Carpentry Level I I

Learning Guide-41

Unit of Competence: Produce

Cement Concrete Casting

Module Title: Producing

Cement Concrete Casting

LG Code: EIS CRP2 M10 LO2-LG-41

TTLM Code: EIS CRP2 M10 TTLM 0919v1

LO 2: Fabricate cement casting

Instruction Sheet	Learning Guide #41

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Preparing formwork and reinforcements
- Mixing , placing and compacting materials
- Removing and curing cast

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- prepare formwork and reinforcements per specification
- mix, place and compact Material to make castings contractor's working instructions
- remove cure and Castings requirement and specifications

Learning Instructions:

Read the specific objectives of this Learning Guide.

1. Follow the instructions described below 3 to 5
2. Read the information written in the information
3. Accomplish the "Self-check 1, Self-check, 2 and Self-check 3" in page -7, 17, and, 25 respectively.
4. If you earned a satisfactory evaluation from the "Self-check proceed to operation sheet,27
5. Do the "LAP test" 28

Information Sheet-1	Preparing formwork and reinforcements

1.1. Preparing formwork

Formwork is a mold or open box, like container in to which fresh concrete is poured and compacted

When the concrete is set, the formwork is removed and a solid mass is produced in the shape of the inner face of the formwork

- . **Formwork materials**

Formwork materials can be classified as:

1. Timber
2. Metals
3. Plastic

1.2. Types of Formwork

- ✓ **Foundation Formwork**

Foundation formworks can be designed in various ways. Basically there is a difference between formwork for individual foundations, normally designed as socket foundations, and formwork for strip foundations. The type of design is dictated by the size, mainly by the height of the foundation formwork.

The formwork for individual foundations is similar to column formwork and the formwork for strip foundations is similar to the formwork.

Normally sheeting panels with formwork bearers in the form of walers are used for foundation formwork. Individual foundations are also secured by means of walers but of rim type.

Bracing is by squared and round timbers as well as boards diagonally arranged. Tie wires as well as metal screws are used as formwork ties.

- ✓ **Wall Formwork**

Wall formwork consists of vertically arranged upright timbers (formwork bearers) to which sheeting boards are nailed at the concrete side. The upright timbers are diagonally braced by means of boards at both sides.

On cleats situated at every third upright timber, there are horizontally arranged walers. The opposite walkers are tied at specified distances.

Prefabricated sheeting panels may also be used instead of sheeting boards.

Cleaning holes are to be provided at the foot of the formwork.

- ✓ **Ceiling Formwork**

Ceiling formwork is the type of formwork mostly found in structures/buildings.

The formwork sheeting may consist of sheeting boards or prefabricated sheeting panels. The formwork sheeting may consist of sheeting boards or prefabricated sheeting panels.

- ✓ **Beam Formwork**

Beam formwork has prefabricated formwork sheeting parts (sheeting bottom and side sheeting panels). Such individual parts are manufactured based on the beam dimensions specified in the project.

- ✓ **Column Formwork**

Similar to beam formworks, the sheeting of column formworks is prefabricated according to the column dimensions from sheeting boards connected by cover straps.

The sheeting panels are placed in a foot rim which is anchored in the soil by steel bolts.

- **Concrete Floor Slab Construction Process**

1. Assemble and Erect Formwork
2. Prepare and Place Reinforcement
3. Pour, Compact and Finish Concrete
4. Curing Concrete and Remove Formwork

1.3 Reinforcement:

The reinforcing steel should be conforming to project specification and as per drawings.

- **Handling and stacking:**

- Number and spacing of supports will be such that there is no sagging of the stacked bars.
- Stacked rebar will be covered with tarpaulins or such other means and protected from mud, oil or any other thing that causes damage.
- Standards as set out in the project specifications will be adhered to in handling and storage of reinforcing materials.

- **Cutting and Bending of Bars:**

The reinforcement will be cut and bent in accordance with the approved bar bending schedules.

The bending of reinforcements will be done on the bending machine, producing a gradual and even motion. Bars will be bent cold and at specified radii.

- **Receipt and Storage of Bars:**

The rebar received from the supplier will be inspected. All defective materials will be repaired or replaced by the supplier.

The storage of rebar will be arranged above ground on padded supports, using timber pieces or sand bags. The rebar will be covered with dark light proof material to prevent rusting.

- **Placing of Reinforcement:**

Minimum concrete cover for reinforcement shall be as per the Reinforced Concrete Works General Notes.

All reinforcement shall be supported and fastened before concrete is placed and shall be secured against displacement within permitted tolerances.

Reinforcement supported by formwork shall rest on bar supports made of plastic or other acceptable materials.

1.4. Reinforcement steel works for concrete structures

This section intends to build the skills of rural masons to:

- Read and explain drawings and sketches describing how reinforcement steel is to be used in concrete structures such as columns, beams and slabs.
- Use hand tools for cutting and bending reinforcement steel bars
- Fabricate, place and fix reinforcement steel for concrete footings, columns, beams and slabs.
- Type and characteristics of reinforcement steel

1.5. Type and characteristics of reinforcement steel

Reinforcement steel is normally provided as individual steel bars or as steel bars welded together into a mesh. The bars are used for beams and columns, while the mesh is prepared for large surfaces such as slabs and walls.

Reinforcement is also commonly used when building rural houses. The common diameters of steel bars used in building work are 6, 8, 10, 12, 16, 18, 20, 22, 25 and 32 mm.

Fig1.1 reinforcement steel

There are two main categories and purposes of reinforcement steel. The main bars are meant to take most of the tension stresses, while the distribution reinforcement serves the purpose of spreading the load and keeping the main reinforcement in position when pouring concrete. The main reinforcement bars are placed in the area where tension occurs. It should be adequately covered with concrete with minimum 20 to25 mm for slabs, 25 to 30 mm for beams on all sides and 40 mm for columns to avoid any corrosion of the reinforcement.

If steel bars need to be extended, some of the critical points to be remembered are:

•The lap length should be greater than 50 times the diameter of the bars used.

•Lapping should not be done close to joints or any other critical areas of the structure.

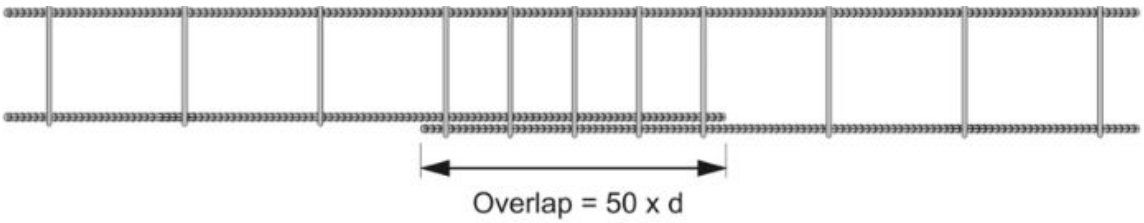


Fig1.2 overlap reinforcement steel

- For smaller works in rural areas the reinforcement bars are cut and bent on site. This requires some skill and the appropriate tools. The reinforcement bar bending schedule describes what type of bars to prepare in terms of size, shape and numbers of each type.
- The stirrup is the outer frame that holds the load bearing bars in the correct position. These are prepared onsite using 10mm diameter bars. The exact length of the bars for stirrups needs to be carefully calculated based on the dimensions of the column or beam. The re-bars have to be covered all round with at least 25mm to 30mm concrete.

The stirrups therefore need to be cut and bent to allow for sufficient coverage.

Make sure the end bend is minimum 50mm

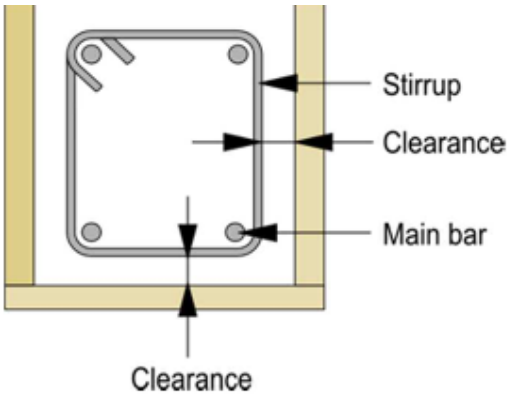


Fig1.3 stirrups reinforcement steel

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. what is Formwork?(3point)
2. write types of formwork (5 points)

Note: **Satisfactory above – 4 out of 8 points Unsatisfactory - below 4 out of 8 point**

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

1._____

_____-----

2._____

_____

Information Sheet-2	Mixing , placing and compacting materials

2.2 .Mixing, placing and compacting materials

2.2.1. Batching of concrete ingredients

Batching is the process of measurement of cement, coarse aggregate, fine aggregate and water for each operation of concrete making.

- **Method of batching**

Batching is done in two ways

I. By volume (volume batching)

II. By weight (weight batching)

I. Volume batching

A) Batching of cement. Cement is always measured by weight. Mostly it is used in terms of bags. One bag of cement weights 50 Kg as a volume of 35 letters. ($0.035m^3$) Cement should not be batch by volume because its weight per unit volume varies according to the way the container is filled.

B) **Batching of aggregate by volume** a gauge box is used for batching of fine and coarse aggregate by volumes is shown in the figure below. The box should not be too shallow. It should be completely filled with the aggregate s. The top of the materials should be struck of f level with a straight edge. The ratio of materials of concrete decides the capacity of the box. Generally capacity equal to the volume of one bag of cement. Convenient sizes of gauge boxes to suite different proportion given in the table below

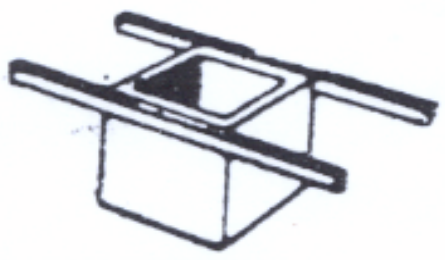


Fig2.1 Gauge box

Capacity in liter	Inside measurement in cm		
	Length	Breadth	Depth
25	25	25	40
30	25	25	48
35	27	27	48
40	29	29	48
45	30	30	50
50	31	31	52

II. Weight batching: -

In weight batching the ingredient of concrete are measured by weight. Generally, weight batching is in practice for constructions where high quality concrete is required. Weight batching is much more accurate than volume batching. Different types of weight batching is available the particular type to be used depends up on the nature of the job. Large weight batching plants have automatic weighting equipment. These are supervised by a qualified and experienced engineer.

Batches of concrete are based either on one bag of cement or its multiples unless bulk cement is used and weighed separately. In this type of batching, no correction is needed to allow for the bulking of sand, but an allowance should be made for weight of water contained by the weight aggregate. For comparatively smaller works weight batch can be done by:-

1. Simple spring balances
2. Plate form weighing machines
3. Automatic weighing Mach

2.2.2. Mixing and discharging of concrete

- **Hand mixing**

For hand mixing, a water – tight platform at least 2m and 3.5 m long or hard concrete surface should be provided. Since a platform should preferably be made of boards 3 to 5 can thick, tongued and grooved so that joints are tight and the platfo4rm is rigid.

- **Working procedure**

Following is the stepwise procedure for mixing concrete by hand.(mixing procedure)

a) Spread out a measured quantity of sand evenly on the mixing platform

b) Spread to cement uniformly on this sand and mix it till the color of the mixture is uniform

c) Spread this mixture evenly again on the platform.

d) Spread on the platform the course aggregate evenly on the surface.

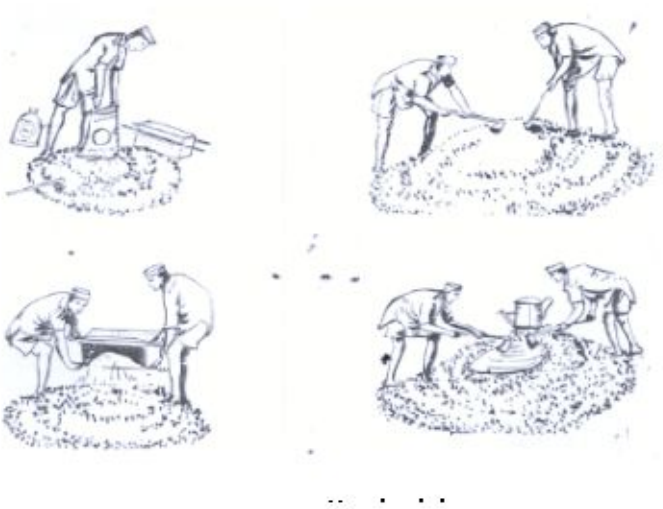


Fig2.2 waste time

- **Machine mixing**

If you are casting large quantity of concrete, hand mixing is laborious and tiresome work. A mechanical mixer will save you a lot of work. Depending on the magnitude of the work choose the correct capacity of mixer that fits your work

Installing mixer, feeding materials into mixer, mixing operation, discharging and closing down of the mixer after use are important steps in operating a mixer.

A) Installation of mixer

e) The mixer should be placed as near to place of concreting as possible.

ii) It should be placed on a firm ground and should be leveled.

iii) Examine the mixer and its blade.

iv) Inspect engine, oil, cooling water and petrol, etc.

B) Charging operation

When the ingredients are fed into to drum directly, the following sequence of feeding the material may be tried

i) First put some portion of water

ii) Next put in half the quantity of the course aggregate.

iii) Put cement followed by sand

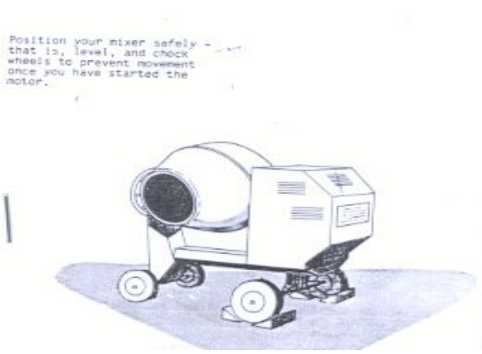
iv) Feed the remaining part of the course aggregate

C) Mixing operation

For good mixing about 20 revolutions of the drum are generally sufficient. But since there is an optimum speed recommended by the maker of the mixers, the mixing time and revolutions are

Interdependent. Generally the speed of a mixer drum varies between 16 r. p. m to 2 r. p. m. The mixing time varies between 1 and 12 minutes.

Mixing time less than one minute reduces the quality of the concrete. Normally the mixing time specified is 12 minutes. The time is measured from the moment all the materials are fed into the drum.



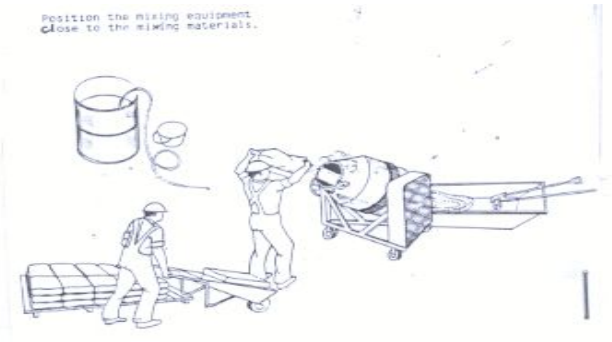


Fig2.3 mixing operation

2.2.3. Place and compact concrete

Introduction

Before you can place your concrete, you need

• Formwork ready and checked

• Batches of mixed concrete arriving quickly and regularly

All the material and equipment ready.

Basic Requirements for Placing Concrete

- Preserve concrete quality
  - ✓ Water-cement ratio
  - ✓ Slump
  - ✓ Air-content
  - ✓ Homogeneity
- Avoid separation of aggregate and mortar
- Avoid excessive horizontal movement
- Consolidate adequately
- Maintain sufficient placement capacity
- Choose the right equipment for the concrete

- **Transporting of concrete**

The precaution to be taken while transporting concrete is that the homogeneity obtained at the time of mixing should be maintained while being transported to the final place of deposition.

There are different ways of handling concrete, and the choice will depend mostly on:

a) The amount of concrete involved

b) The size and type of construction

c) The topography of the job site

d) The location of the batch plant

e) The relative cost

Fig3.4 Transporting of concrete

All the material and equipment ready.

- **Basic Requirements for Placing Concrete**

➢ Preserve concrete quality

- ✓ Water-cement ratio
- ✓ Slump
- ✓ Air-content
- ✓ Homogeneity

➢ Avoid separation of aggregate and mortar

➢ Avoid excessive horizontal movement

➢ Consolidate adequately

➢ Maintain sufficient placement capacity

➢ Choose the right equipment for the concrete

- **Placing**

It is of at most importance that the concrete must be placed in a systematic manner to yield optimum results.

- ✓ The main objective is to deposit the concrete as close as possible to its final position so that the segregation is avoided and the concrete can be fully compacted. To achieve this objective, the following rules should be borne in mind.
- ✓ The concrete should be placed in uniform layers, not in large heaps or sloping layers;
- ✓ The rates of placing and compacting should be equal

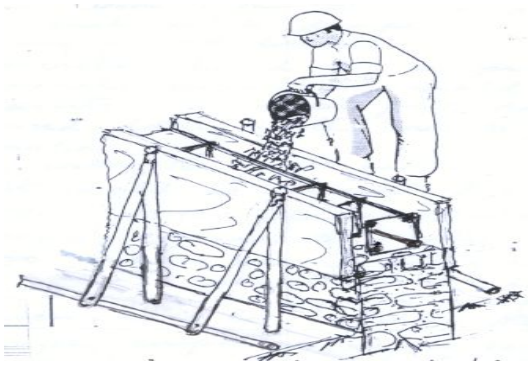
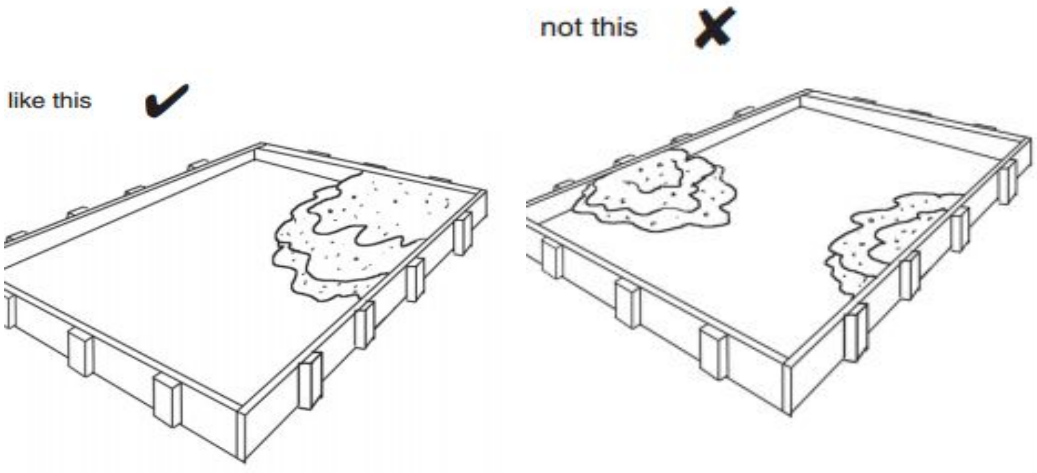


Fig3.5. Placing concrete

- **Note: Stat placing loads from a corner at one end of the slab**



- **Compaction**

✓ Compaction is one of the last, but important steps in concrete making, because the density, strength and durability of the concrete depend so much on it.

✓ Compaction of concrete is the process adopted for expelling the entrapped air from the concrete.

✓ If this entrapped air is not removed fully, the concrete loses strength considerably. 1%entrapped air cause 5-6% reduction in concrete strength.

The following methods are adopted for compacting the concrete:

A. Hand compaction **C. Compaction by pressure and jolting**

B. Compaction by vibration **D. Compaction by spinning**

I. Internal vibrator (needle vibrator)

ii. Formwork vibrator (external vibrator)

iii. Table vibrator

iv. Platform vibrator

v. Surface vibrator (screed vibrator)

vi. Vibratory roller

- **The duration of vibration is dependent on:-**
  - The height of the layer,
  - The size and characteristic of the vibrator, and
  - The workability of the concrete mix.

Fig3.6. Placing Concrete in a Sloping Lift

✓**Correct**

Start placing at bottom of slope so that compaction is increased by weight of newly added concrete. Vibration consolidates the concrete.

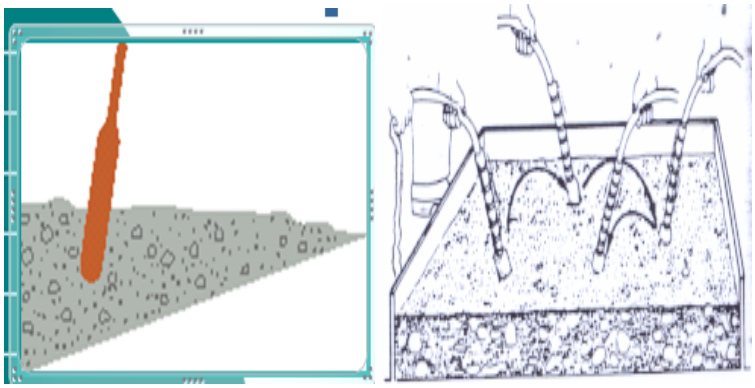


Fig3.7. Correct use of vibrator

Incorrect

When placing is begun at top of slope the upper concrete tends to pull apart especially when vibrated below as this starts flow and removes from concrete above.

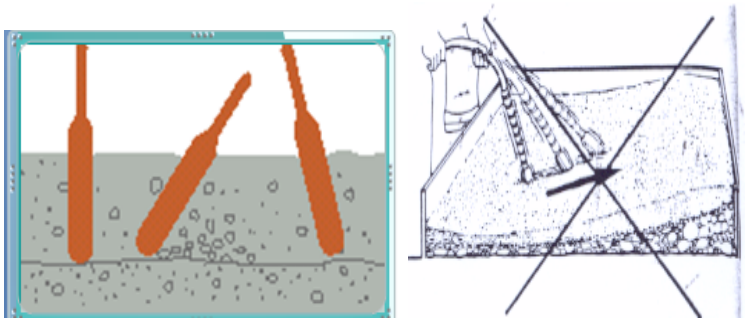


Fig3.8 Wrong use of vibrator

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write the basic requirements for Placing Concrete? (5pts)

2. List method of batching?(2pts)

Note: **Satisfactory above – 3.5 out of 7 points Unsatisfactory - below 3.out of 7point**

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

1._____

_____

2_____

_____

Information Sheet-3	Removing and curing cast

3.1. Removing castings

- Once concrete is set, remove the bolts , carefully tilt the baluster flat to the ground taking care not to rest heavy casting on edges of mold (best to remove on grass area, carpet, cardboard for softer surface).
- Now unmold the castings by pulling and lifting on the ends of the mold.
- The concrete will continue to set up for 5 more days so be gentle with handling until it is fully cured.
- Clean the mold immediately after use and store molds out of the sun.
- It is normal to have some air bubbles in the surface of your baluster which you can patch easily by mixing a small batch of one part cement and one part sand and enough water to moisten. Apply with a damp sponge to smooth over the area.

Fig3.1 Remove the mold

3.2. Curing

Curing is the name given to procedures for promoting the hydration of cement. It may be defined as the act of maintaining controlled condition for freshly placed concrete for some definite period following the depositing and finishing operations to assume the proper hydration of cement and proper hardening of concrete.

3.3. Advantage of Curing

i) Improves wearing quality of the concrete

ii) Improves the strength of the concrete

iii) Improves the impermeability of the concrete depending on the grade of the concrete.

v) Improves the durability of the concrete

vi) If chemicals are used it shortens the removing time of the form work

3.4 Methods of curing

When making provision for the two extremes, frost and heat, the factors to consider are those which influence the gain of strength, i.e. cement and water. Water is needed to provide workability and commence the hardening process, and the proportion used, known as water / cement ratio (W/C), must be sufficient for these two tasks. The ratio will need to be varied to suit climatic variations.

In cold weather the water / cement ratio needs to be kept to the minimum necessary to provide the desired workability. Since cement and water react more rapidly as the temperature increases, it is an advantage to use warm water to assist early setting as a precaution against frost damage. In hot weather the water will have a tendency to evaporate more rapidly because the speeded up hardening process produce more heat. To increase the water / cement without taking additional precautions would only create problems of cracking and loss of strength. To overcome these problems there are different methods of curing and are mentioned few of them below.

A. Shading of concrete work

B. Covering concrete surface with wet material

C. Continuous sprinkling of exposed surfaces

D. Ponding method

a) Shading of concrete work

This method consists of curing surfaces by canvas stretched on frames in initial stages of hardening even prior to setting when the concrete is mechanically weak. In very hot and dry climates, it is necessary to prevent the evaporation of water. In cold climates, it is necessary to preserve the heat of hydration.

This method has a limited application. Firstly, it is hard to handle in strong winds. Wherever possible, the canvas or burlap should be placed directly on the surface of the concrete unless a very smooth finish is required. This method is inefficient when w/c ratios are low. In the case of slabs where smooth finish is important, the suspension of canvas on the frames is an expensive affair.

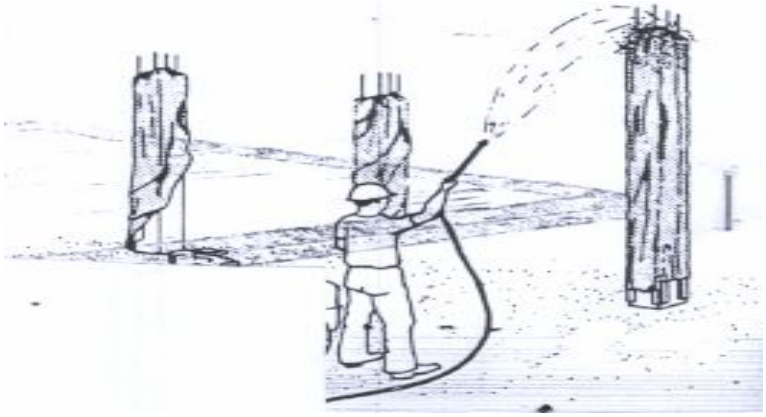


Fig3.2 shading of concrete work

b) Covering concrete surfaces with wet material

This is the most widely used method. It is done by covering the concrete surfaces by wet Hessian cloth, canvas or sacking and is kept constantly wet for at least 7 days from the date of placing of concrete. Normally, for the first 24 hours, the concrete is protected by formwork. In structural concrete formwork supporting the vertical surfaces are struck of after 24 hours. These surfaces such as those of columns and walls are then kept moist by surrounding it with Hessian cloth. Horizontal surfaces such as those of road-slabs, house floors, etc. are covered by wet Hessian, damp sand or damp sawdust. A layer of at least 5 cm of earth and sand or sawdust or 15 cm of straw is spread and is kept wet.

The frequency of wetting depends upon the temperature, velocity of wind, humidity, etc. With higher temperatures, greater wind velocity and dry climates, wetting should be frequently resorted. It is important that the concrete should not be allowed to dry and exposed to extremes of temperature even for short intervals.

Fig3.3 covering concrete

C) Continuous sprinkling of exposed surfaces

Continuous sprinkling is done by spraying water through hose. In this type, it is important to ensure that the surface is continuously kept wet for three days and later on, the spraying may be intermittent. Floor slabs can be kept wet by a single hose pipe. But for long walls or sloping surfaces of large areas and columns the spraying is done by a perforated hose-pipe, allowing the water to trickle from the top along the surface.

Sprinkling of water starts when the concrete surface has initially sufficiently hardened. The efficiency of this method is the same as that of ponding, but the total water requirement is higher. It should, therefore, be used only when the ponding method is n

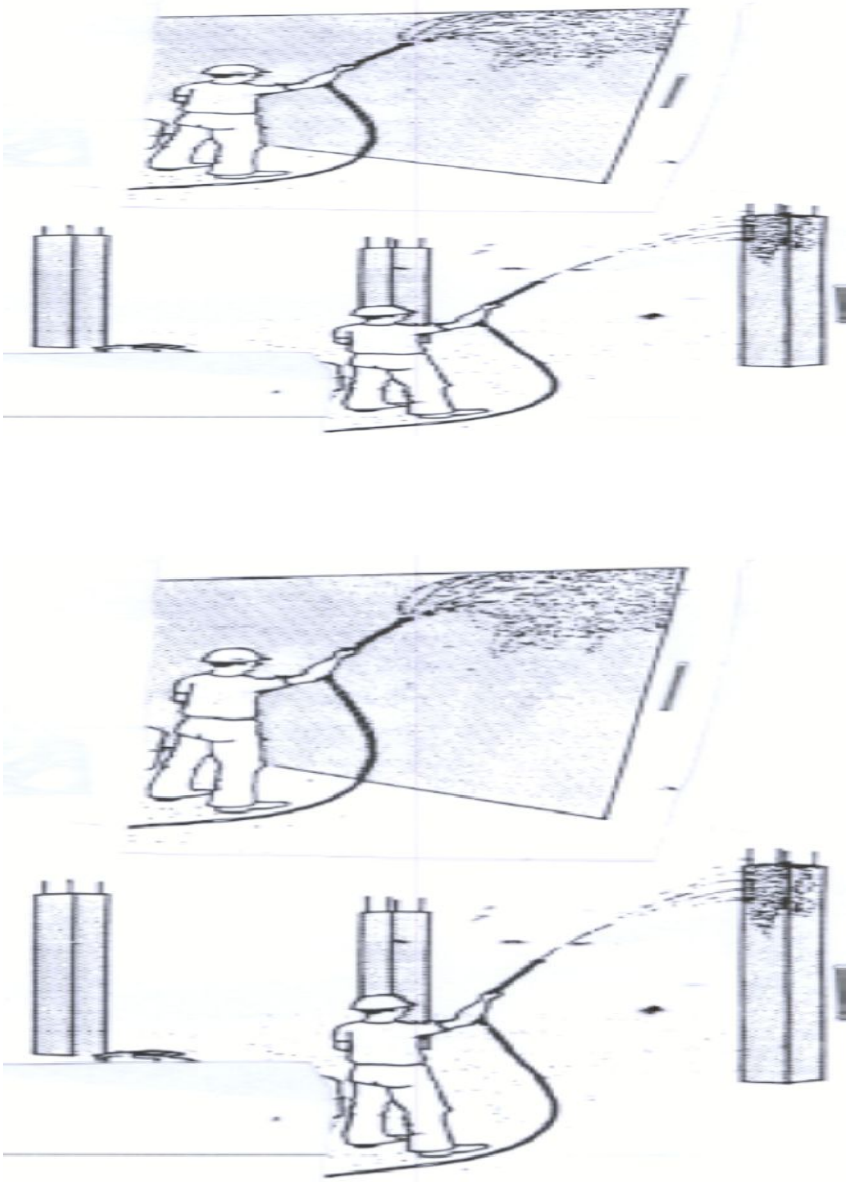


Fig3.4 Continuous sprinkling of exposed surfaces

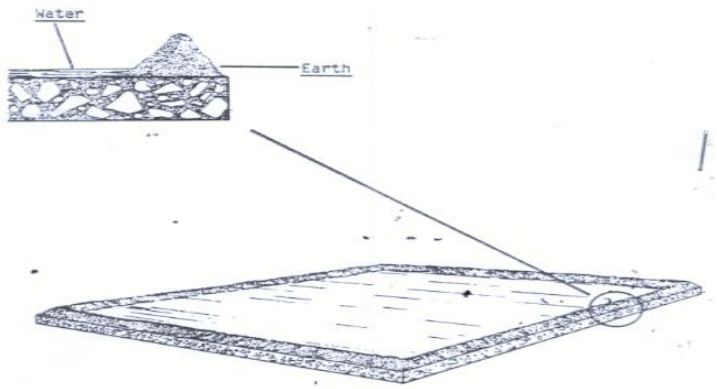
D).Depending method

This is the most efficient method of curing. For the first 18 to 24 hours.

The exposed surface is covered with moist Hessian or canvas. After that small banks of dykes of clay or earth are built across and along the slab, dividing the slab into number of rectangular ponds. These ponds are filled with water. This method is suitable for the construction of floors, roof slabs, roads and airfields.

This method is very efficient especially when the concrete has a low w/c ratio below 0.4.

The water requirement for this method is higher than that for the Hessian cloth method but less than that for the continuous spraying method. One disadvantage is the difficulty of removing the mud from the slab on completion of the curing process. But this is not serious in view of its efficiency.



3.5. Duration of curing

Concrete mix design strength is determined on specimens cured under water for 28 days. The test samples for quality control of construction are also cured for 28 days. For the development of the stipulated design strength therefore, the same curing period of 28 days should be specified.

From practical considerations, however, this is rarely done. The exposed surfaces of concrete should be kept continuously in a damp or west condition for at least 7 days from the date of placing concrete. For concrete roads stipulates moist curing with west Hessian for the first day, and thereafter 14 days curing by bonding water in earthen dykes made on the slab. The dykes are to be filled with water on the fourteenth day; and the wet earth cover left in place till such time that the required strength of concrete is attained.

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Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is Advantage of Curing?(5pts)

2. What is the method of Curing?(3point)

Note: **Satisfactory above_4 out of 8 points** **Unsatisfactory - below 4out of 8 point**

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

1._____

_____

_____

2._____

_____

Operation Sheet 1	Mixing , placing and compacting materials

Mixing , placing and compacting materials Procedure:

Step 1- Spread out a measured quantity of sand evenly on the mixing platform

Step 2- Spread to cement uniformly on this sand and mix it till the color of the mixture is uniform

Step 3- Spread this mixture evenly again on the platform.

Step 4-Spread on the platform the course aggregate evenly on the surface.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hour.

Task1 Mixing, placing and compacting materials?

List of Reference Materials

.

1. https://www.ilo.org/wcmsp5/groups/public/---

2http://www.nzdl.org/gsdlmod?e=d-

Annex I

Answer keys for learning guide -41

Answer key

Self-check

Information Sheet-1

1, **Formwork i**s a mold or open box, like container in to which fresh concrete is poured and compacted

2. Foundation formwork, beam, column formwork

Information Sheet-2

1, Avoid separation of aggregate and mortar

Avoid excessive horizontal movement

Consolidate adequately

2. by volume and by weight

Information Sheet-3

1, Improves wearing quality of the concrete

ii) Improves the strength of the concrete

2. Shading of concrete work

Covering concrete surface with wet material

Continuous sprinkling of exposed surfaces

Ponding method

Acknowledgement

The Ministry of Education wishes to extend thanks and appreciation to the many representatives of business, industry, academe and government agencies who donated their time and expertise to the development of this **TTLM** preparation on **carpentry_Level II**.

The trainers (who developed the curriculum)

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