MASCP301 -CEMENT PAVEMENT

MASCP301 PERFORM CEMENT PAVEMENT

REQF LEVEL: 3

LEARNING HOURS: 100

CREDITS: 10

SECTOR: CONSTRUCTION

SUB-SECTOR: MASONRY

MODULE STRUCTURE

LEARNING UNIT I: PREPARE THE AREA

LO 1.1. Select Tools, equipment

LO 1.2. Prepare materials

LO 1.3. Prepare surfaces

LEARNING UNIT II: CONDUCT SITE SURVEY

LO 2.1. Identify screeding types

LO 2.2. Perform screeding

LEARNING UNIT 3: CARRY OUT SMOOTHING

LO 3.1. Smooth the plaster

LO 3.2. Clean tools and equipment

LO 3.3. Clean work area

LEARNING UNIT I: PREPARE THE AREA

LO 1.1. SELECT TOOLS, EQUIPMENT

A pavement is the durable surface material laid down on an area intended to sustain vehicular or foot traffic, such as a road or walkway

In the past, gravel road surfaces, cobblestone and granite setts were extensively used, but these surfaces have mostly been replaced by asphalt or concrete laid on a compacted base course.

The followings are different tools

Trowel

A **trowel** is a small hand tool used for digging, applying, smoothing, or moving small amounts of viscous or particulate material. Common varieties include the masonry trowel, garden trowel, and float trowel.

Numerous forms of trowel are used in masonry, concrete, and dry wall construction, as well as applying adhesives such as those used in tiling and laying synthetic flooring.

Masonry trowels are traditionally made of forged carbon steel, but some newer versions are made of cast stainless steel, which has longer wear and is rust-free.

These include:

- **Bricklayer's trowel** has an elongated triangular-shaped flat metal blade, used by masons for leveling, spreading, and shaping cement, plaster, and mortar.
- **Pointing trowel**, a scaled-down version of a bricklayer's trowel, for small jobs and repair work.
- **Tuck pointing trowel** is long and thin, designed for packing mortar between bricks.
- **Float trowel** or **finishing trowel** is usually rectangular, used to smooth, level, or texture the top layer of hardening concrete. A **flooring trowel** has one rectangular end and one

pointed end, made to fit corners. A **grout float** is used for applying and working grout into gaps in floor and wall tile.

- **Gauging trowel** has a rounded tip, used to mix measured proportions of the different ingredients for quick set plaster.

- **Pool trowel** is a flat-bladed tool with rounded ends used to apply coatings to concrete, especially on swimming pool decks.

- **Margin trowel** is a small rectangular bladed tool used to move, apply, and smooth small amounts of masonry or adhesive material.

- **Notched trowel** is a rectangular shaped tool with regularly spaced notches along one or more sides used to apply adhesive when adhering tile, or laying synthetic floor surfaces.

- **Garden trowel**, a tool with a pointed, scoop-shaped metal blade and wooden, metal, or plastic handle. It is used for breaking up earth, digging small holes, especially for planting and weeding, mixing in fertilizer or other additives, and transferring plants to pots.

FLOAT

A **concrete float** is a tool used to finish a concrete surface by making it smooth. A float is used after the surface has been made level using a screed. In addition to removing surface imperfections, floating will compact the concrete as preparation for further steps.

A float can be a small hand tool, a larger bull float with a long handle, or a power trowel (also called a power float) with an engine.

- **Mixers**
  But whether you're mixing in a truck, a portable mixer or a wheelbarrow, you want to be sure your concrete is thoroughly mixed for maximum strength and durability.
- **Wheelbarrows**
  Ideal for transporting (or even mixing) small batches of concrete or tools on the job site.
- **Rubber Boots or Work Boots**
  Concrete is stiff stuff, and wearing waterproof boots is the best way to get through it and prevent contact with your skin. It's also easy to rinse your footwear after the concrete is down.
- **Gloves**
  Many concrete mixes contain potentially caustic admixtures that can cause serious burns from extended contact with bare skin. Gloves prevent overexposure to these components (and save a few occasional blisters, too).
- **Safety Glasses**
  Standard on most job sites, wearing safety glasses is an important safety measure when drilling, grinding, power trowelling or sawing concrete.
- **Compactors**
  If the site of the concrete slab is to be prepped with a sub-base of any type, a compactor helps settle the stone or aggregate into position.
- **Levels**
  Both the sub-base and slab surface must be level. A standard long-line level, or a laser level, will let you verify that the slab is completely according to spec before pouring and after.
- **Tape Measures**
  Concrete forms and slab depth need the same "measure twice, pour once" verification as any other material on the job site. They are also useful for testing placement and mapping.
- **Saws**
  Reciprocating saws, circular saws or grinders can be necessary to cut rebar or forms on the job site. They can also be necessary if a problem develops under the slab and a portion of the concrete has to be removed after it has set and dried.
- **Shovels**
  Shovels help distribute concrete around the job site to fill in gaps left during the pouring process or for smaller applications. Square-ended shovels generally work better for concrete; rounded ones spread concrete unevenly.

- **Tampers**
  A tamper is used with low slump concrete to push the aggregate below the slab surface. There are types that are used standing on the wet concrete or roller types that can be used from the slab edge.
- **Vibrators**
  Concrete vibrators help release trapped air pockets and excess water from the concrete mix to prevent possibly compromising problems in medium to high slump concrete.
- **Screeds**

A flat board (screed board, floating screed) or a purpose-made aluminium tool used to smooth and true materials like concrete, stucco and plaster after it has been placed on a surface or to assist in flattening
Screeds come in a variety of sizes and can be a specific tool (also called straight edges or bump cutters), or can be simple flat pieces of dimensional lumber. The purpose of a screed is to smooth concrete after it has been moved into place by scraping away any excess from the slab surface.

LO I.2. PREPARE MATERIALS

The followings are different materials used in cement pavement:

- Cement
- Sand
- Aggregates
- Additive (Admixtures)
- Water

CEMENT

Cement is a commonly used binding material in the construction.

Cement is obtained by burning a mixture of calcareous (calcium) and argillaceous (clay) material at a very high temperature and then grinding the clinker so produced to a fine powder.

It was first produced by a mason Joseph Aspdin in England in 1924.
He patented it as **Portland cement**.

TYPES OF CEMENT

In addition to ordinary Portland cement there are many varieties of cement.
Important varieties are briefly explained below:

(*i*) **White Cement:** The cement when made free from colouring oxides of iron, maganese and Chlorium results into white cement.
In the manufacture of this cement, the oil fuel is used instead of coal for burning. White cement is used for the floor finishes, plastering, ornamental (decorative) works etc. In swimming pools white cement is used to replace glazed tiles. It is used for fixing marbles and glazed tiles.

(*ii*) **Coloured Cement:** The cements of desired colours are produced by thoroughly mixing pigments with ordinary cement.
The chlorium oxide gives green colour. Cobalt produce blue colour.

Iron oxide with different proportion produce brown, red or yellow colour. Addition of manganese dioxide gives black or brown coloured cement.
These cements are used for giving finishing touches to floors, walls, window sills, roofs etc.

(*iii*) **Quick Setting Cement:** Quick setting cement is produced by reducing the percentage of gypsum and adding a small amount of aluminium sulphate during the manufacture of cement. Finer grinding also adds to quick setting property.
This cement starts setting within 5 minutes after adding water and becomes hard mass within 30 minutes.
This cement is used to lay concrete under static or slowly running water.

(*iv*) **Rapid Hardening Cement:** This cement can be produced by increasing lime content and burning at high temperature while manufacturing cement.
Grinding to very fine is also necessary.
Though the initial and final setting time of this cement is the same as that of Portland cement, it gains strength in early days.
This property helps in earlier removal of form works and speed in construction activity.

(*v*) **Low Heat Cement:** In mass concrete works like construction of dams, heat produced due to hydration of cement will not get dispersed easily.
This may give rise to cracks.
Hence in such constructions it is preferable to use low heat cement.
This cement contains low percentage (5%) of tricalcium aluminate (C_3A) and higher percentage (46%) of dicalcium silicate (C_2S).

(*vi*) **Pozzulana Cement:** Pozzulana is a volcanic power found in Italy.
It can be processed from shales and certain types of clay also.
In this cement pozzulana material is 10 to 30 per cent.
It can resist action of sulphate. It releases less heat during setting. It imparts higher degree of water tightness. Its tensile strength is high but compressive strength is low. It is used for mass concrete works. It is also used in sewage line works.

(*vii*) **Expanding Cement:** This cement expands as it sets.
This property is achieved by adding expanding medium like sulpho aluminate and a stabilizing agent to ordinary cement.
This is used for filling the cracks in concrete structures.

(*viii*) **High Alumina Cement:** It is manufactured by calcining a mixture of lime and bauxite.
It is more resistant to sulphate and acid attack. It develops almost full strength within 24 hours of adding water.
It is used for under water works.

(*ix*) **Blast Furnace Cement:** In the manufacture of pig iron, slag comes out as a waste product. By grinding clinkers of cement with about 60 to 65 per cent of slag, this cement is produced.
The properties of this cement are more or less same as ordinary cement, but it is cheap, since it utilise waste product.

This cement is durable but it gains the strength slowly and hence needs longer period of curing.

(*x*) **Acid Resistant Cement:** This cement is produced by adding acid resistant aggregated such as quartz, quartzite, sodium silicate or soluble glass.
This cement has good resistance to action of acid and water.
It is commonly used in the construction of chemical factories.

(*xi*) **Sulphate Resistant Cement:** By keeping the percentage of tricalcium aluminate C_3A below five per cent in ordinary cement this cement is produced.
It is used in the construction of structures which are likely to be damaged by alkaline conditions. Examples of such structures are canals, culverts, etc.

(*xii*) **Fly Ash Blended Cement:** Fly ash is a byproduct in thermal stations.
The particles of fly ash are very small and they fly in the air, creating air pollution problems.
It is found that one of the best way to dispose fly ash is to mix it with cement in controlled condition and derive some of the beneficiary effects on cement.

Properties of Ordinary Portland Cement

(1) Chemical properties: Portland cement consists of the following chemical compounds:

(*a*) Tricalcium silicate	3 $CaO.SiO_2$ (C_3S)	40%
(*b*) Dicalcium silicate	2$CaO.SiO_2$ (C_2S)	30%
(*c*) Tricalcium aluminate	3$CaO.Al_2O_3$ (C_3A)	11%
(*d*) Tetracalcium aluminate	4$CaO.Al_2O_3.Fe_2O_3$ (C_3AF)	11%

There may be small quantities of impurifies present such as calcium oxide (CaO) and magnesium oxide (MgO).
When water is added to cement, C_3A is the first to react and cause initial set.
It generates great amount of heat. C_3S hydrates early and develops strength in the first 28 days. It also generates heat. C_2S is the next to hydrate. It hydrates slowly and is responsible for increase in ultimate strength. C_4AF is comparatively inactive compound.

(2) Physical properties: The following physical properties should be checked before selecting a portland cement for the civil engineering works. IS 269–1967 specifies the method of testing and prescribes the limits:

(*a*) Fineness
(*b*) Setting time
(*c*) Soundness
(*d*) Crushing strength.

(*a*) ***Fineness:*** It is measured in terms of percentage of weight retained after sieving the cement through 90 micron sieve or by surface area of cement in square centimeters per gramme of cement.
According to IS code specification weight retained on the sieve should not be more than 10 per cent.

(*b*) ***Setting time:*** A period of 30 minutes as minimum setting time for initial setting and a maximum period of 600 minutes as maximum setting time is specified by IS code, provided the tests are conducted as per the procedure prescribed by IS 269-1967.

(*c*) ***Soundness:*** Once the concrete has hardened it is necessary to ensure that no volumetric changes take place.
The cement is said to be unsound, if it exhibits volumetric instability after hardening.

(*a*) ***Crushing strength:*** For this mortar cubes are made with standard sand and tested in compression testing machine as per the specification of IS code. The minimum strength specified is 16 N/mm^2 after 3 days and 22 N/mm^2 after 7 days of curing.

Physical Tests on Cement

(*a*) **Soundness Test:** It is conducted by sieve analysis. 100 gms of cement is taken and sieved through IS sieve No. 9 for fifteen minutes. Residue on the sieve is weighed. This should not exceed 10 per cent by weight of sample taken.

(*b*) **Setting Time:** Initial setting time and final setting time are the two important physical properties of cement.
Initial setting time is the time taken by the cement from adding of water to the starting of losing its plasticity.
Final setting time is the time lapsed from adding of the water to complete loss of plasticity.

(*c*) **Soundness Test:** This test is conducted to find free lime in cement, which is not desirable

(*d*) **Crushing Strength Test**

Uses of Cement

Cement is used widely for the construction of various structures. Some of them are listed below:

(*i*) Cement slurry is used for filling cracks in concrete structures.
(*ii*) Cement mortar is used for masonry work, plastering and pointing.
(*iii*) Cement concrete is used for the construction of various structures like buildings, bridges. water tanks, tunnels, docks, harhours etc.
(*iv*) Cement is used to manufacture lamp posts, telephone posts, railway sleepers, piles etc.
(*v*) For manufacturing cement pipes, garden seats, dust bins, flower pots etc. cement is commonly used.
(*vi*) It is useful for the construction of roads, footpaths, courts for various sports etc.

SAND
Sand is a natural product which is obtained as river sand and pit sand.
Sand consists of small angular or rounded grains of silica
Sand is commonly used as the fine aggregate in cement concrete
Both natural and artificial sanda are used for this purpose

However sea sand should not be used for the following reasons:
1. It contains salt and hence structure will remain damp. The mortar is affected by efflorescence and blisters appear.
2. It contains shells and other organic matter, which decompose after some time, reducing the life of the mortar.

Use of sand

Sand is used in mortar and concrete for the following purpose:
1. It sub-divides the paste of binding material into thin films and allows it to adhere and spread.
2. It fills up the gap between the building blocks and spreads the binding material.
3. It adds to the density of the mortar.
4. It prevents the shrinkage of the cementing material.
5. It allows carbon dioxide from the atmosphere to reach some depth and thereby improve setting power.
6. The cost of cementing material per unit volume is reduced as this low cost material increases the volume of mortar.
7. Silica of sand contributes to formation of silicates resulting into the hardened mass.
8. It reduces shrinkage and craking of concrete

The properties of good sand are:
1. It should be chemically inert.
2. It should be free from organic or vegetable matter.
3. It should be free from salt.
4. It should contain sharp, angular and coarse grains.
5. It should be well graded.
6. It should be hard and durable.
7. It should be free from coatings of clay and silt

AGGREGATES

In concrete, aggregates are addede to provide good quality of concrete

Aggragate is used in two size groups:

Fine aggreagate (sand): Particle size less than **4.75 mm**

Coarse aggreagate: Particle size more than **4.75 mm**

Coarse aggregate

Coarse aggregate is a portion of aggregate retained on the 2.00 mm (No 10) sieve for bituminous concrete or retained on the 4.75 mm (No 4) sieve for Portland cement concrete

Functions of coarse aggregates

1. Coarse aggregate makes solid and hard mass of concrete with cement and sand
2. It increase the crushing strength of concrete
3. It reduces the cost of concrete, since it occupies the major volume

WATER

The water used in concrete plays an important part in the mixing, laying, compaction, setting and hardening of concrete.

The strength of concrete directly depends on the quantity and quality of water used in the mix

Functions of water

1. Water is only the ingredient that reacts chemically with cement and thus setting and hardening takes place
2. Water acts as a lubricant for the aggregate and makes the concrete workable
3. It facilitates the spreading of cement over the fine aggregate

ADMIXTURES

Admixture is defined as a material other than cement, aggregate and water used as an ingredient of concrete, added to the batch immediately before or during mixing, to modify the properties of ordinary concrete to make it more suitable for required situation.
Instead of using a special cement, properties of cement can be changed by addictives to cement.

The major reasons for using admixtures are:

1. To reduce the cost of concrete construction
2. To achieve certain properties in concrete more effectively than by other means
3. To maintain the quality of concrete during the stages of mixing, transporting, placing, and curing in adverse weather conditions
4. To overcome certain emergencies during concreting operations

TYPES OF ADMIXTURES

Following types of admixtures are generally used in construction

- Accelerators
- Retarders
- Water reducing agent (plastic users)
- Super plastisizer
- Air entraining agents
- Water proofing agents
- Gas forming agents
- Grouting admixtures
- Corrosion inhibitors
- Bonding admixtures
- Fungicidal, germicidal, insecticidal admixtures
- Colouring admixtures
- Pumping aids
- Pozzolanic or mineral admixtures

AIR-ENTRAINING ADMIXTURES

Air-entraining admixtures are used to purposely introduce and stabilize microscopic air bubbles in concrete.
Airentrainment will dramatically improve the durability of concrete exposed to cycles of freezing and thawing.
Entrained air greatly improves concrete's resistance to surface scaling caused by chemical deicers.
Furthermore, the workability of fresh concrete is improved significantly, and segregation and bleeding are reduced or eliminated.
An air-entraining admixture, on the other hand, is added directly to the concrete materials either before or during mixing.

WATER-REDUCING ADMIXTURES

Water-reducing admixtures are used to reduce the quantity of mixing water required to produce concrete of a certain slump, reduce water-cement ratio, reduce cement content, or increase slump.
Typical water reducers reduce the water content by approximately 5% to 10%.
An increase in strength is generally obtained with water-reducing admixtures as the water-cement ratio is reduced.

PLASTICIZERS FOR FLOWING CONCRETE

Plasticizers, often called superplasticizers, are essentially high-range water reducers meeting; these admixtures are added to concrete with a low-to-normal slump and water-cement ratio to make high-slump flowing concrete.
Flowing concrete is a highly fluid but workable concrete that can be placed with little or no vibration or compaction while still remaining essentially free of excessive bleeding or segregation.

RETARDING ADMIXTURES

Retarding admixtures are used to delay the rate of setting of concrete.
High temperatures of fresh concrete (30°C [86°F]) are often the cause of an increased rate of hardening that makes placing and finishing difficult.

Retarding admixtures are useful in extending the setting time of concrete, but they are often also used in attempts to decrease slump loss and extend workability, especially prior to placement at elevated temperatures.

ACCELERATING ADMIXTURES

An accelerating admixture is used to accelerate the rate of hydration (setting) and strength development of concrete at an early age.

CORROSION INHIBITORS

Corrosion inhibitors are used in concrete for parking structures, marine structures, and bridges where chloride salts are present.
The chlorides can cause corrosion of steel reinforcement in concrete

Corrosion-inhibiting admixtures chemically arrest the corrosion reaction.

COLORING ADMIXTURES (PIGMENTS)

Natural and synthetic materials are used to color concrete for aesthetic and safety reasons.
Red concrete is used around buried electrical or gas lines as a warning to anyone near these facilities.
Yellow concrete safety curbs are used in paving applications.
Generally, the amount of pigments used in concrete should not exceed 10% by weight of the cement.
Pigments used in amounts less than 6% generally do not affect concrete properties.

Before a coloring admixture is used on a project, it should be tested for color fastness in sunlight and autoclaving, chemical stability in cement, and effects on concrete properties.

PUMPING AIDS

Pumping aids are added to concrete mixtures to improve pumpability.
Pumping aids cannot cure all unpumpable concrete problems; they are best used to make marginally pumpable concrete more pumpable.
These admixtures increase viscosity or cohesion in concrete to reduce dewatering of the paste while under pressure from the pump.
Some pumping aids may increase water demand, reduce compressive strength, cause air entrainment, or retard setting time.

DAMPPROOFING ADMIXTURES

The passage of water through concrete can usually be traced to the existence of cracks or areas of incomplete consolidation.
Sound, dense concrete made with a watercement ratio of less than 0.50 by mass will be watertight if it is properly placed and cured.
Admixtures known as dampproofing agents include certain soaps, stearates, and petroleum products.
They may, but generally do not, reduce the permeability of concretes that have low cement contents, high watercement ratios, or a deficiency of fines in the aggregate.

Their use in well-proportioned mixes, may increase the mixing water required and actually result in increased rather than reduced permeability.
Dampproofing admixtures are sometimes used to reduce the transmission of moisture through concrete that is in contact with water or damp earth.

Many so-called dampproofers are not effective, especially when used in concretes that are in contact with water under pressure.

PERMEABILITY-REDUCING ADMIXTURES

Permeability-reducing admixtures reduce the rate at which water under pressure is transmitted through concrete.
One of the best methods of decreasing permeability in concrete is to increase the moist-curing period and reduce the water-cement ratio to less than 0.5.
Most admixtures that reduce water-cement ratio consequently reduce permeability.

BONDING ADMIXTURES AND BONDING AGENTS

Bonding admixtures are usually water emulsions of organic materials including rubber, polyvinyl chloride, polyvinyl acetate, acrylics, styrene butadiene copolymers, and other polymers.
They are added to portland cement mixtures to increase the bond strength between old and new concrete.
Flexural strength and resistance to chloride-ion ingress are also improved.
They are added in proportions equivalent to 5% to 20% by mass of the cementing materials; the actual quantity depending on job conditions and type of admixture used.

Some bonding admixtures may increase the air content of mixtures.

FUNGICIDAL, GERMICIDAL, AND INSECTICIDAL ADMIXTURES

Bacteria and fungal growth on or in hardened concrete may be partially controlled through the use of fungicidal, germicidal, and insecticidal admixtures.
The most effective materials are polyhalogenated phenols, dieldrin emulsions, and copper compounds.
The effectiveness of these materials is generally temporary, and in high dosages they may reduce the compressive strength of concrete.

ANTIWASHOUT ADMIXTURES

Antiwashout admixtures increase the cohesiveness of concrete to a level that allows limited exposure to water with little loss of cement.
This allows placement of concrete in water and under water without the use of tremies.
The admixtures increase the viscosity of water in the mixture resulting in a mix with increased thixotropy and resistance to segregation.
They usually consist of water soluble cellulose ether or acrylic polymers.

GROUTING ADMIXTURES

Portland cement grouts are used for a variety of purposes: to stabilize foundations, set machine bases, fill cracks and joints in concrete work, cement oil wells, fill cores of masonry walls, grout prestressing tendons and anchor bolts, and fill the voids in preplaced aggregate concrete.

To change the properties of grout for specific applications, various air-entraining admixtures, accelerators, retarders, and nonshrink admixtures are often used.

GAS-FORMING ADMIXTURES

Aluminum powder and other gas-forming materials are sometimes added to concrete and grout in very small quantities to cause a slight expansion of the mixture prior to hardening.

This may be of benefit where the complete grouting of a confined space is essential, such as under machine bases or in post-tensioning ducts of prestressed concrete.

These materials are also used in larger quantities to produce autoclaved cellular concretes.

The amount of expansion that occurs is dependent upon the amount of gas-forming material used, the temperature of the fresh mixture, the alkali content of the cement, and other variables.

Where the amount of expansion is critical, careful control of mixtures and temperatures must be exercised.
Gas-forming agents will not overcome shrinkage after hardening caused by drying or carbonation.

AIR DETRAINERS

Air-detraining admixtures reduce the air content in concrete.

They are used when the air content cannot be reduced by adjusting the mix proportions or by changing the dosage of the air-entraining agent and other admixtures.

However, air-detrainers are rarely used and their effectiveness and dosage rate should be established on trial mixes prior to use on actual job mixes.

SHRINKAGE-REDUCING ADMIXTURES

Shrinkage-reducing admixtures, introduced in the 1980s, have potential uses in bridge decks, critical floor slabs, and buildings where cracks and curling must be minimized for durability or aesthetic reasons

These admixtures have negligible effects on slump and air loss, but can delay setting.

They are generally compatible with other admixtures

Table below provides a much more extensive classification of admixtures.

Type of admixture	**Desired effect**	**Material**
Accelerators	Accelerate setting and early-strength Calcium chloride and development	Triethanolamine, sodium thiocyanate, calcium formate, AASHTO M 194, Type C) calcium nitrite, calcium nitrate

Air detrainers	Decrease air content	Tributyl phosphate, dibutyl phthalate, octyl alcohol, waterinsoluble esters of carbonic and boric acid, silicones
Air-entraining admixtures	Improve durability in freeze-thaw, deicer, sulfate, and alkali- reactive environments Improve workability	Salts of wood resins (Vinsol resin), some synthetic detergents, salts of sulfonated lignin, salts of petroleum, acids, salts of proteinaceous material, fatty and resinous acids and their salts, alkylbenzene sulfonates, salts of sulfonated hydrocarbons
Antiwashout admixtures	Cohesive concrete for underwater placements	Cellulose, acrylic polymer
Bonding admixtures	Increase bond strength	Polyvinyl chloride, polyvinyl acetate, acrylics,butadiene-styrene copolymers
Coloring admixtures	Colored concrete	Modified carbon black, iron oxide, phthalocyanine, umber, chromium oxide, titanium oxide, cobalt blue
Corrosion inhibitors	Reduce steel corrosion activity in a chloride-laden environment	Calcium nitrite, sodium nitrite, sodium benzoate, certain phosphates or fluosilicates, fluoaluminates, ester amines
Dampproofing admixtures	Retard moisture penetration into dry concrete	Soaps of calcium or ammonium stearate or oleate Butyl stearate Petroleum products
Foaming agents	Produce lightweight, foamed concrete with low density	Cationic and anionic surfactants Hydrolized protein
Fungicides, germicides, and insecticides	Inhibit or control bacterial and fungal growth	Polyhalogenated phenols Dieldrin emulsions Copper compounds
Gas formers	Gas formers Cause expansion before setting	Aluminum powder
Grouting admixtures	Adjust grout properties for specific applications	See Air-entraining admixtures, Accelerators, Retarders, and Water reducers
Hydration control admixtures	Suspend and reactivate cement hydration with stabilizer and activator	Carboxylic acids Phosphorus-containing organic acid salts
Permeability reducers	Decrease permeability	Latex Calcium stearate
Pumping aids	Improve pumpability	Organic and synthetic polymers Organic flocculents Organic emulsions of paraffin, coal tar, asphalt, acrylics Bentonite and pyrogenic silicas Hydrated lime (ASTM C 141)
Retarders	Retard setting time	Lignin Borax Sugars Tartaric acid and salts
Shrinkage reducers	Reduce drying shrinkage	Polyoxyalkylene alkyl ether Propylene glycol
Superplasticizers	Increase flowability	Sulfonated melamine formaldehyde condensates

	(workability) of concrete Reduce water-cement ratio	Sulfonated naphthalene formaldehyde condensates Lignosulfonates Polycarboxylates
Water reducer	Reduce water content at least 5%	Lignosulfonates Hydroxylated carboxylic acids Carbohydrates (Also tend to retard set so accelerator is often added)

DETERMINE THE PORTION OF MATERIALS (MIX RATIO) TO MIX MORTAR

How to calculate cement, sand and water quantity required for any mortar mix?

Points to be known before estimating

Dry volume of mortar = Wet volume x 1.33

Density of cement = 1440 kg/ m^3

Density of sand = 1920 kg/ m

How many KG in 1 bag of cement = 50kg

Cement quantity in litres in 1 bag of cement = 34.7 litres

1 Bag of cement in cubic metres = 0.0347 cubic meter

How many CFT (Cubic Feet) = 1.226 CFT

Numbers of Bags in 1 cubic metre cement = 28.8 Bags

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Numbers of Bags in 1 cubic metre cement = 28.8 Bags

Specific gravity of cement = 3.15

Grade of cement = 33, 43, 53

Where 33, 43, 53 compressive strength of cement in N/mm^2

1 m^3 of sand = 35.3147 cubic feet (CFT)

Example: How to calculate the quantity of cement, sand and water for 1 m^3 mortar, 1: 4 mix ratio

Solution:

Quantity of mortar

Volume of mortar: 1 m^3
Mix ratio 1:4
Dry volume of mortar = Wet volume x 1.33
Dry volume = 1.0 m^3 x 1.33 = 1.33 m^3
Summation of ratio = 1+ 4 = 5

Quantity of cement

Quantity of cement = (Dry volume of mortar x Cement ratio) / (Sum of Ratio)
Quantity of cement = (1.33 x 1) / (1+4) = 0.266 m^3
Density of cement = 1440kg/m^3
Weight of cement = 1440 x 0.266 = 383.04 kg
1 bag of cement contains 50 kg of cement
Number of bags = 383.04 kg / 50 = 7.661 No's

Quantity of Sand

Cement: Sand :: 1: 4

Quantity of sand = Quantity of Cement x 4

- ∴ Quantity of sand = 0.266 m^3 x 4 = 1.064 m^3
- ∴ **Or Quantity of sands = (Dry volume of mortar x sand ratio) / (Sum of ratio)**

Quantity of sand = (1.33 x 4) / (1+4) = 1.064 m^3

1 m^3 = 35.3147 Cubic Feet (CFT)
Quantity of sand = 1.064 x 35.3147 = 37.574 CFT
Density of sand = 1920 kg/ m3

- ∴ Weight of sand = 1.064 x 1920 = 2042.88 kg => 2.0428 tonnes

Quantity of water

Water cement ratio (W/C) = Weight of water / Weight of cement
W/C → 0.50
Weight of Water = (Weight of cement) x (W/C ratio)
Weight of Water = 383.04 x 0.50 = 191.52 kg (Litre)

Example 2.

Determine the Portion of materials to mix mortar for pavement of a single room measuring 4m x 3m at the mix ratio of 1:4
The thickness of the pavement is 25 mm

Answer:

Given data: - Dimension of the room: L= 4 m
B= 3 m
- Thickness: 25 mm = 0.025 m
- Mix ratio: 1:4

Application: Total mix ratio: 1+4 = 5
Volume of the room: V=L x B x T = 4 x 3 x 0.025 = 0.3 m^3
Dry volume of mortar= 0.3 m^3 x 1.33 = 0.399 m^3

Quantity of Cement

Quantity of cement = 0.399 x 1/5 = 0.0798 m^3
Weight of cement = 0.0798 m^3 x 1440 kg/m^3 = 114.912 kg
Number of cement bags = 114.912kg / 50 kg = 2.298 Nos

Quantity of Sand

Quantity of sand = 0.399 x 4/5 = 0.319 m3
Quantity of sand = 0.319 x 35.3147 cft = 11.192 CFT
Weight of sand = 0.319 x 1920 = 612.86 kg

Quantity of Water

Quantity of water = Mass of cement x W/C ratio = 114.912 x 0.5
= 57.45 kg = 57.45 l

LU II. CONDUCT SITE SURVEY

LO II.1. IDENTIFY SRCEEDING TYPES

Screeding

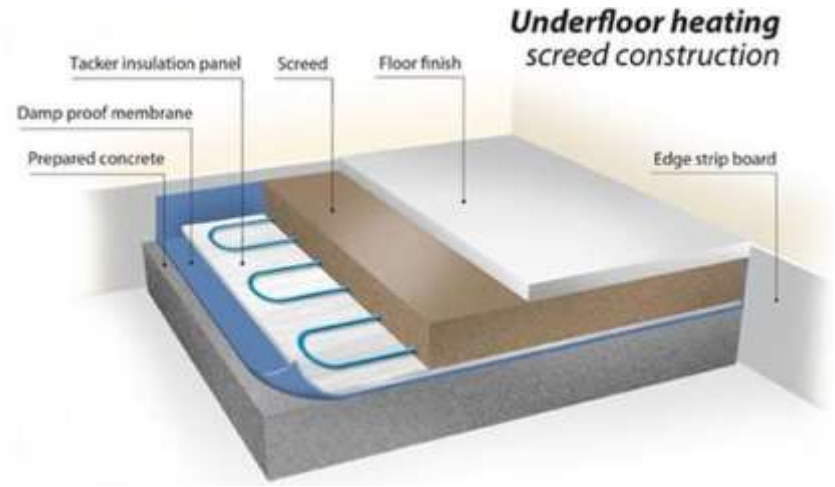
Screed is a type of concrete used to form a level surface. It is used to either to receive floor finishes, to encase underfloor heating pipes or to be left as the wearing surface.

Screeding is the process a person called a concrete finisher performs by cutting off excess wet concrete to bring the top surface of a slab to the proper grade and smoothness.

Screeding a floor is the simple act of applying a well blended mixture of Ordinary Portland Cement with graded agregates and water to a floor base, in order to form a sturdy sub-floor that is capable of taking on the final floor finish or act as a final wearing surface.

Further more it can laid either on top of an existing concrete base, a damp proof membrane (DPM) or insulation.

On top of insulation can be with or without underfoor heating (UFH) pipes. It is very important to ensure the base preparation is correct as it will have consequences for the long-term quality of the screed.



Types of Floor Screed

There are different types of floor screed that is specified based on the requirements and applications and the functionality of the floor:

- Unbonded screed floor (Figure 3 and Figure 6)
- Bonded screed floor (Figure 3 and Figure 4)
- Floating screed floor (Figure 3 and Figure 5)
- Heated screed floor (Figure 3 and Figure 7)

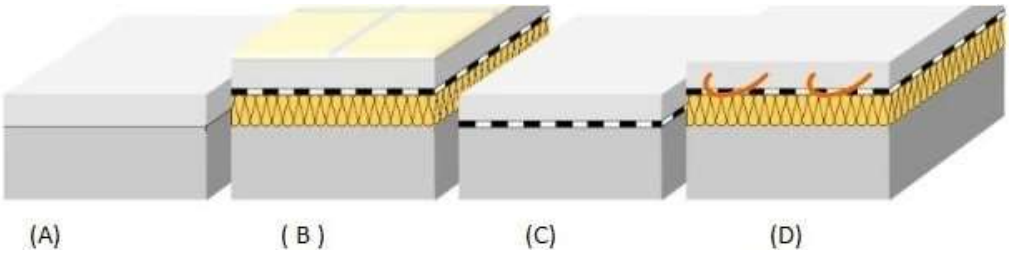


Fig.3: Different Types of Floor Screeds; (A) Bonded Screed, (B) Floated Screed, (C) Unbonded Screed and (D) Heated Screed

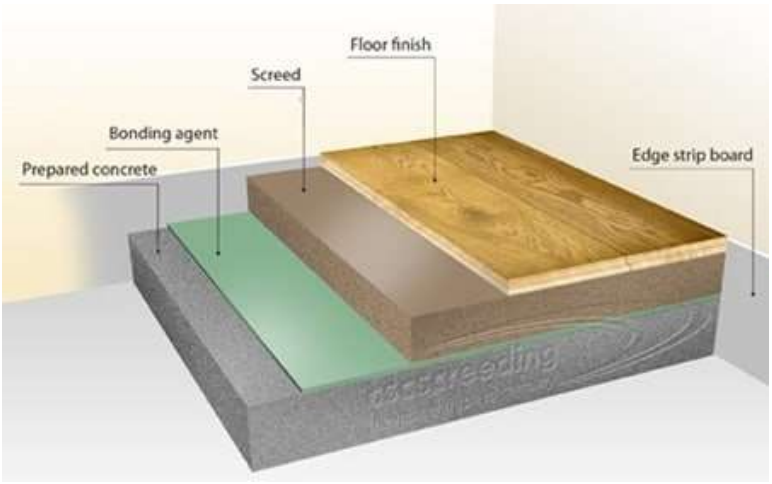


Fig.4: Bonded Screed Floor

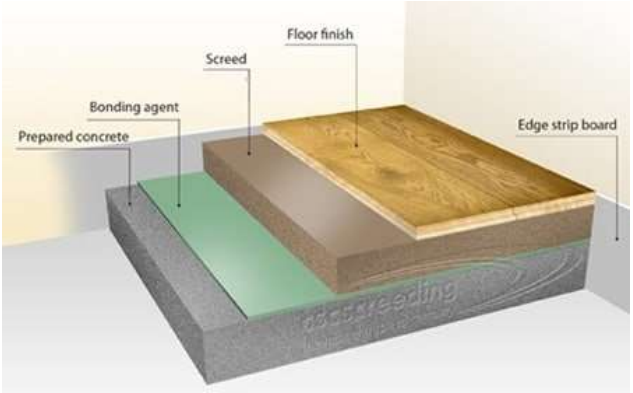


Fig.5: Floated Screed Floors

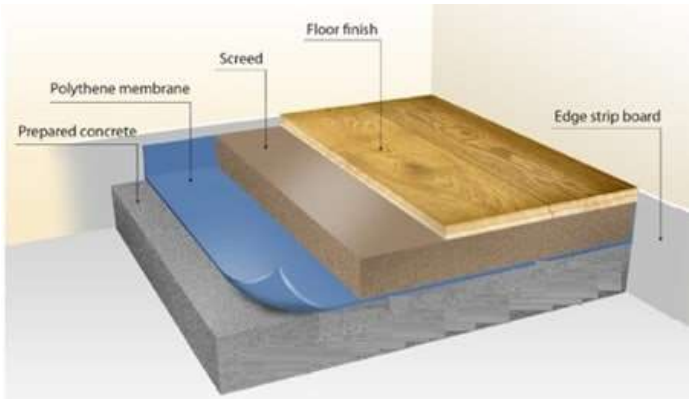


Fig.6: Unbonded Screed Floors

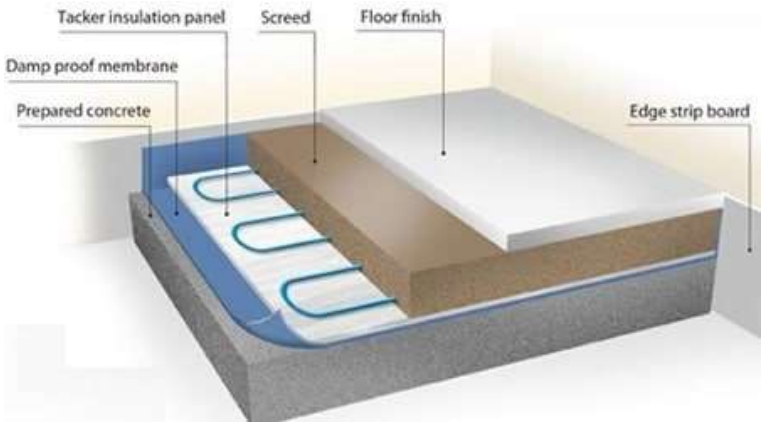


Fig.7: Heated Screed Floor

Materials for Floor Screed

Following are the materials used for construction of floor screeds:

- Cement
- Clean and sharp sand
- Water
- And occasionally additives are added to obtain specific properties. Polymer materials or metal mesh or glass are likely to be introduced to reinforce the screed.

The above components are adequately blended based on the prepared material proportions. If the thickness of the floor screed does not exceed 40mm, then the recommended mix is 1 Portland cement: 3 sands or 1 Portland cement: 4.5 sand.

However, 1 cement: 1.5fine sand: 3 coarse aggregate (10 mm maximum aggregate size) should be considered if the floor screed thickness is greater than 40mm.

It should be known that drying shrinkage gets reduced as the proportion of cement to sand is decreased.

Suitable amount of water should be specified to provide required workability since excessive water would reduce floor screed strength and inadequate water quantity lead to poor compaction.

Requirements of a Floor Screed

- Floor screeds should have **adequate thickness** which is based on the screed type and application frequencies. Recommended floor screed thickness based on the type of the screed floor and the construction conditions are provided in Table-1.

Table-1: Recommended Floor Screed Based on the Type of Screed and Construction Condition

Recommended floor screed thickness, mm	Floor screed type and construction condition
12	For monolithic construction. In this case floor screed will be placed no longer than 3 hours after the placement of concrete. This will guarantee a satisfactory bond between floor screed and placed concrete beneath it.
40	For screed floor placed on hardened concrete. The concrete should be cut by appropriate means then cleaned, wetted and finally screed is placed. Not only will this ensure good bond but also make the screed to dry slowly and prevent cracks.
50	For floor screed placed on impermeable damp proof membrane. In this case a bond between the screed and the layer below it would not exist and hence shrinkage is unrestrained.
65	For screed installed on compressible course of sound or heat insulation material. This is recommended for domestic application only, otherwise the thickness of the screed should be increased. Lesser thickness will suffer from crack development.
75	For screed installed on compressible course of sound or heat insulation material. This is advised for applications other than domestic utilization. Lesser thickness will suffer from crack development.

- Floor screed strength should be 20MPa for domestic application and 30MPa for industrial utilization

- It should be solid and compact so as to provide satisfactory base for the floor finish
- It should be curried properly to prevent shrinkage and rapid drying which lead to cracks. So, it should undergo almost all shrinkage, which floor screed might experience, prior to applying floor finish. This will lead to prevent the initiation of cracks.
- Finally, floor screed surface should be flat and smooth.

USE OF SCREEDING

A screed is a layer of material laid in situ, directly onto a base, for one or more of the following purposes:
• To obtain a defined level
• To carry the final flooring
• To provide a wearing surface.

DIFFERENT THICKNESSES OF SCREEDS

- The optimum thickness of a sand and cement ***bonded screed*** is **25–40mm**,
- An ***unbonded screed*** should have a minimum thickness of **50mm**,
- Whilst a ***floating screed*** should have a thickness greater than **65mm** for lightly loaded floors and **75mm** for more heavily loaded floors.
- When using traditional sand cement screeds the minimum thickness of **heating screed** is **65 mm**. Ideal thickness is between **65 mm and 75 mm** approximately, however **100 mm** thick screeds have been used successfully.

LO 2.2. PERFORM SCREEDING

Screed Mixing

The screed mix generally consists of sharp sand, cement and water.

The standard mix ratio is a 1:4 mix design. Screed needs to be mixed using a forced action to ensure that it is correctly batched. This should be done with a screed pump.

A screed will fail if the mix design is incorrect or its not been mixed correctly.

The screed pumps also transport the mix to the working area via hoses.

This ensures that underfloor heating pipes are not damaged in the process which is a common complaint when using a wheelbarrow.

Five essential steps to get your floor screeding right:

1. The right floor screeding contractor
2. The right floor screed
3. The right screed mix
4. The right process for installing the screed

5. The right measures for screed protection

The Right Floor Screeding Contractor

The right screeding contractor would hold extensive experience, a skilled work force and modern equipment's, be up to date with the latest technology and have strong references to back up their claims. The more the experience, the better adept the screeder will be in managing the nuances of screeding- all the way through planning, choice of screed, mix design, screed laying and screed protection to delivering on time and within the agreed budget.

The Right Floor Screeding

With the different kind of screed types, screed constructions and screed brands available, it could be a difficult task to arrive at a decision quickly. It is important to consider what each type has to offer and how well it fits in with your requirement and make an informed choice.

- **Traditional screed:** The standard screed mix of cement and sand mixed in the ratio of 1:3-5 is used for creating a defined layer for installing the final floor finish such as tiles, wood, linoleum, vinyl etc. Traditional screeds are generally suitable for use in hospitals, schools, retail, homes etc.
- **Free flowing screeds:** The anhydrite free flowing, self-leveling and self compacting screeds present the major advantage of easy placement and provide reliable results. However, the anhydrite screeds are not suitable for areas that are prone to getting wet. They cannot be used as a final wearing surface and are not compatible with cementitious products.
- **Floor levelling compounds:** These compounds vary from the general screeds in that they are used for levelling or as the final layer of screed to increase the tolerance while laying the floor finishes such as tiles, vinyl etc.

They are generally expensive and are used for screeding in warehouses and areas which require a very high level of surface regularity or flatness.

- **Structural Screeds:** This type of screed suitable for installing on precast floor surfaces. It is important to seek accurate specifications and calculations from a structural engineer before the installation of structural screeds as the information is vital to decide on the load requirements, flexural strength, bending moment, point loadings, etc.
- **Fast drying floor screeds/Accelerated Screeds:** If your project is on a strict time line and you do not have the time to wait for the industry benchmark of 1mm per day and 0.5mm thereafter (110 days for 75mm) for the screed to dry, it would be best to go for fast drying floor screeds like Flexi Dry which allows you to go for the installation of the final floor finish as early as 3 days after screeding.

The Right Screeding Mix

The right screed mix is one that is homogenously blended in the right proportion, following the agreed mix design. When there is the option to choose between ready mix and site mixing of

screeds, it is important to consider the viability of each option depending on the location and available space at the work site.

- **Site mixing of screed** is a very efficient and economical way of screed mixing and is suitable for most projects, provided the screed is force action mixed and the work is handled by a skilled work force. The three methods that are generally followed by screeders for site mixing of screeds are:

- **Hand Mixing:** This is suitable only for very small areas and is not recommended for bigger projects, as the work is tough and the estimated quantities and manual errors while mixing can seriously affect the quality of the screed.
- **Free Fall Mixers:** Free fall mixers are sometimes used by screeders for mixing larger quantities of screed at the work site. When these are sufficient for mixing general concrete mixes and mortar which are of a fluid consistency, screeds mixed using free fall mixers are often found to be of poor quality, weak and crush easily under impact.
- **Forced Action Mixers:** Forced action mixing is the most efficient and economic method for producing high quality screed mixes on site. Forced action mixing blends the cement and mix homogeneously and is ideal when additives or admixtures are to be added. Forced action mixers are usually of two types:

i) **Screed Pumps:** These are generally used for forced action mixing of large quantities of screed at the work site.

ii) **Pan mixers:** These are portable forced action mixers which are ideal for producing high quality screed mix at work sites where the use of bigger equipments is difficult.

- **Ready Mix Screeds** are a good option for work sites where the storage of materials is difficult. But there is always the problem of heavy traffic posing as a barrier in getting the screed at the site on time, and might result in a considerable amount of wastage and economic loss.

The Right Process for Installing the Screed

It is important to carry out the process of screed installation in a systematic manner to achieve the best results. There are several steps to be followed while preparing to install the screed:

- Check the specification is fit for purpose
- Make sure the substrate is ready to receive the screed.
- Check the access and egress is suitable for screed installation, plant and materials.
- Check the building is watertight.
- Check the datum levels, record the measurement down to finished screed level to ensure minimum and maximum depths are achievable and compliant with tendered nominal allowance.
- Check that running potable water is available at an adjacent point of the material location.
- Check that a waste facility is adjacent to the working areas.
- Check the mixing plant is safe and suitable to use.

- Mix the screed in the correct proportion.
- Apply the screed in a sequential manner, avoiding dry joints.
- Apply trowel cuts where necessary for crack control.
- Keep the working area tidy.

The Right Screeding Protection Measures

The last step in screeding – but this is definitely not the least important of the lot. Appropriate screed protection measures right after screed installation until the laying of the final floor finish is an extremely important step in preventing screeding failures, and is of greatest importance in achieving a screed of high quality, finish and durability.

From the regulation of site traffic to covering the screeded surface with screed protectors, there are several measures to be considered for protecting the screed.

At a basic level, it is imperative to ensure that:

- No site traffic is allowed at least for 24-48 hours after the installation of the screed
- Heavy site traffic is regulated until the installation of the final finish
- Heavy weights are not loaded unless after the consultation with a structural engineer

Procedure of Floor Screeding

- Evaluate the surface of the base
- Estimate materials used for screeding
- Prepare the base
- Prepare the floor screed mixture
- Apply bonding agents such as water or bonding slurry
- Place the floor screed mixture
- Finally, properly cure the placed materials