46 \times 10^{-3}\ \text{m}^3$

Number of bricks required $= \dfrac{500}{2.46 \times 10^{-3}} = 203257$ nos.

Question: Determine the required amount of cement, sand and brick in 10ft span of a 10" x 12" size of beam in ratio 1:1.5:3 (EGCB – 2015)

Solution:

Wet volume of beam $= \frac{10}{12} \times \frac{12}{12} \times 10 = 8.3$ cft

Dry volume $= 8.3 \times 1.5 = 12.78$ cft

Cement $= \frac{1}{5.5} \times 12.78 = 2.32$ cft

Sand $= \frac{1.5}{5.5} \times 12.5 = 3.48$ cft

Aggregate $= \frac{3}{5.5} \times 12.5 = 6.97$ cft

Question: Determine the volume of cement, sand and stone chips of 10 cft of cement concrete mix with ratio is 1:1.5:3. (BPDB – 2018, BCPCL-2016)

Solution:

Dry volume $= 10 \times 1.54 = 15.4$ cft

Given, Sum of the mix ratio $= 1: 1.5: 3 = 1 + 1.5 + 3 = 5.5$

Cement required $= \frac{1}{5.5} \times 15.4 = 2.80$ ft^3 $= 2.80/1.25 = 2.24$ bags

Sand required $= \frac{1.5}{5.5} \times 15.4 = 4.20$ cft

Stone chips required $= \frac{3}{5.5} \times 15.4 = 8.40$ cft

Question: Find the quantity of stone chips and cement for the casting of a RCC slab of size 12 ft x 8 ft and thickness 5 inch, the ration of casting is 1:1.5:3 (EED – 2019)

Solution:

Wet volume $= 12 \times 8 \times 5/12 = 40$ cft

Dry volume $= 1.54 \times 40 = 61.6$ cft

Sum of the mix ratio $= 1: 1.5: 3 = 1 + 1.5 + 3 = 5.5$

Cement required $= \frac{1}{5.5} \times 61.6 = 11.2$ cft

Stone chips required $= \frac{1.5}{5.5} \times 61.6 = 16.8$ cft

Question: Eight cube of 6" x 6" is made of concrete with ratio 1:3:6. How many bags of cement is required. (BWDB – 2018)

Solution:

Wet volume $= 8 \times \frac{6}{12} \times \frac{6}{12} \times \frac{6}{12} = 1$ cft

Dry volume $= 1.54 \times 1 = 1.54$ cft

Amount of cement required $= \frac{1}{1+3+6} \times 1.54 = 0.154$ cft $= 0.123$ bags

Question: একটি কংক্রিট ব্লকের সাইজ যদি 5 ft x 2.5 ft x 5 inch হয় এবং কংক্রিট ডেনসিটি 2130 kg/m³ হলে 1:2:4 অনুপাতে কংক্রিট তৈরি করতে কত কেজি সিমেন্ট প্রয়োজন হবে ? (HED – 2020)

Solution:

Wet volume $= 5 \times 2.5 \times 5/12 = 5.21$ cft

Dry volume $= 1.54 \times 5.21 = 8.0234$ cft

Weight of concrete block $= \frac{8.0234 \times 2130}{3.28 \times 3.28 \times 3.28} = 484.30$ kg

Amount of cement $= \frac{1}{1+2+4} \times 484.3 = 69.18$ kg

Question: Evaluate the amount of cement, sand and stone aggregate needed to cast an RCC beam of 20 ft long and 12" x 24" size, Consider mixing ration is 1:1.5:3 (EED – 2015)

Solution:

Wet volume of beam $= \frac{12}{12} \times \frac{24}{12} \times 20 = 40$ cft

Dry volume $= 40 \times 1.54 = 61.6$ cft

Cement required $= \frac{1}{5.5} \times 61.5 = 11.2$ cft

Sand required $= \frac{1.5}{5.5} \times 61.5 = 16.8$ cft

Aggregate required $= \frac{3}{5.5} \times 61.5 = 33.6$ cft

Question: Nine column having $\frac{\pi}{2}$ ft diameter and π m height need to casted in a mix ratio of 1:2:4. Find the amount of ingredients. (PGCB – 2018)

Solution:

Wet volume $= 9 \times \pi r^2 h = 9 \times \pi \times \left(\frac{\pi}{2 \times 2}\right)^2 \times \pi \times 3.28 = 179.72$ cft

Dry volume $= 1.54 \times 179.72 = 276.76$ cft

Amount of cement $= \frac{1}{1+2+4} \times 276.76 = 39.53$ cft

Amount of fine aggregate $= \frac{2}{1+2+4} \times 276.76 = 79.07$ cft

Amount of course aggregate $= \frac{4}{1+2+4} \times 276.76 = 158.14$ cft

Question: Calculate the materials needed for 100 cft fresh concrete with a mix ratio = 1: 2.5: 4.5 (SGFL – 2021)

Solution:

Dry volume = 100 x 1.54 = 154 cft

Given, Sum of the mix ratio = 1: 2.5: 4.5 = 1 + 2.5 + 4.5 = 8

Cement required $= \frac{1}{8} \times 154 = 19.25$ ft^3 = 19.25/1.25 = 15.4 bags

Sand required $= \frac{2.5}{8} \times 154 = 48.125$ cft

Stone chips required $= \frac{4.5}{8} \times 154 = 86.625$ cft

Question: A partition wall is 5" thickness, 25' length and 10' height. Using standard brick size determine the amount of bricks, cement and sand if the mortar ratio is 1:3 (BUET M. Sc – 2019)

Solution:

Volume of brick wall $= 25 \times 10 \times \frac{5}{12} = 104.16$ cft

Dimension of one brick without mortar = 9.5" x 4.5" x 2.75"

Dimension of one brick without mortar = 10" x 5" x 3"

No. of bricks required $= \frac{104.16 \times 12 \times 12 \times 12}{10 \times 5 \times 3} = 1200$ bricks

Volume of 1200 bricks without mortar $= \frac{1200 \times 9.5 \times 4.5 \times 2.75}{12 \times 12 \times 12} = 81.64$ cft

Volume of mortar = 104.16 – 81.64 = 22.52 cft

Dry volume of mortar = 22.52 x 1.33 = 29.95 cft

Amount of cement $= \frac{1}{4} \times 29.95 = 7.48$ cft

Amount of sand $= \frac{3}{4} \times 29.95 = 22.46$ cft

Question: Calculate the amount of cement, coarse aggregate, fine aggregate and reinforcement (consider 0.75%) of the footing size 10' x 10' and thickness 18" (HBRI – 2019)

Solution:

Assume, mix ratio = 1: 2: 4

Wet volume = $1.50 \times 10 \times 10 = 150\ ft^3$

Dry volume = $1.54 \times 150 = 231\ ft^3$

Amount of cement = $\frac{1}{7} \times 231 = 33$ cft

Amount of fine aggregate = $\frac{2}{7} \times 231 = 66$ cft

Amount of coarse aggregate = $\frac{4}{7} \times 231 = 132$ cft

Volume of concrete = $10 \times 10 \times 1.50 = 150$ cft = $4.247\ m^3$

Amount of reinforcement = $4.247 \times 0.0075 \times 7850 = 250.04$ kg