Grade of Concrete:

→ According to compressives strength, the concrete is generally graded.

→ in the designation of concrete mix, m refers to the mix & the no refers to the characteristic strength at 28 days. Expressed in mpa (N/mm^2)

m_5, $m_{7.5}$ → Lean concrete. Simple foundation for masonary wall.

lower then m_5 → Not suitable for R.C.C.
lower then M_{30} → Not suitable for prestressed conc

Advantages:

→ Concrete is economic. It can be made from locally available coarse & fine aggregate except cement.

→ Concrete is possess high compressive strength the corrosive and weathering effect are minimal.

→ Newly mixed concrete can be easily moulded handled formed to any shape & size according to specification.

→ It is durable fire resistance & require low maintance.

→ Excellent water resistance characteristic. i.e. withstand in water deterioration. Due to this property decay under water & submerged application.

→ Concrete can withstand high temperatures better wood & steel.

→ multi mode operation.

Dis Advantages →

→ Conc has low tensile strength, hence crack easily.

→ Conc Expands & Concract with the changes in temparature.

→ Conc is not entirely impervious to moisture & Curtain soluble salts which may cause efflorences.

→ Difficult of transportation

cement.

Composition of cement

Oxide	%
Lime (CaO)	60-65
Silica (SiO_2)	17-25
Alumina (Al_2O_3)	3.5-9
iron oxide (Fe_2O_3)	0.5-6
magnesia (MgO)	0.5-4.
Sulphur trioxide (SO_3)	1-2
alkali	0.5-1.3.

Types of cement

(1) ordinary portland cement
- (a) 33 Grade
- (b) 43 grade
- (c) 53 grade.

→ There are different types of cement as classified by Bureau of indian standards.

(1) ordinary portland cement

(1) → The ordinary portland cement or the setting cement is the basic portland cement and is manufactured in large quantities than all the other cement.

→ it is presently available in three different grade viz 33, 43, & 53.

→ it is used in generally concrete construction where, there is no Exposure to sulphate in the soil or ground water.

(2) Rapid hardening cement (RHC):

→ it is fine then ordinary portland cement.

→ it contain more C_3S & less C_2S then the (OPC)

→ The one day strength of calcium this cement is equall to the 3 day strength OPC with same cement ratio.

(3) Extra rapid hardening cement:

→ it is obtain by mixing calcium chloride not exceeding 2% by weight of the rapid hardening cement) with rapid harding cement.

→ Addition of calcium imparts quick setting properties in extra rapid hardening cement

→ The acceleration of setting hardening and evolution of heat in the early period of hydration make This cement very suitable for concreting on cold water.

Low heat cement →

→ It is portland cement which is obtain by Reducing the more rapidly cement. C_2S.

→ Addition of $CaCl_2$ imparts quick setting properties in extra Rapid hardening cement.

→ The acceleration of setting hardening and evolution of heat in the early period of hydration make This cement very suitable for concreting on cold water.

→ As per the Indian standard specification the heat of hydration of low heat cement shall be as follows.

portland balt furance slag cement :-

→ This cement is made by intergrinding portland cement clinker and granulated balast furnace slag.

→ in generally blast furnace slag cement is found to gain strength more slowly than.

→ it has poorly high sulphate resistance it suitable for use in environment exposed to sulphate (in the soil or ground water)

→ it is used for all purpose for which ordinary portland cement is used.

Acid resisting Cement

→ An acid resistance cement is composed of the following.

(i) Acid resistance aggregate such as quartzite

(ii) additive such as Na_2SiF_6 (this accelerates hardening)

(iii) Solution of sodium silicate sole able glass sodium silicate is a binding material.

→ The addition 0.5% of linseed oil 2% of Curcissite increases resistance to water also.

High Alumina Cement

- It is very different is composition from portland cement.
- It is characterise by it dark colour, high early strength high heat of hydration and resistance to chemical attack.

Super Sulphate cement

- It is made from well g blast furnace slag (80-85%) calcium, sulphate 10-15% and portland cement (1-2%) and is ground finer. than the portland cements.
- It has low heat hydration
- It has high resistance to chemical attack.

Hydration of Cement

(i) Chemical reaction take place between cement & water is refered to as hydration of cement.

(ii) The reaction of cement with water is exothermic i.e liberates as considerable quantity of heat and thus liberated heat of hydration.

(iii) The hydration process is not an instantaneous the reaction is faster in the early periods and continues identify at a decreasing rate.

(iv) Calcium silicate hydrate is the most important product of hydration and determines the good properties of concrete.

water cement ratio:

(i) The ratio of the amount of water to the amount of cement is termed as water cement ratio the strength & quality depends upon it.

(ii) The water enters into chemical action with cement and this action cause the setting & hardening of concrete.

(3) The water lubricates the aggregate & it facilitate the passage of cement through voids of aggregates this means that water makes the conc workable..

Setting time of cement

→ This test is used to detect the deterioration of cement due to storage.

Initial setting time.

→ The initial setting time is the interval between the addition of water to cement and the stage when the needle penetrate completly.

→ The time should be about 30min for ordinary cement.

Final setting times.

This time should be about 10hours. Soundness cement.

→ The purpose of the test is to detect the presence of uncombined lime in cement.

→ it performed with the help of le chatlier apparatus.

Aggregate

Classification - Geological
Natural - sand gravel.
Artificial - clean broken brick, blast furnace slag.
Size - Coarse grained, fine grained, single size aggregate.
weight - low weight, heavy weight, Normal weight, rounded, irregular angular, blocky

characteristics of aggregate.

→ The aggregate to be used in concrete must be hard, strong properly shaped and well graded.

→ The aggregate must possess chemical stability resistance to fire.

→ They should not contain deteriorous materials which may cause physical and chemical changes such as cracking softening, swelling.

-> It include shape and texture, size gradation moisture content. specific gravity.

Deleterious substances in aggregates.

-> The material whose presence may adversely affect strength. workability and long term performance of concrete. are termed deleterious materials.

-> Divided into 3 categories.

-) Impurities interfering with the process of hydration of cement.

-) Coating preventing the development of good bond between aggregate and the cement paste.

-> unsound particles which are weak or bring about chemical reaction between the aggregate. and cement paste.

Fineess modulus:

→ The fineness modulus is a numerical index of fineness giving some idea of the mean size of particles present in the entire body of the aggregate.

→ The object of finding finess modulus is to grade the given aggregate for the most economical use for the required strength and workability with minimum quantity of cement.

Grading of aggregate:

→ The particle size distribution of an aggregate as determined by sieve analysis is known as the grading of the aggregate.

→ If all the particles of an aggregate are of uniform size the compacted mass will contain more void where as an aggregate particles of various size will give a mass containing lesser voids.

→ Quality of mixing water.

→ The water used for the mixing and curing of concrete should be free from injurious amounts of deleterious materials.

→ Effect of impurities in water on properties of concrete.

→ The strength & durability of concrete is reduced due to the presence of impurities in the mixing water.

→ water containing large quantities of chlorides, tends to cause persistant dampness, surface efflorescence and increase the corrosion of the reinforcing steel.

* Suspended particles → The presence of suspended particles of clay & silt in the mixing water upto 0.02% by weight of water doesn't effect the properties of concrete.

* Miscellaneous inorganic salts → The presence of salts of manganese, tin, zinc, copper, & lead in water causes reduction in the strength of concrete. The zinc chlorides retards the setting of conc.

* Salts in seawater → sea water generally contain 3.5% of dissolved salts. The salts present in sea water reduce the ultimate strength of Concrete.

Acid's & Alkalies.

→ The industrial waste water containing acid's & alkalies is usually unsuitable for concrete Construction. water having pH value higher than 6 can be used.

Algae → Algae may be present in mixing water on the surface of aggregate particles.
→ It combines with cement & reduces the bond between aggregate & the cement pastes.

Sugar → if the amount of sugar present in the mixing water is less than 0.05% by weight of water, there is no adverse effect on the strength of Concrete.

Curing of water.

→ The use of water in curing the concrete is intended to penetrate the concrete.
→ It is necessary for the water to be uniformly distributed throughout the mass of concrete.

-) Hydration may effectively proceed in the interior of the member, but near the surface, three as inadequate amount of water in the covering so that penetration by curing water is desirable

-) The water which is satisfactory for mixing concrete can also be used for curing of. but should not produce any objectionable stain or unsightly deposit on the surface.

Admixture.

Anything added to concrete except cement, sand, aggregate & water to modify the property of cement.

water reducing admixtures.

-) These are organic substances or mixture of organic & inorganic substances that allow the reduction of water in the preparation of concrete having small workability or increase the workability of the conc. at some w/c ratio.

Retarding :-) These are the admixtures that are used to slow down the chemical process of hydration & to make the conc.

→ Its normal does various between 0.05 to 0.11.
→ calcium sulphate, sugare, starch, cellulose act as retarders.

Accelerating

→ These are the type of admixtures which are used to increase the rate of gain of strength in the concrete.

→ These are generally used in cold weather concreting pre fabricated concrete const. emergency road work & where form work is to be reused for speedy construction.

Ex→ calcium chlorides, Quartz) silicates. fluro silicates triethanol amine.

Air entering admixture.

→ This admixtures entrap millions of air bubble from the atmosphere in bet^n the voids of the cement particles that acts as flexible ball bearing which slip pass over each other. there by helps in modifying the properties of conc plasticity, workability, segregation permeability & frost action.

Ex→ Natural wood resins, paint.

Physical requirements of admixtures :-

→ The admixtures are available in liquid and powder forms. water proofing agents are normally sold in powder form.

→ To optimise the benefit which is obtained by incorporating an admixture in concrete mix, there is a preferred point of its addition in the mixing cycle of the concrete.

Functions of admixture's :-

→ To enhance the workability.
→ To " the bond of conc. to the steel reinforcement.
→ To increase the durability of conc.
→ To increase the resistance to chemical attack.
→ To increase the strength of conc. by reducing water content.
→ To accelerate the critical set of concrete. i.e. to speedup the rate of developement of strength at early ages.
→ To decrease the cst. of conc. per cubic meter.

properties of fresh concrete.

→ The mix should be able to produce a homogeneous fresh conc. from the constituent materials of the batch under the action of the mixing forces.

→ The mix should be stable it should not segregate during transportation and placing.

→ it should be possible to attain a satisfactory surface finish without honeycombing.

workability.

→ it is that property of freshly mixed concrete or mortar which determines the ease and homogeneity with which it can be mixed placed, compacted and finished.

→ workability of fresh conc. is a complex system of two critical parameters consistency & homogeneity.

measurement of workability.

1) → slump test
2) → compacting factor test.
3) → The vebee consistency test.
4) → The flow test.

Slump test :-

- It is widely used because simplicity of apparatus.
- The slump test indicates the behaviour of fresh mixed conc. under the action of gravitational force.

procedure :-

- The test is carried out with a mould called the slump cone.
- The slump cone is placed on a horizontal & non-absorbent surface & filled in 3 equal layers of fresh concrete each layer being tamped 25 times with a standard tamping rod.
- Then the mould is lifted vertically without disturbing the concrete cone.
- The conc after the test which slumps evenly all around is called true slump.

Vebee test

- Suitable for stiff conc. mixes ~~size of aggregate less than 38 cm~~. having low & very low work ability.

-) This test consists in moulding a fresh concrete conc in a cylindrical container mounted on a vibrating table.

-) The conc when subjected to vibration by starting the vibrator starts to occupy the cylindrical container by the way of getting remoulded.

-) The remoulding is considered complete when the conc surface becomes horizontal.

Flow test:

-) This test consist of moulding a fresh conc on the top of the platform of flow table. 15 jounts of 12.5 mm magnitudes.

-) The spread of the concrete, measured as the increase in diameter of conc is taken as measured of the flow of the conc.

Compacting factor test:

-) it gives the behaviour of fresh conc under the action of external force it measures the compactibility of the concrete.

-) which is an simp compact a speed of workability by measuring the of compaction. achive for a given amount of work.

→ The compacting factore test has been help to be more accurate than slump test, especially for Conc. mixes of medium and low workabilities. i.e compacting factor of 0.9 to 0.8 because the test is more sensitive and gives more Consistent results.

Requirements of workability:

→ The workability of fresh Conc. should be such that it can be placed in the formwork & compacted with minimum effort, without segg. segregation & bleeding.

→ The value of workability will generally increase with the increase in size of aggregate & will be same what lower for aggregate of smaller size than indicated.

→ The aim should be to have the minimum possible workability. Consistent with satisfactory placement & compaction of Concrete.

→ An in sufficient workability may result in incomplete Compaction thereby, severely effecting the strength, durability & surface finish of concrete & may indeed prove to be uneconomical in the long run.

Segregation → it can be defined as separating out of the ingredients of concrete mix so that the mixes no longer in a homogeneous condition.

→ it depends upon handling & placing operations.

→ The segregation of coarse particles in a lean dry mix may be corrected by the addition of a small quantity of water which improves cohesion of the mix.

Bleeding → separation of cement paste from the mix in the case lean and wet mixes.

→ it cause the formation of a porous weak at the top & non durable surface layer.

properties of hardened concrete.

→ Concrete is strong in compressive strength. cubes cylinders, prisms & 3 types of comp. test specimens used to determine the comp. strength.

→ cubes are generally 100 mm or 150 mm side cylinders are 150 mm dia by 300mm height.

Flexural strength of concrete.

-) The determination of flexural tensile strength is essential to estimate the load at which the conc. may crack.

-) Tensile strength of conc. is done by conducting flexural testing.

-) The flexural tensile strength at failure or the modulus of rupture is thum determined.

-) The modulus of rupture is determined by testing standard test specimens of 150 mm x 150 x 700 mm over span of 600mm.

-) The modulus of rupture is determined from the moment at failures of $f_r = m/2$. The computation of f_r assumes a linear behaviour of material up to failure which is only a rough estimation.

Shrinkage.

-) Shrinkage is the decrease of Concrete volume with time.

-) The decrease is due to variations in the moisture content of the concrete.

⇒ plastic shrinkage occurs during the 1st few hours after fresh concrete is placed.

⇒ Drying shrinkage occurs after the conc. has already attained it's final set and a good portion of the chemical hydration process in the cement gel has been accomplished.

* Creep.

⇒ It is defined as continous deformation under constant loading condition. The effects of creep can be considered long term analysis. Creep is closely related to shrinkage & both phenomena are related to the hydrated cement paste.

⇒ It is influenced by the composition of concrete. the env. conditions & the size of the specimen.

* Efflorescence.

⇒ The water leaking through cracks or faulty joints or through the areas of poorly compacted pores. concrete dissolves some of the readily soluble calcium hydroxide and white deposits on the surface.

Sulphate attack.

-) Sulphates are generally found in ground water & sub soil. sew water. also contains large amount of Sulphate. sulphate can be natural occuring or Could be as a consequence industrial waste disposal.

-) They are harmful to concrete as they can lead to increase in the concrete volume and consequent cracking.

-) blended cement are most preffered when both sulphates & chlorides are present in an environment at the same time.

Permeability:-

-) It is ~~depend~~ defined as the property that gives the Rate of flow of fluid into a porous Solid.

-) or it can be define ability to resist weathering action Chemical attack - abrasion or any process of deterioration.

→ The permeability of cement paste also varies with the age of concrete or with the degree of hydration.

· Durability of concrete :-

Acid attack :-

(i) Concrete structures are also used for storing liquids, some of which are harmful for concrete, in industrial plants, concrete floors in contact with liquid which damage:

Production of Concrete

Batching:

→ A proper accurate measurement of all the material used in the production of concrete is essential to ensure uniformity of properties and aggregate grading in successive batches.

→ Batching is usually done by weighing.

→ The factors affecting the choice of proper batching system.

(i) Size of Job.
(ii) Required production Rate

→ It is types are.

(a) manual batching.
(b) Semiautomatic
(c) Automatic batching.

Mixing of concrete.

(i) The process of rolling folding and spreading of particles is known as the mixing of concrete.

(ii) The material of cone should be mixed thoroughly so that there is uniform distribution of material in the mass of concrete.

(iii) The through mixing also ensure the cement water paste completely covers the surface of aggregate.

(iv) The mixing of material of concrete can be done either with hand or with the help of machine

(v) Its object is to coat the surface of all aggregate particles with cement paste & the blend all the ingredient of concrete into a uniform mass.

Transportation of concrete:-

(i) The concrete as come out of the mixer or as it is Ready for use on the platform is to be transported and placed on the Form work.

(ii) The type of equipment to be used for transport of concrete depend on the Natural work height above eq.l and distance between the points of preparation & placing of cement.

→ The Requirement to be Full filled during transportation.

(i) No segregation of material in the concrete.

(ii) Concrete delived at the point of placing should be uniform and of proper consistency.

placing of concrete

→ Effect of homogeneity, density, and behaviour of concrete depends upon placing of concrete.

→ The surface against which the fresh concrete is to be placed must be examined as to their possible effect in absorbing mixing water.

→ The actual procedure depends largely upon the types of structure, the quality of concrete and of the receiving surface.

Compaction of Concrete

→ (1) During the manufacture of concrete a considerable quantity of air is entrapped & during it's transportation there is a possibility of partial segregation taking place.

→ The compaction of concrete can be achived in four way's.

(i) hand rodding.
(ii) mechanical vibrations.
(iii) Centrifugation or spinning.
(iv) High pr. and shock.

→ The choice of particular technique of compaction of concrete depends upon the factors are:

* Type of structural element.
* The properties of concrete mix, particularly it's water cement ratio.

Vibrator.

→ Vibration is the commonly used method of compaction of concrete

which reduces the internal friction between the different particles of concrete.

→ The mechanical vibrations can be imparted by means of vibrators which are operated with the help of an electric motor or diesel engine.

☆ Form work

→ Formwork generally forms a part of concrete construction practice. but as it influences the performance of hardened concrete.

→ The Formwork includes the total system of support of freshly placed concrete.

Types of Formwork

(i) Timber Formwork:

→ The timber used for Formwork should be cheap, easily available & easy to work manually & on machines.

→ A good timber for formwork should be light for easy handling and lifting.

(iii) Plywood Formwork.

→ The main advantages is that large panel surface are available.

→ The fixing of forms is rapid & economical it doesn't exp. swell and shrink during the setting of concrete.

(iii) Steel Reinforcement.

→ steel formwork are commonly employed for big projects. where the forms are to be repeatedly used. the steel forms can be easily fabricated and doesn't require many adjustment at the units are standardized.

Stripping of form.

→ The removal of forms after the concrete has set is termed. Stripping of forms.

→ The stripping or striking of forms should proceed on a definite order.

Quality control:

→ The quality control of concrete depends upon several factors such as variation in the quality of constituents materials, variations in mix proportions due to batching process variation in the quality of batching and mixing equipment available. the quality of overall workmanship and supervision at the site.

Factors causing variations in the quality of concrete.

→ personnel → The basic requirement for the success of any quality control plan is the availability of experienced, knowledge & trained personnel at all levels.

→ material, equipment and workmanship.

→ For uniform quality of concrete the ingredients should preferably be used from a single source. Adequate storage and cover is necessary for protection from moisture, set cement with hard lumps is to be rejected.

→ The aggregate should be free from impurities and deleterious materials.

→ The water used for mixing concrete should be free from salt, organic matter, alkalis & suspended impurities.

Field quality control.

→ The field control i.e. inspection and testing play a vital role in the overall quality control plan. Inspection could be of two types → quality control inspection and acceptance inspection.

Concrete mix design

☆ Data required for mix design :-

(1). Design stipulations.

(i) characteristic compressive cube strength at 28 days - 20 mpa.

(ii) Maximum size of aggregate - 20 mm.

(iii) Type of aggregate - crushed rock.

(iv) Degree of workability - 0.90 cf (Slump - 10-20)

(v) Degree of quality control - weight batching.

(2) Characteristics of materials :-

(i) Cement.

type - ordinary portland cement

specific gravity - 3.15.

(ii) Aggregate -

(iii) water cement ratio -

maximum size = 20 mm.

workability = medium.

☆ Basic consideration for concrete mix design :-

-) Concrete mix design is a process of selecting suitable ingredient for concrete & determining their properties which would produce as economically.

as possible a concrete.

> That satisfies the job requirement. i.e conc. having a certain minimum comp. strength, workability & durability.

-> The comp strength of concrete is governed by water cement ratio.

-> For the given aggregate characteristics, the workability of concrete is governed by the water content.

Methods of concrete mix design.

-> Most of the available mix design method are based ampirical relationship, charters & graphs. The requirements of the concrete mix are usually dictated by general experience with regard to the structural design condition durability & condition of placing. Some commonly used design methods:

(a) Trial & adjustment method of mix design.
(b) DOE (British) mix design method.
(c) ACI mix design method
(d) mix design according to Indian standard.
(e) Rapid method for mix desing.

* Methods of proportioning concrete mix:

→ The maximum nominal size of the aggregate, which is economically available is determined as per the specified requirements.

→ The degree of workability in terms of Slump Compacting factor or vebee time is selected as per requirement.

→ The mean target strength is estimated from the specified characteristic strength & the level of quality control.

→ A suitable water cement ratio to obtain a concrete mix of desired strength.

→ The cement content is calculated & it's quantity is checked for the requirement's of durability.

→ The final proportions are expressed either on mass or volume basis.

Special Concrete

-> Ex:- ready mix concrete, high performance concrete, silica fume concrete, shot-crete concreting on curing.

-> Ready mix concrete that is manufactured in a batch plant, ready mix concrete is normally delivered in 2 way's first is the paved truck or dr. transit mixers.

-) They type of truck delivers concrete in a plastic state to the site.

-) Batch plants combine a precise amount of gravel, sand, water, cement by weight.

-) R.m.c is bought and sold by volume usually expressed in cubic meters.

High performance concrete

-) it is a concrete mixer that has higher durability & higher strength.

→ This concrete consists of one are more cementious material such as fly ash, silica fume ground granular blast furnace slag.

→ The use of certain natural & chemical admixture such as silica fume & organic enchances strength durability & practical properties.

Characteristics of HPC.

→ Due to the tight & refined pore structure of the cement paste, it has very low porocity.

→ It has very low permeability of conc.

→ low heat of hydration.

→ high early strength & continued strength development.

→ it's strength Range is 50 - 100 mpa.

Silicate Fume Concrete.

-> It is ultrafine powder collected as a by product of the silica & ferrosilicon alloy production. & Consists of spherical particles.

-> It is also known as microsilica is a highly pozzolanic material that is used to enchance.