

FLAKINESS INDEX

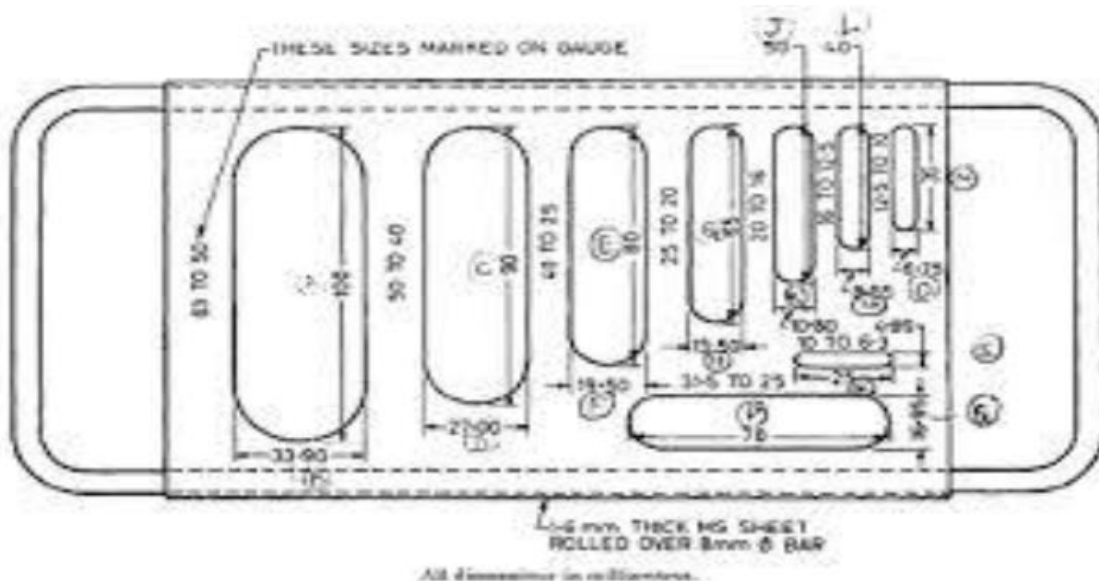
It is the percentage by weight of particles in it whose least dimension is less than $3/5^{\text{th}}$ of their mean dimension. The Flakiness index is not applicable to sizes smaller than 6.3 mm.

The test is conducted by using a metal thickness gauge. A sufficient quantity of aggregate is taken such that a minimum number of 200 pieces of any fraction can be tested. Each fraction is gauged in turn for thickness on the metal gauge. The total amount passing in the gauge is weighed. The flakiness index is the total weight of the material passing the various thickness gauges expressed as a percentage of the total weight of the sample taken.

ELONGATION INDEX

It is the percentage by weight of particles, whose greatest dimension is greater than 1.8 times their mean dimension. The elongation index is not applicable to sizes smaller than 6.3 mm.

The test is conducted by using a metal length gauge. A sufficient quantity of aggregate is taken such that a minimum number of 200 pieces of any fraction can be tested. Each fraction is gauged individually for length on the metal gauge. The total amount retained by the gauge is weighed. The elongation index is the total weight of the material retained on the various length gauges expressed as a percentage of the total weight of the sample gauged





ABRASION RESISTANCE

Three tests are in common use to test aggregate for its abrasion resistance. They are Dorry Abrasion test, Deval Attrition test, Los Angeles test. Aggregates which are used for road constructions and pavement construction are tested with respect to its resistance to wear. In Deval Attrition test, particles are subjected to wear in an iron cylinder. The proportion of material crushed finer than 1.7mm size is expressed as a percentage of the original material taken. this percentage is the attrition value of aggregate.

In Dorry Abrasion test a cylindrical specimen is subjected to abrasion against rotating metal disc sprinkled with quartz sand. The loss in weight of the cylinder after 1000 revolutions of the table is determined.

Los Angeles test involves taking specified quantity of material along with specified number of abrasive charge in a standard cylinder and revolving it for specified revolutions. The particles smaller than 1.7mm sizes are separated out. The loss in weight gives the abrasion value of the aggregate.



Los Angeles abrasion test

MORTAR

Mortar is a paste prepared by adding required quantity of water to a mixture of binding material and fine aggregate. The binding material like cement or lime is referred as matrix and the fine aggregate like sand is referred as the adulterant. The matrix binds the particles of the adulterant and the durability, quality and strength of mortar depend on the quantity and quality of matrix.

CLASSIFICATION OF MORTAR

Mortars are classified based on the following:

- (1) Bulk density
- (2) Kind of binding material
- (3) Nature of application
- (4) Special mortars

Based on bulk density, mortar is classified into heavy mortars and light weight mortars. Mortars having a bulk density of 15 KN/m^3 or more are heavy mortars and that having a bulk density less than 15 KN/m^3 are light weight mortars. Based on the kind of binding material, mortar is classified into lime mortar, surkhi mortar, cement mortar, gauged mortar, gypsum mortar. In lime mortar, lime is used as the binding material. The lime may be fat lime or hydraulic lime. The fat lime shrinks to a great extent and hence it requires about 2 to 3 times its volume of sand. The proportion of lime to sand by volume is about 1:2 for hydraulic lime. It is used for lightly loaded above ground parts of building. Surkhi mortar is prepared by using surkhi instead of sand or by replacing half of sand in case of fat lime mortar. It is used for masonry work of all kinds in foundation and superstructure. In cement mortar, cement is used as the binding material. The proportion of cement to sand by volume varies from 1:2 to 1:6. It is used in underground constructions. Gauged mortar is also known as composite mortar or lime cement mortar. It is formed by the combination of cement and clay. It is used for bedding and for thick brick walls. Gypsum mortars are prepared from gypsum binding materials such as building gypsum and anhydrite binding materials.

Based on nature of application, mortar is classified into brick laying mortar and finishing mortars. Brick laying mortars are used for brick work and walls. Finishing mortars include common plastering work and mortars for developing architectural or ornamental effects.

Special mortars include fire resistant mortar, light weight mortar, packing mortar, sound absorbing mortar, X-ray shielding mortar etc. Fire resistant mortar is prepared by adding aluminous cement to the finely crushed powder of fire bricks. It is used for lining furnaces, fire places, ovens etc.

Light weight mortar is prepared by adding, materials like saw dust, wood powder to the lime mortar or cement mortar. It is used in sound proof constructions. To pack oil wells, special mortars are formed, known as packing mortar. To reduce the noise level, the sound absorbing plaster is formed with the help of sound absorbing mortar. X-ray shielding mortar is used for providing plastering coat to walls and ceiling of x-ray cabinets.

PROPERTIES OF GOOD MORTAR

- It should be capable of developing good adhesion with the building units.
- It should be capable of developing the designed stresses.
- It should be capable of resisting penetration of rain water.
- It should be cheap.
- It should be durable.
- It should be easily workable
- It should not affect the durability of materials with which it comes into contact.
- It should set quickly so that speed in construction is achieved
- The joints formed by mortar should not develop cracks.

USES OF MORTAR

- a) To bind the building units into a solid mass.
- b) To carry out pointing and plastering work on exposed surfaces of masonry.
- c) To form an even and soft bedding layer for building units.
- d) To form joints of pipes.
- e) To improve the general appearance of structure.
- f) To prepare moulds for coping, corbels, cornice etc.
- g) To serve as a matrix or cavity to hold coarse aggregates etc.
- h) To hide the open joints of brickwork and stone work.
- i) To fill up the cracks detected in the structure during maintenance process.
- j) To distribute uniformly the super incumbent weight from upper layer to lower layer of bricks.

Selection of mortar

No	Nature of work	Type of mortar
1	Construction work in waterlogged areas and exposed positions	Cement or lime mortar prop. 1:3
2	Damp proof courses and cement concrete roads	Cement mortar prop. 1:2
3	General R.C.C work such as lintels, pillars, slabs, stairs etc	Cement mortar prop. 1:3
4	Internal walls and surfaces.	Lime mortar prop 1:3
5	Mortar for laying fire bricks	Fire resisting mortar
6	Partition walls and parapet walls	Cement mortar prop. 1:3
7	Plaster work	Cement mortar prop. 1:3
8	Pointing work	Cement mortar prop. 1:1 to 1:2
9	Reinforced brickwork	Cement mortar prop. 1:3
10	Stone masonry with best varieties of stone	Lime mortar prop 1:2
11	Stone masonry with ordinary stones	Lime mortar prop 1:2
12	Thin joints in brickwork	Lime mortar prop 1:3

MANUFACTURE OF STEEL

The steel is suitable for all constructional purposes and hence it has practically replaced cast iron and wrought iron in the present day practice of building construction. It is equally good in compression as well as in tension.

The steel is manufactured by the following processes.

- Bessemer process
- Cementation process
- Crucible steel process
- Duplex process
- Electric process
- L.D. process
- Open hearth process

1) Bessemer process:

This process can be acidic or basic based on the nature of lining material of converter. Acidic process is adopted when iron ores contain very small amount of sulphur and phosphorous. Basic process is adopted for pig iron containing impurities of any type. The converter is charged with molten pig iron and is brought in an upright position. A blast of hot air is forced through the tuyeres. Air oxidizes impurities of pig iron and a yellow flame is seen at the nose of the converter. When the blast is shut off, the required amount of ferro manganese is added to get steel of desired quality.

2) Cementation process

It consists of converting pig iron into pure wrought iron and then preparing steel by adjusting carbon content. The cementation furnace is heated and the bars of pure wrought iron are subjected to intense heat. The wrought iron combines with carbon and steel of desired quality is obtained.

3) Crucible steel process:

The fragments of blister steel are taken and they are mixed with charcoal. They are placed in fire clay crucibles and heated. The molten iron is poured into suitable moulds. The steel produced is known as cast steel. It is used for making surgical instruments.

4) Duplex process:

It is a combination of two processes. (1) acid Bessemer process (2) basic open hearth process.

The molten pig iron is treated in acid lined Bessemer converter. It is then treated in basic lined open hearth. The process is economical and it results in saving of time.

5) Electric process:

An electric furnace is used in this process. It is made from steel plates. Electricity is used for heating and melting the metal. The furnace is provided with electrodes. When electric current is switched on, the electric arcs are formed between the electrodes and the surface of metal and with the intense heat of arcs, the metal is heated and melted.

6) L.D. process:

This is a modification of Bessemer process. It is known as Lintz- Donawitz process. In this process pure oxygen is used instead of air. A jet of pure oxygen is blown at extra ordinary speed on molten metal. The high temperature developed in the converter burns away impurities of metal and low carbon steel is prepared.

7) Open hearth process:

The process is carried out in open hearth furnace. The hearth is filled with molten pig iron from cupola furnace. A mixture of pre-heated air and coal gas is allowed to pass over the hearth. This mixture catches fire and produces intense heat. The molten metal is poured into mould for forming ingots. These are treated to form steel of commercial pattern.

USES OF STEEL

Based on carbon content, steel is designated as mild steel, medium carbon steel or high carbon steel. The carbon content of mild steel is about 0.1 to 0.25%. The carbon content of low carbon steel is less than 0.1%. The carbon content of medium carbon steel is about 0.25 to 0.6%. The high carbon steels is also known as hard steel and its carbon content varies from 0.6 to 1.1%.

Name of Steel	Carbon content	Uses
Mild Steel	Upto 0.1%	Motor body, sheet metal, tin, plate etc
Medium carbon steel	Upto 0.25%	Boiler plates, structural steel etc
	Uto 0.45%	Rails, Tyres etc
	Upto 0.6%	Hammers, Large stamping and pressing dies etc
High carbon steel	Upto 0.75%	Sledge hammers, springs, stamping dies
Hard steel	Upto 0.9%	Minor's drills, smith's tool, stone mason's tools etc
	Upto 1%	Chissels, hammers, wood working tools
	Upto 1.1%	Axes, cutlery, drills, knives, picks, punches

Operations involved:

- i) Drawing
- ii) Forging
- iii) Pressing
- iv) Rolling

i) Drawing:

This operation is carried out to reduce the cross section and to increase the length proportionately. The metal is drawn through dies. The drawing is continued till wire of required diameter is obtained.

ii) Forging:

This operation is carried out by repeated blows under a power hammer or a press. The process increases the density and improves grain sizes of metals. It is used for the manufacture of bolt, cramps etc.

iii) Pressing:

It is carried out in equipment known as press. It does not involve any shock. The metal is pressed between die and punch and article of desired shape is obtained.

iv) Rolling:

It is carried out in specially prepared rolling mills. The ingots are passed in succession through different rollers until articles of desired shape are obtained. It is used for the manufacture of angles, channels, joists etc.

HEAT TREATMENT PROCESS OF STEEL

- i) Annealing
- ii) Case hardening
- iii) Cementing
- iv) Cyaniding
- v) Hardening
- vi) Nitriding
- vii) Normalising
- viii) Tempering

i) Annealing:

The object of the process is to make the steel soft so that it can be easily worked upon with a machine. The steel to be annealed is heated to the desired temperature and allowed to cool slowly in the furnace. The annealing reduces the tensile strength, but it increases ductility and brings back the steel to the best physical state to resist fracture.

ii) Case Hardening:

In this treatment, the outside surface becomes hard, the core of the materials retains original properties. The case hardening is important for components like gears, bearing surfaces etc.

iii) Cementing:

In this process, the skin of the steel is saturated with carbon. It consists of heating of steel in a carbon rich medium between 880 and 950°C.

iv) Cyaniding:

The process is used to produce hard cases on the surfaces of low or medium carbon steel. It consists of adding carbon and nitrogen to the surface layer of steel so as to increase its hardness, wear resistance and fatigue limit.

v) Hardening:

The process is the reverse of annealing process. The steel is made hard by this process whereas it is made soft by the annealing process. In hardening process, cooling is carried out at a controlled rate. Such a control rate of cooling is known as quenching.

vi) Nitriding:

The process of saturating the surface layer of steel with nitrogen by heating is known as nitriding. Heating is carried out between 480 to 650 degree Celsius in an atmosphere of Ammonia. Treatment makes the steel hard and increases its resistance to corrosion.

vii) Normalising:

The object of this process is to restore steel structure to normal condition, when it is disturbed due to mechanical work. The process is done by heating steel 40 to 50 degree Celsius above its upper critical temperature and maintained at that temperature and allowed to cool.

viii) Tempering:

The process is applied to steel which are treated with hardening process. The hardened steel is in a stressed condition and very brittle and cannot be used for practical purposes. Hence steels after hardening must be tempered to obtain good mechanical properties and to relieve internal stresses.

Properties of mild steel

- It can be magnetized permanently
- It can be readily forged and welded.
- It cannot be easily hardened and tempered.
- It has fibrous structure
- It is malleable and ductile.
- It is not easily attacked by salt water.
- It is tougher and more elastic than wrought iron
- It is used for all type of structural work.
- It rusts easily and rapidly
- Its melting point is about 1400 degree Celsius.

Properties of hard steel

- It can be easily hardened and tempered.
- It can be magnetized permanently
- It cannot be readily forged and welded.
- It has granular structure.
- It is not easily attacked by salt water.
- It is tougher and more elastic than mild steel.
- It is used for finest cutlery, edge tools
- It rusts easily and rapidly
- Its melting point is about 1300 degree Celsius.
- Its specific gravity is 7.90.

ANTICORROSIVE MEASURES FOR STEEL

- a) Coal tarring
- b) Electroplating
- c) Embedding in cement concrete
- d) Enamelling
- e) Galvanizing
- f) Metal spraying
- g) Painting
- h) Parkersing
- i) Sherardising
- j) Tin plating and terne plating

a) Coal tarring:

In this method, iron is dipped in hot coal tar so that a film of coal tar sticks to the surface. The film protects the iron surface from atmospheric actions leading to the corrosion.

b) Electroplating:

A thin layer of chromium, cadmium, copper or nickel is laid on the surface of ferrous metal with the help of electric current and by employing the principle of electrolysis.

c) Embedding in cement concrete:

If steel is embedded in cement concrete, it is not affected by corrosion. The cement concrete

should be properly laid and cured so that it does not contain voids.

d) Enamelling:

The surface of iron is provided with a smooth surface by melting a suitable flux on it. It is used for ornamental iron works.

e) Galvanizing:

The surface of the metal is cleaned and treated with dilute solution of HCl and after washing it is then dipped in a bath of molten zinc.

f) Metal spraying:

The metal is covered with a spray of vaporized aluminium, lead, tin or zinc. The spraying gives a thin film of uniform thickness

g) Painting

The metal surface is covered with a layer of paint. The surface is properly cleaned before the application of paint.

h) Parkersing:

The article is immersed in a hot water bath of a chemical known as Parco. The insoluble phosphates are formed on the surface of article due to reactions and these keep away the moisture.

i) Sherardising:

The article is washed with acid solution and with clean water. It is then dried and covered with dust of pure zinc. It is heated to a high temperature. zinc melts and combines with metal and forms a protective layer.

j) Tin plating and terne plating:

The metal is cleaned with dilute solution of acid and dipped in a bath of molten tin. The method of terne plating is similar to tin plating except that the lead tin alloy is used for coating instead of pure tin.