Bar bending& concreting
Level II

Learning Guide #27

Unit of Competence: **Erect and dismantle Formwork for Footings, slabs Beam, Stairs & column**

Module Title: **Erecting and dismantling Formwork for Footings, Slabs Beam, Stairs & column**

LG Code: **EIS BBC2 MO6 LO2-LG-27**
TTLM Code: EIS BBC2 M06 TTLM 1019v1

LO 2: Erect formwork.

Instruction Sheet	Learning Guide #27

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

- Identifying design of footing, Beam & Column and/or slab from job drawings and specifications,
- Setting out formwork.
- Selecting fixing and fasteners consistent with construction requirements of the job.
- Constructing and erecting formwork shutters and/or edge boxing.
- Bracing formwork support.
- Installing block-outs and cast-in services.
- Applying Release agents to formwork face

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 –

- identify check design of footing, beam & column and/or slab on ground from job drawings and specifications,
- Formwork set out to requirements of drawings and specification
- Construct and erect formwork shutters and/or edge boxing.
- Brace formwork support to job requirements and specifications.
- Install block-outs and cast-in services to specify locations.
- Specify apply release agents to formwork

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 7.
3. Read the information written for each “Information Sheets given below
4. Accomplish the “Self-check after reading & understanding of each information sheet
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet
6. Lastly do the “LAP test
7. If you have any question ask your teacher

Information Sheet 1	Identifying design of footing, Beam & Column and/or slab from job drawings and specifications,

2.1. Identifying design of footing, Beam & Column and/or slab from job drawings and specifications,

2.1.1. Introduction

Footings are structural elements that transmit column or wall loads to the underlying soil below the structure. Footings are designed to transmit these loads to the soil without exceeding its safe bearing capacity, to prevent excessive settlement of the structure to a tolerable limit, to minimize differential settlement, and to prevent sliding and overturning.

The settlement depends upon the intensity of the load, type of soil, and foundation level. Where possibility of differential settlement occurs, the different footings should be designed in such a way to settle independently of each other.

- **Footing**
  - ✓ **Square footing**

The area of the form work for square footing is calculated by taking the external perimeter of the footing pad and multiplying by the depth of the pad. For a square pad of size 2.3m, for instance, the total length of the form work will be 4x2.3m which is equal to 9.2meter. If for instance the depth of the footing pad is 35cm, then the area of the form work for this pad will be the product of the length and the depth which will become 9.2m x 0.35m = 3.22 m^2.

- **Circular footing**

The method is the same. The length of the form work is calculated by taking the external perimeter of the pad. For instance the radius of the footing is 2meter, the length of the form work will be 2ΠR. Which is equal to 2 x 3.14 x 2m = 12.56m. This length of the pad is then multiplied by the depth of the pad. If the depth is 45cm, then the area will be 12.56m x 0.45m = 5.65m^2.Other forms of footings will be discussed in class.

Note: The area of form work for footings include the area of the form work for the pad and the column below the grade beam. However the two areas can also be separately estimated.

Footings may be classified as deep or shallow. If depth of the footing is equal to or greater than its width, it is called deep footing, otherwise it is called shallow footing. Shallow footings comprise the following types:

- **Isolated Footings:**

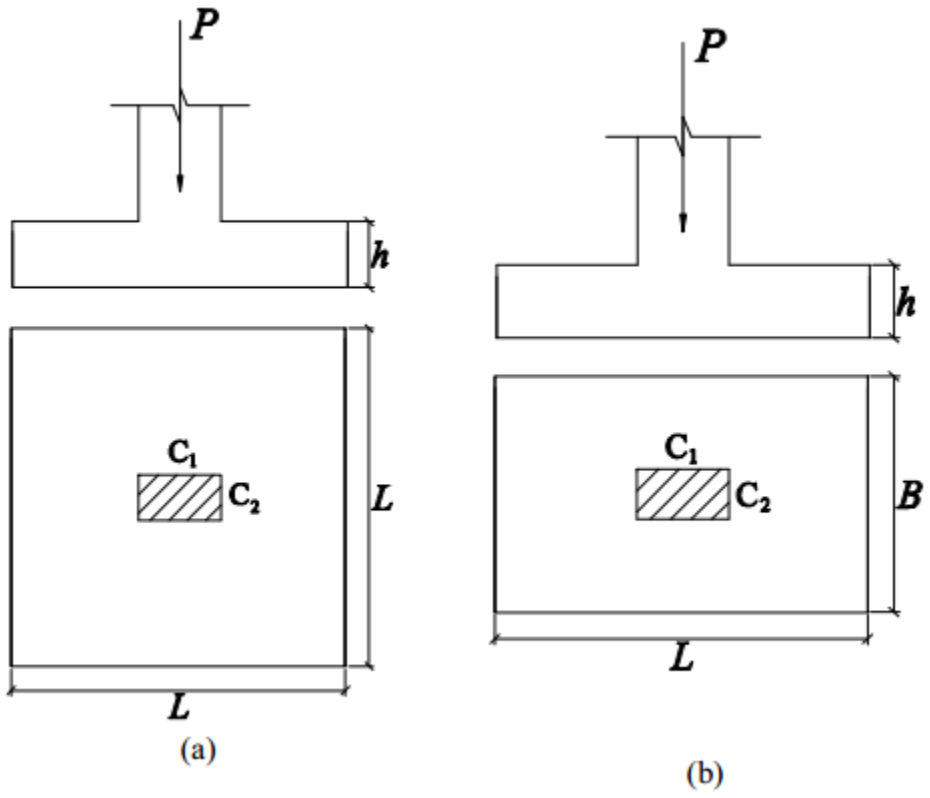


Figure (a) Square isolated footing; (b) Rectangular isolated footing

- **Footing Design**

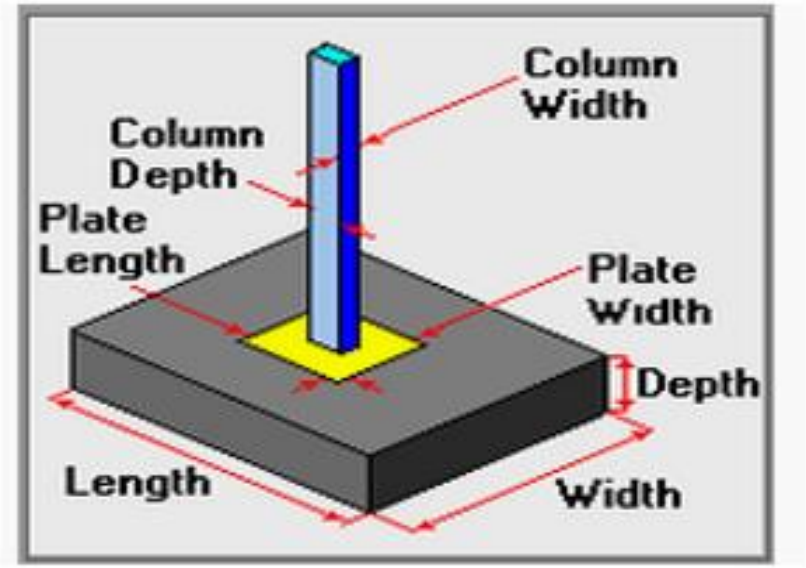


Fig 1.Column footing

- **Depth of Footing**

The depth to which foundations shall be carried is to satisfy the following:

- ✓ Ensuring adequate bearing capacity.
- ✓ In the case of clay soils, footings are to penetrate below the zone where shrinkage and swelling due to seasonal weather changes are likely to cause appreciable movement.
- ✓ The footing should be located sufficiently below maximum scouring depth.
- ✓ The footing should be located away from top soils containing organic materials.
- ✓ The footing should be located away from unconsolidated materials such as garbage.

- **Beam Design**

A beam is a structural element that primarily resists loads applied laterally to the beam's axis. Its mode of deflection is primarily by bending. The loads applied to the beam result in reaction forces at the beam's support points.

Beams are structural elements that resists loads applied laterally to their axis. They typically transfer loads imposed along their length to their end points where the loads are transferred to walls, columns, foundations, and so on.

- **Beams may be:**
  - ✓ **Simply supported**: that is, they are supported at both ends but are free to rotate.
  - ✓ **Fixed**: Supported at both ends and fixed to resist rotation.
  - ✓ **Overhanging**: overhanging their supports at one or both ends.
  - ✓ **Continuous**: extending over more than two supports.

Fig 2 Beam Design

- **Column Design**

Column is the main supporting structural member of any building. Column: Column is defined as compression member which has an effective length greater than its least lateral dimension.

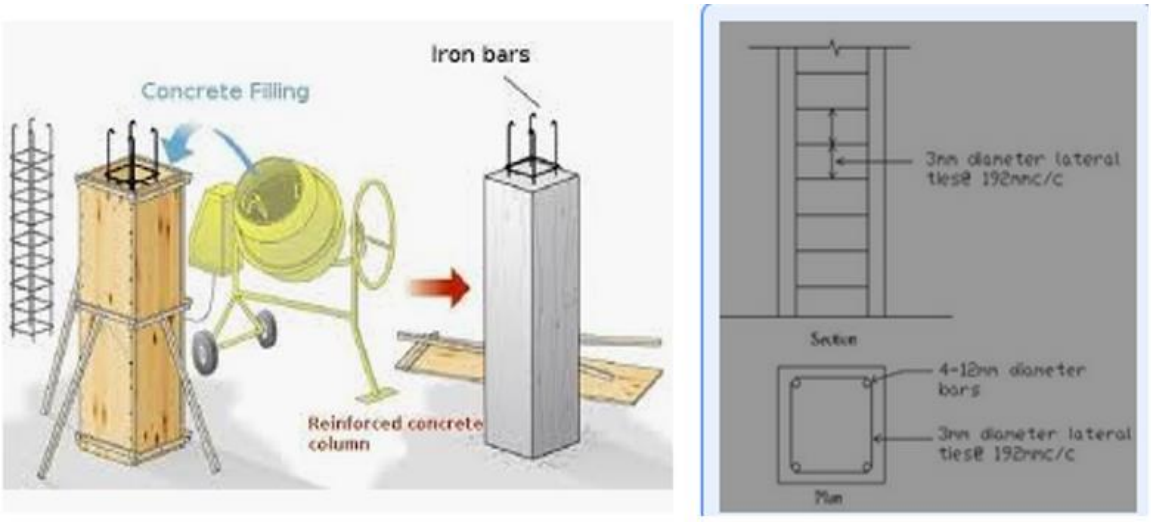


Fig 3. Column Design

- **Formwork For column**

Column formwork is made usually with either timber or metal panels. The principle is to create an enclosed box with frames at the exact size of the column and fix it tightly on the kicker left from base or at the last stage of column concreting. The box is held in position by steel column clamps or bolted yokes and supported by timber studs or props

Form-work for column consists of vertical board called sheeting, cleats, wedge and yokes. Usually the boards are 25 mm thick. The width of the boards may vary depending on the section of the column. Boards internal dimensions are normally constructed the same size as the external dimensions of the columns. In large column, boards up to 32 mm thick are used. The cleats used at the base of the box are larger so as to withstand the pressure which is exerted by the weight of the concrete.

Fig 4 Formwork for column

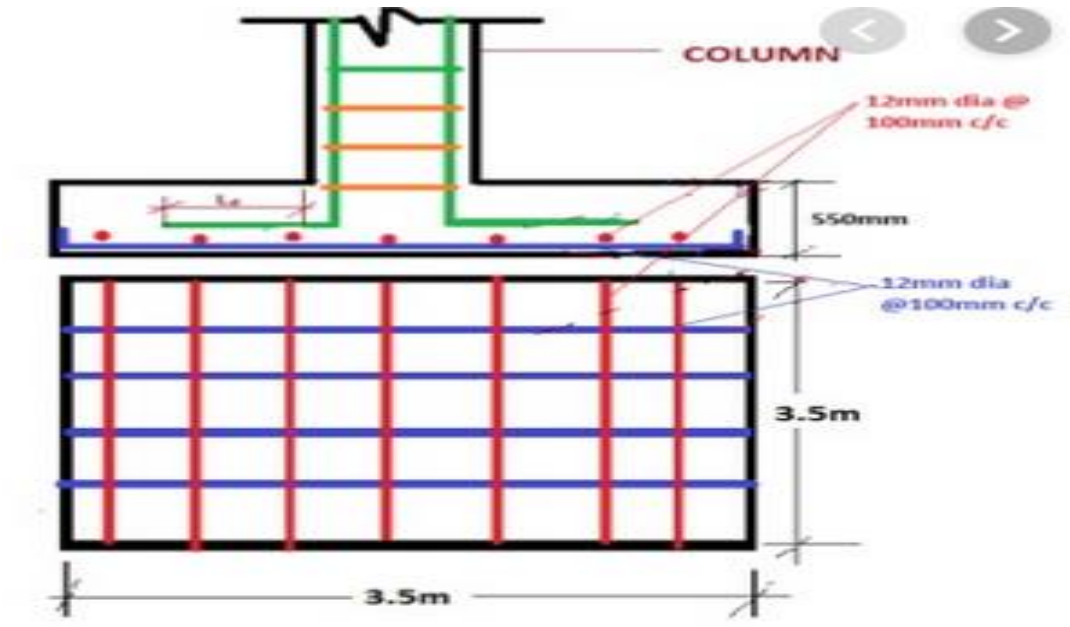


Fig 5.Detail of reinforcement

- **Slab Beam**

A slab is one way slab when a slab is supported on two edges and bends in only one direction. Of such slabs run parallel to the span. For the transverse direction, a minimum amount of shrinkage reinforcement is provided.

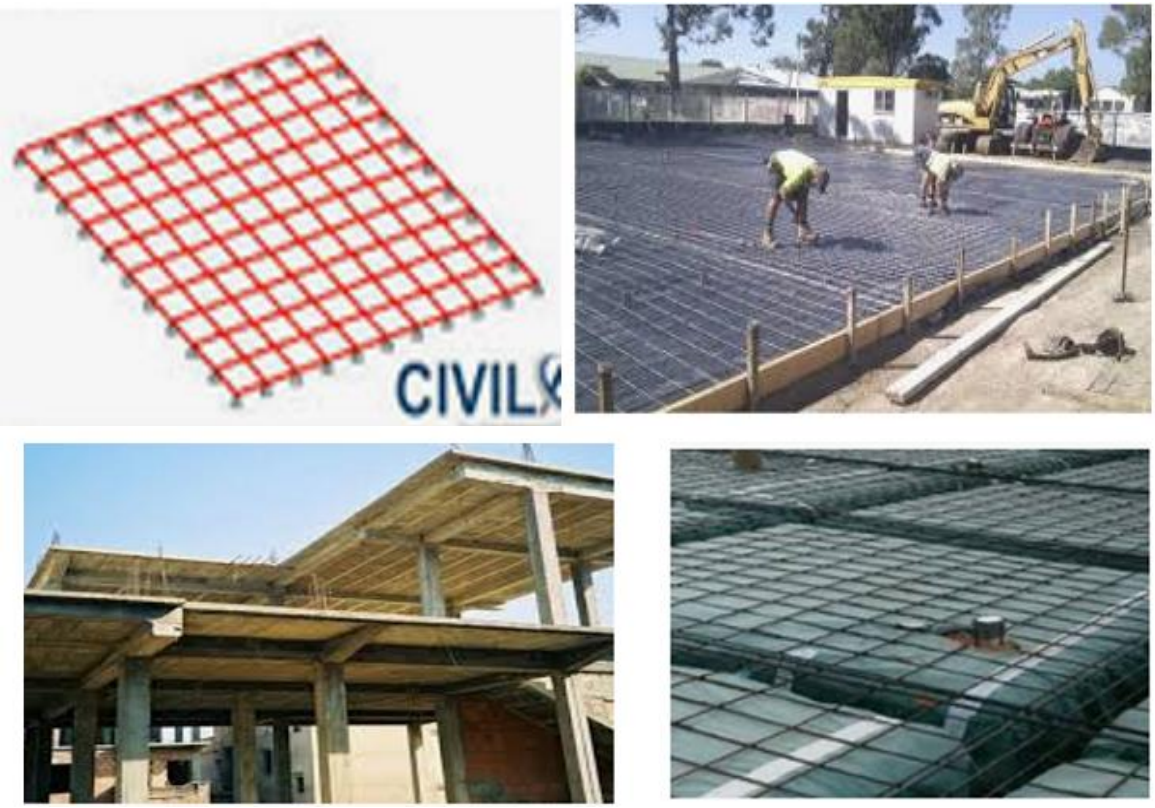


Fig 6. Slab Beam

- **Types of formwork**

Formwork can be mainly made of

- ✓ Timber,
- ✓ Plywood,
- ✓ Steel,
- ✓ Precast concrete or fiberglass,

used separately or in combination. The type of material to be used for formwork depends upon the nature of construction as well as the availability and cost of material.

- **Timber Formwork**

Timber used for the formwork should satisfy the following requirements:

- ✓ It should be well seasoned.
- ✓ It should be light in weight.
- ✓ It should be easily workable with nails without splitting, and
- ✓ It should be free from knots

Timber used for shuttering exposed concrete work should have smooth and even surface on all faces, which are to come in contact with concrete. In situations where concrete surfaces are not exposed as in the case of foundations, undressed timber can be used.

Use of plywood instead of timber planks is getting popular these days. In this case resin bonded plywood sheets are attached to timber frames to make up panels of required sizes. The panels thus formed can easily be assembled by bolting in the form of shuttering. This types of shuttering ensures quality surface finish and is especially recommended in works where large exposed areas of the concrete are to be constructed such as floor slab, faces of retaining walls, etc. Generally, the number of reuses of plywood formwork is more as compared with timber shuttering.

Timber for form-work should be neither too dry nor too wet. If the timber is too dry, it will absorb water from the wet concrete and swell and may be distorted or decayed. On the other hand, if it is too wet, shrinkage may result especially moisture content of timber. The normal moisture content of timber used for form-work should be 20 percent.

- Advantages of Timber Formwork
  - ✓ It is relatively cheap.
  - ✓ It is more economical than steel where work is non-repetitive.
  - ✓ It can be found locally.

- Disadvantages of Timber Formwork

- ✓ It is susceptible to insect and fungal attack.
- ✓ It warps, especially when it is not well seasoned.
- ✓ It is not good for repetitive work.

- **Steel Formwork**

This consists of panels fabricated out of thin steel plates stiffened along the edges by small steel angles. The panels can be fabricated in large numbers in any desired modular shape or size. Although steel shuttering costs more initially, it may work out to be economical in the long run due to its large number of re-uses of the same shuttering. Steel formworks are available in the market on rental basis.

- **Advantages of Steel Formwork**
  - ✓ It is durable and can be used as many times as necessary.
  - ✓ It gives smooth finish.
  - ✓ It is not liable to warp.
- It is more economical than timber where repetitive work is necessary.

- **Disadvantages of Steel Formwork**
  - ✓ The initial outlay of money is great.
  - ✓ It is easily dented.
  - ✓ It rusts under humid conditions.

- **Formwork materials can be generally classified as**

✓ Timber

✓ Metals

✓ Plastics

Fig 7Timber formwork

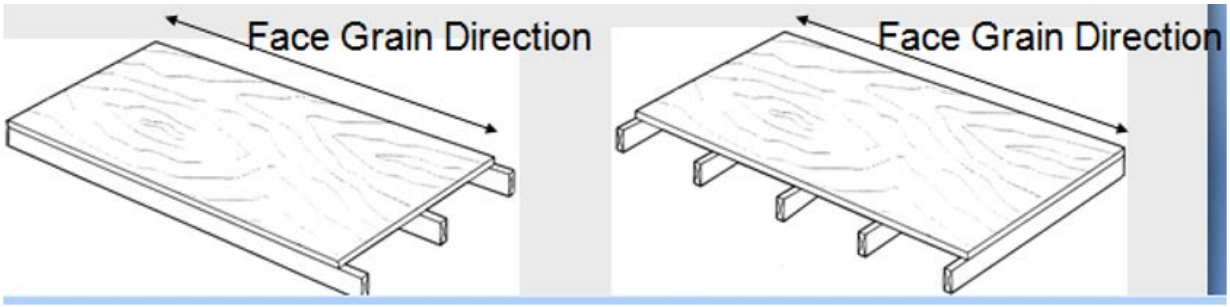
✓ **Plywood**

The use of plywood in concrete forming for form facing has improved the quality of finished concrete.

•The relatively large sheets of plywood have reduced the cost of building and at the same time have provided smooth surfaces that reduces cost of finishing of concrete surfaces.

Plywood is a manufactured wood product consisting a number of veneer sheets, or plies . Type of plywood can be grouped as exterior and interior. For formwork the exterior plywood is used. Adhesive used to bond the piles in manufacturing of exterior plywood is watertight and gives maximum number of reuses.

Fig 8 Plywood formwork



Plywood Formwork

- ✓ **Metals**

The initial cost of metal formwork is more than timber formwork but the lumber of reuses of metal formwork is higher than that of timber. In long run metal formwork can be economical. İn heavy construction works metal formwork may require a lifting mechanism to handle the formwork panels or props.

- Steel sheet formwork has the problem of rusting also. To avoid rusting, in every use the surfaces should be oiled with an appropriate releasing agent. In metal formwork usage, the metal sheets are prepared as panels of standard sizes. This brings the difficulties of erecting irregular dimensions of formwork.

• Steel or aluminum or magnesium is the most widely used metals.

Fig 9. Metal formwork

✓ **Plastics**

They have impervious surfaces that usually create a smooth finish to the concrete. • Plastic formwork could be reinforced or unreinforced. Plastic is reinforced by glass fibers. Reinforced plastics are specially produced for a specific formwork type. Un-reinforced plastics are produced in sheet form with smooth or textured surfaces. • Plastic formwork is lighter but less durable than metal formwork.

Fig 10 Plastic Formwork

- ✓ **Formwork For beam**
  - Grade beam
  - Tie beam

A beam formwork consists of a three-sided box which is supported by cross members called head trees which are propped to the underside of the soffit board. In the case of framed buildings, the beam box is provided by the column form. The soffit board should be thicker than the beam sides since this member will carry the dead load until the beam has gained sufficient strength to be self-supporting. Soffit boards should be fixed inside the beam sides so that the latter can be removed at an early date, this will enable a flow of air to pass around the new concrete to speed up the hardening process and also releasing the form work for reuse at the earliest possible time. Generally the beam form is also used to support the slab form work and the two structural members are then cast together.

Fig 11.Beam Formwork

- ✓ **Slab Formwork**

Floors require a large area of formwork to be provided usually from beam to beam. Timber floor formwork consists of timber boards or plywood sheets supported on a framework and resting on a series of timber joists. Again timber and metal props can be used for vertical supports. Metal panels can be used and bolted or clipped together and held in place by a system of metal beams or a tabular scaffold system. Adjustable props need for levelling purposes

Fig 11 Steel slab formwork

Fig 12.Wood formwork

Beam and slab formwork

Fig 13 Wall Formwork

- ✓ **Formwork For stair**

In constructing formwork for stairs, the landing is first set in position. The process for constructing the formwork for the landing is the same as that of floors.

After the landing has been set, two strings are tied to the landing and grounds (or upper) floor maintaining the width and the inclination of the flight. The soffit (50 mm thick) is most often prefabricated, especially when the flight is short. The soffit boards are held underneath by timber measuring 100 mm x 75 mm placed at 300 mm centers. The prefabricated soffit is raised and its position checked with strings.

The stringers are set in position, on these boards, the positions for the tread and risers are marked off with chalk. The face boards for risers are cut to the required height. They are then nailed to the stringers and are supported by cleats.

Braces are nailed to the side boards and to the protruding part of bearer. These prevent the side boards from falling apart when concrete is poured on due to vibration.

Fig 14 Steel stair formwork

Fig.15. Timber stair formwork

Self-Check 1	Multiple Choice item

Directions: Select the correct answer and encircle the letter of your choice

1. Formwork can be mainly made of:
   A. Timber
   B. Plywood
   C. Steel,
   D. All are correct
2. One is not advantages of Steel Formwork
   A It is durable and can be used as many times as necessary
   B. It gives smooth finish
   C. It is not liable to
   D. None of the above

3. Among the following one is the advantages of timber formwork

A. It is relatively cheap

B. It is more economical than steel where work is non-repetitive

C. It can be found locally

D. All

Information Sheet 2	Setting out formwork

2.2. . Setting out formwork

2.2.1. Introduction

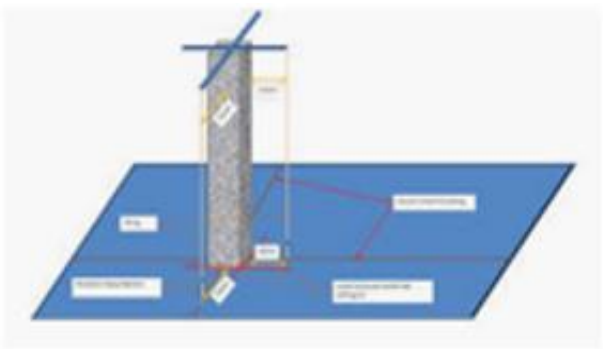
Formwork is a temporary structure that supports part or the whole of a permanent structure until it is self-supporting. Individual components of formwork, for example frames, are plant. Once assembled the components form the temporary structure. Some formwork systems are designed to remain with the permanent structure. Generally work carried out to design, construct, erect, alter, maintain, dismantle or remove formwork will be defined as construction work.

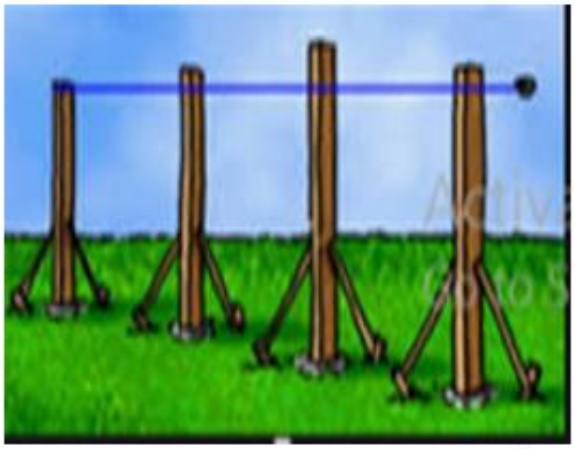
Formwork means the surface used to contain and shape wet concrete until it is self-supporting. This includes the forms on or within which the concrete is poured and the frames and bracing which provide stability. Although commonly referred to as part of the formwork assembly, the joists, bearers, bracing, foundations and footings are technically referred to as falsework. For the purpose of this code, the term 'formwork' will be used to describe both formwork and falsework.

Building designers, including engineers and architects, mustconsider the 'buildability' of a structure or building with the objective of producing a design that minimizes the risk of injury during construction.

The design of the final concrete structure may have a major effect on the ease of formwork construction and consequently, on the safety of people during construction. Generally, a more basic and simple final concrete structure is safer to erect.

A formwork designer should be consulted during the design of any building to provide input on ways to minimize the risk of injury arising from formwork activities.





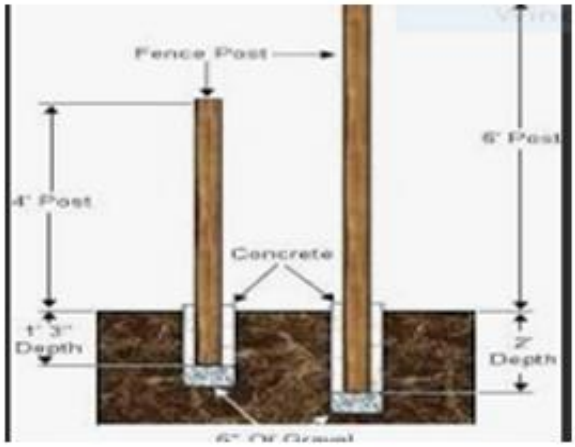
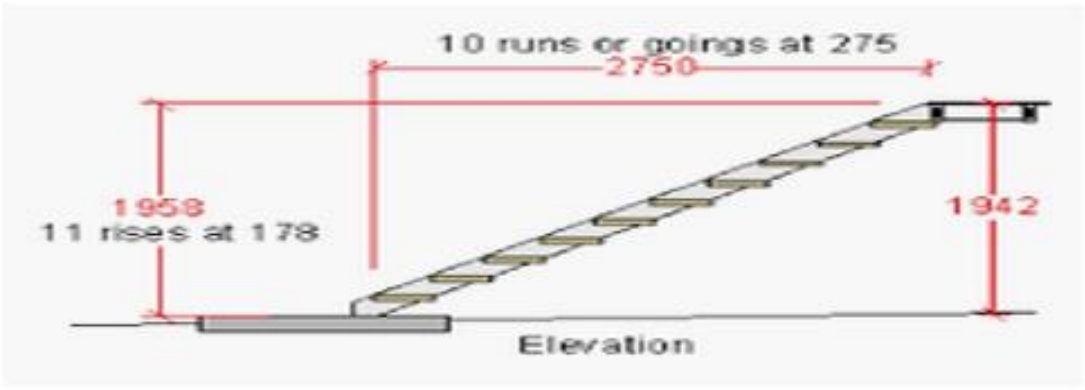


Fig 2.1 Formwork setting out

Fig 2.2.Foundation Setting out



Stair setting out.

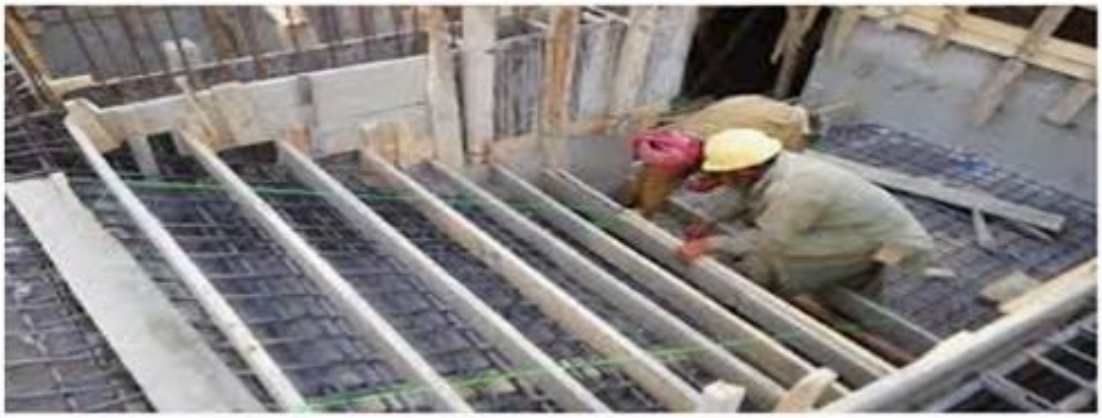


Fig 2.3.Setting out Formwork

Self-Check 2	Multiple Choice item

Directions: Select the correct answer and encircle the letter of your choice

1. After the formwork panels have been stripped:

A. Cleaning of any sediment that has adhered to the panels

B. Release agent should be applied

C. A and B

D, None of the above

2. One of the following tool is not used in Setting out formwork

A Carpentry square

B. Claw hammer

C. String

D. All are correct

3. Which of the following type of formwork is more durable?

A. Timber

B. Wood

C. Metal

D. All

Information Sheet 3	Selecting fixing and fasteners consistent with construction requirements of the job.

2.3. Selecting, fixing and fasteners consistent with construction requirements of the job

- **Formwork Ties**

When concrete is placed in wall formwork, the pressure exerted by the fresh concrete tends to force the opposite sides of the formwork apart. Normal economic solution to this problem is to collect the force exerted by the concrete firstly onto the face material, generally plywood, and then to the walling to distribute the force into soldiers on either side of the formwork.

The soldiers are prevented from moving apart by use of steel rods called tie rods passing through the concrete to connect the two soldiers together.

Two types of Tie Categories:

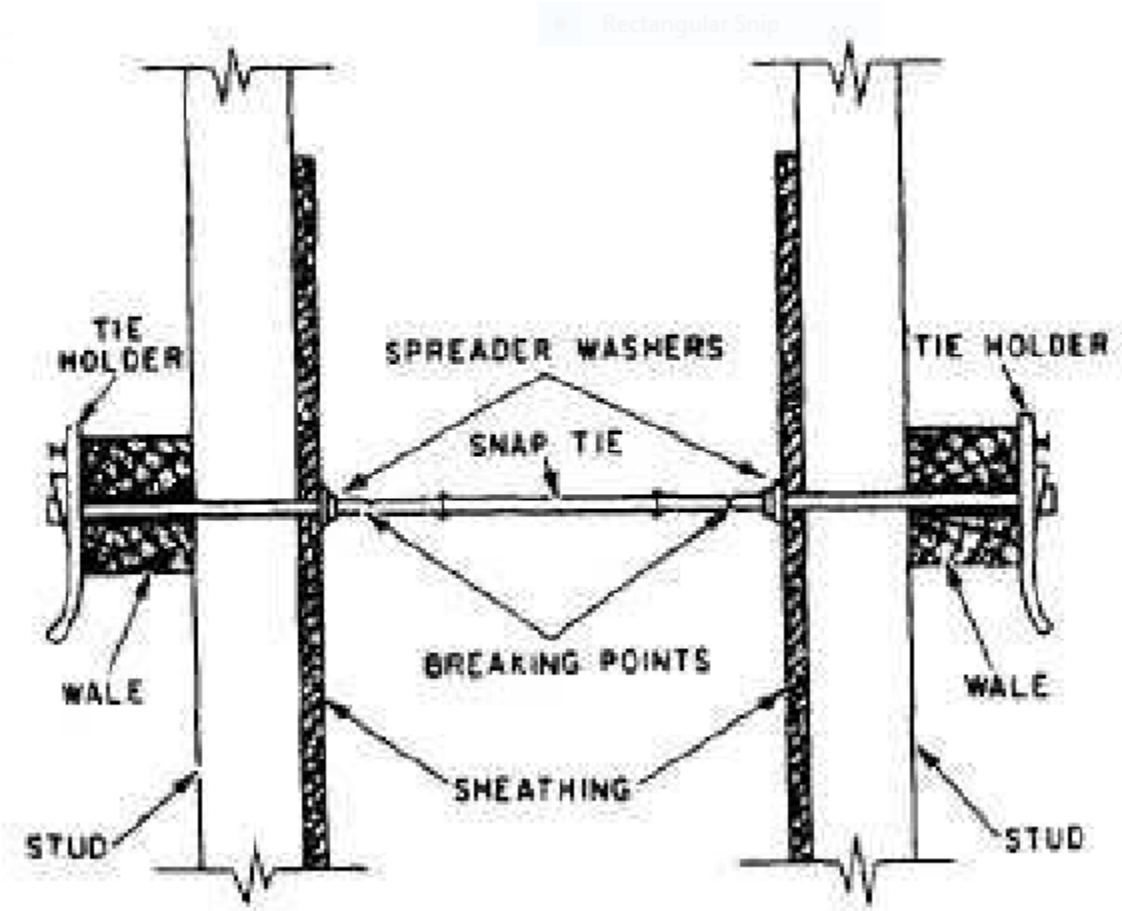
I. non-recoverable ties and
II. Recoverable ties.

I. Non-recoverable ties

- **Snap ties**

The principal of snap ties is that it is cast into the wall and has normal wedge connection at each and for fixing to the formwork. Once the wall is concreted and the formwork is ready for removal the snap tie is then physically over-stressed and

the ends "snap" generally inside the concrete. The snap tie arrangement also acts as a spacer to the formwork so that ordering the right length of snap tie automatically gives the correct wall thickness. Essentially these ties are used in building works on strip and re-erect type of formwork.



- **Mild Steel Ties**

Mild steel tie rod systems usually comprise an expendable section of mild steel all thread rod. On each end of the tie rod there is a tapered rubber cone which gives the cover to the expendable tie. After formwork is positioned bolts are used through the formwork into

the rubber cone. The system acts as a spacer tie and as with the snap tie the correct length of tie automatically gives the correct wall thickness. The rubber cones are removable after the formwork is struck and the large holes that they make are more easily made good with 2 mortar.

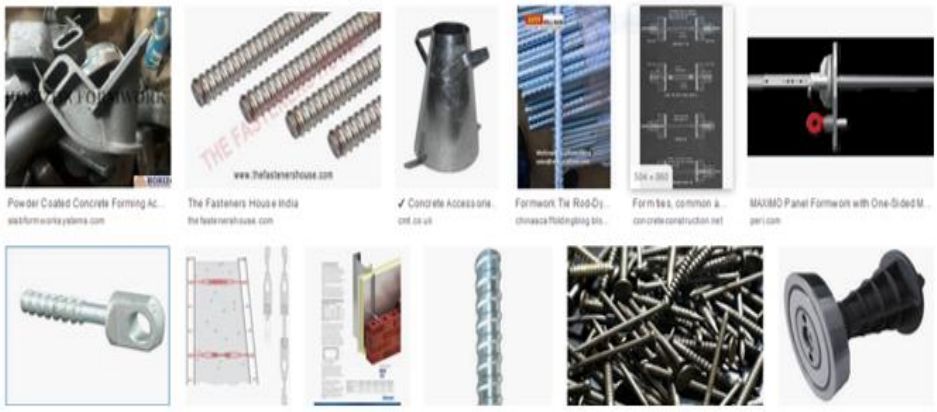


Fig 3.1.Different Formwork ties

- **Coil Ties**

The coil tie system is very similar in principle to the mild steel tie. The expendable section of tie comprises two coils of wire. Simple re-useable plastic cone is usually screwed onto the ends of the coil to form a cover to the tie rod after striking.

The big advantage of this system is the course rope thread of the tie bolt which screws into the coils, which makes connection much faster than that of the finer.

Fig Screw fastener

- **Anchor Ties**

Cast in hook bolts, anchors, loops and fixings to form bedded in ties are generally known as anchor ties. They are often designed to take both tensile and shear loading and will be used for single face climbing formwork. The loading often depends on the strength of the concrete in which they are embedded.

Self-Check 3	Multiple Choice item

Directions: Select the correct answer and encircle the letter of your choice

1. One is not among the two types of Tie Categories:

   A. Recoverable ties

   B. non-recoverable ties and

   C. None.

   D. Anchor tie

2. One is note formwork Ties**.**

   A Nail

   B. Concrete nail

   C. Bolt

   D. None of the above

3. One is not concrete tie:

   A. Snap ties

   B. Mild Steel Ties

   C. Coil Ties

   D. None

Information Sheet 4	Constructing and erecting formwork shutters and/or edge boxing

4.1. Constructing and erecting formwork shutters and/or edge boxing

Generally, the construction of formwork normally involves the following operations: Propping & centering, shuttering and Surface treatment.

- **Propping and Centering***:*

The props used for centering may be of steel or timber posts. In case wooden posts are used as props, they should rest squarely on wooden sole plates laid either on the ground or on brick masonry pillars. The wooden plate should have an area of at least O.1m^2 and 40mm thickness. Double wedges are essentially provided between the sole plates and the timber props with a view to permit accurate adjustment of the shuttering prior to concreting operation and to allow easy removal of shuttering afterwards. In case brick masonry pillars are used at props, the wooden sole plates are provided at the top of the pillars, and the double wedges are inserted between the sole plates and the bottom of the shuttering.

Fig 4.1. **Props and Supports**

- **Shuttering***:* As described earlier the shuttering can be made up of timber planks, or it may be in the form of panel units made either by fixing plywood to timber frames or by welding steel plates to angle framing. The shuttering joints should be tight against leakage of cement grout.

Fig 4.2. **Shuttering**

- **Surface treatment***:*

Before laying concrete, the formwork should be cleaned of all rubbish particles. All surfaces of timber shuttering that are to come in contact with concrete should be well wetted with water. Similarly steel forms that have been exposed to hot weather should be cooled by watering before laying concrete. In addition, all surfaces of shuttering which are to come in contact with concrete should be given a good coating of linseed oil or soft soap solution or any other suitable material so as to prevent the concrete getting struck to the formwork and thus facilitate easy removal.

Before erecting column formwork, apply a release agent to all internal surfaces. If specified, fix any required edging, metal corners, arise pieces or casted inserts. Prior to the erection of formwork for structural members, it is important to check the exact location of grids relating

to the structural member being formed. The location, size of column, height, and specified finish should be clarified from site documentation. Often hurdles restrict the positioning of grid locations, therefore offsets may be required. It is the contractor's responsibility prior to the erection to check site documentation for the exact position of the structural member you are working on.

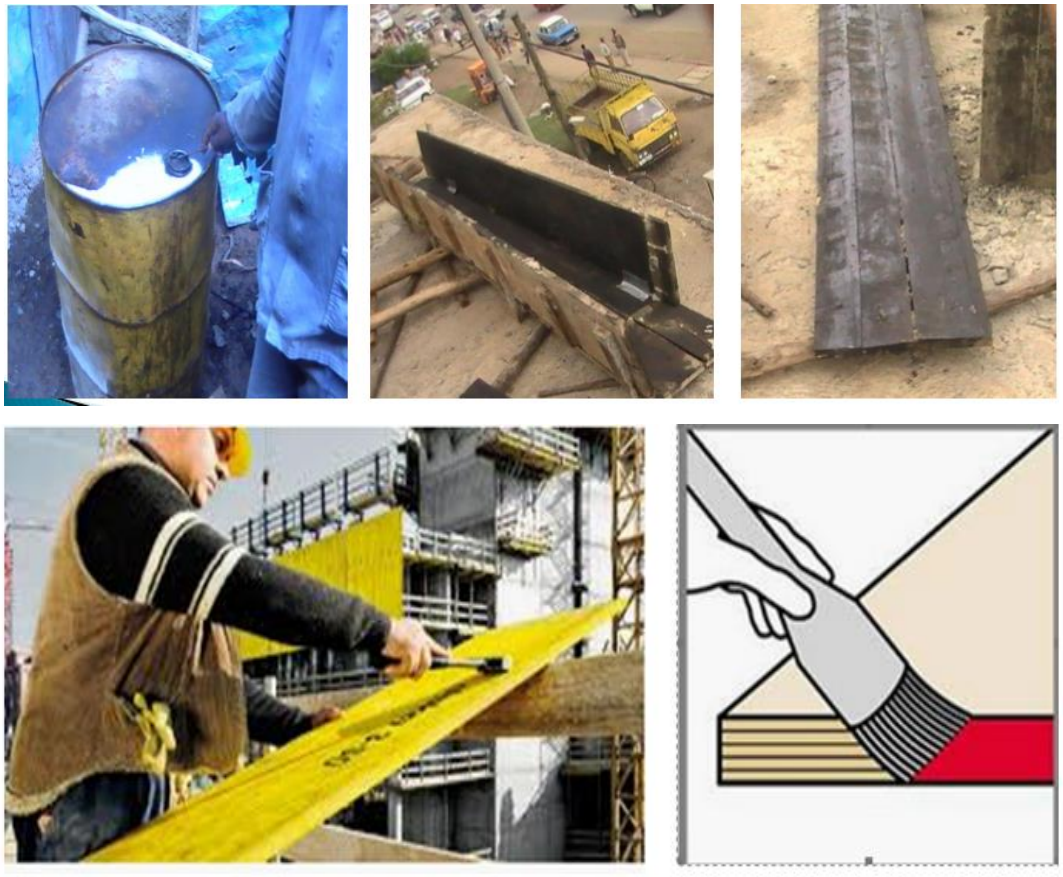


Fig 4.3. **Surface treatment**

- **Erection Procedure for a column**
  - ✓ Prior to positioning column formwork check that steel for the column has been inspected and cleared for casting.
  - ✓ Position formwork for the column from predetermined grids.
  - ✓ Plumb formwork both ways and securely support using adjustable steel props.
  - ✓ Ensure the steel props are safely secured to the column formwork and the floor, and
  - ✓ That adjustment for pushing and pulling is operational.

- ✓ Set out the positions of column clamps from a store rod.
- ✓ Transfer the column clamp positions from the store rod onto column formwork.
- ✓ Use nails to support the arms of column clamps while wedging.
- ✓ Position and wedge the bottom, middle and top clamps sets.
- ✓ Check the formwork at the top for square.
- ✓ Position and wedge the remainder of the column clamps.
- ✓ Using a plumb bob suspended from a gauge block plumb the column.
- ✓ When all the column formwork is securely propped a final check must be made for Plumb and column alignment before and immediately after the concrete has been Poured and vibrated

Self-Check 4	Multiple Choice item

Directions: Select the correct answer and encircle the letter of your choice

- The construction of formwork involves one of the following operations:

A. Propping.

B. Centering &shuttering

C. Surface treatment

D. All are correct

2. The props used for centering may be made of:

A Steel

B. Timber,

C. Round wood

D. All are correct

3. Before laying concrete, the formwork should be cleaned of all rubbish particles This is called

A. Shuttering

B. Surface treatment

C. Bracing

D. All

Operation Sheet-1. Construct and erect formwork shutters / edge boxing

Procedure to Construct and erect formwork shutters / edge boxing

Step 1. Wear appropriate PPE.

Step 2. Check that steel for the column has been inspected and cleared for casting

Step 3. Position formwork for the column from predetermined grids.

Step 4. Plumb formwork both ways and securely support using adjustable steel props

Step 5. Set out the positions of column clamps from a store rod.

Step 6. Transfer the column clamp positions from the store rod onto column formwork.

Step 7.Use nails to support the arms of column clamps while wedging.

Step 8. Position and wedge the bottom, middle and top clamps sets.

Step 9.Check the formwork at the top for square.

Step 10.Position and wedge the remainder of the column clamps.

Step 11.Usea plumb bob suspended from a gauge block plumb the column

.

Information Sheet 5	Bracing formwork support

Braces should be attached to the frames as soon as practicable and designated access ways should be indicated by using bunting or by other means.

If side bracing or other edge protection is installed progressively on formwork frames other control measures to prevent a fall occurring may not be required.

Many conventional formwork frames consist of diagonal braces that cross in the middle. While these braces are not considered to be suitable edge protection for a completed formwork deck, they may provide reasonable fall protection during frame erection. This is only the case where braces are installed in a progressive manner as soon as the frames are installed.

As the height of formwork frames increase there is a greater need to provide lateral stability to the frames. Ensure framing, including bracing, is carried out in accordance with on-site design documentation and manufacturers' instructions. People erecting formwork must be trained to erect formwork using safe methods.

- **Terms used in formwork**

Braces:- these are diagonal or cross pieces fixed on the standards to provide Falsework, in relation to a form or structure, means the structural supports and bracing used to support all or part of the form or structure until the concrete is poured and is strong enough to support loads.

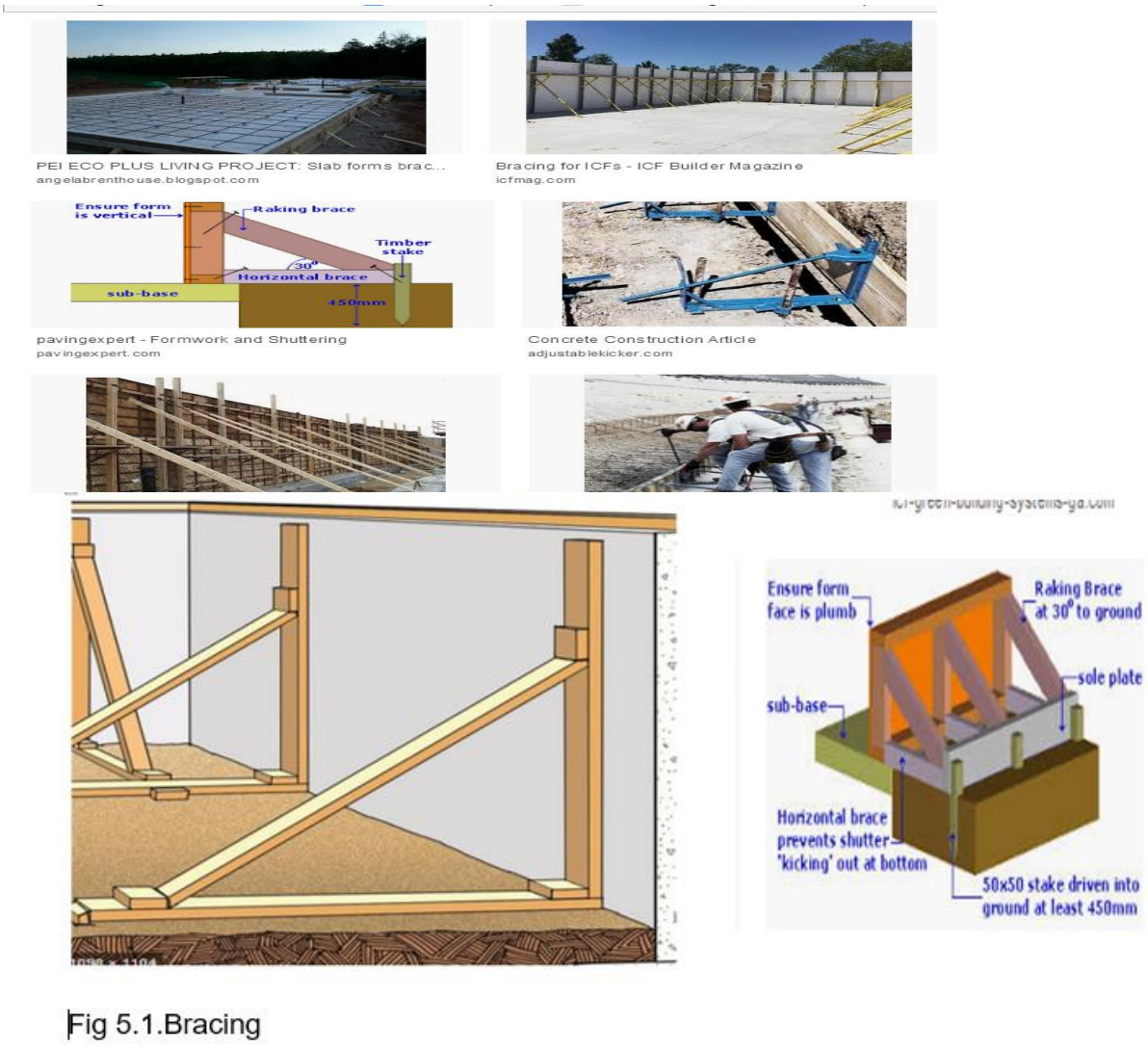
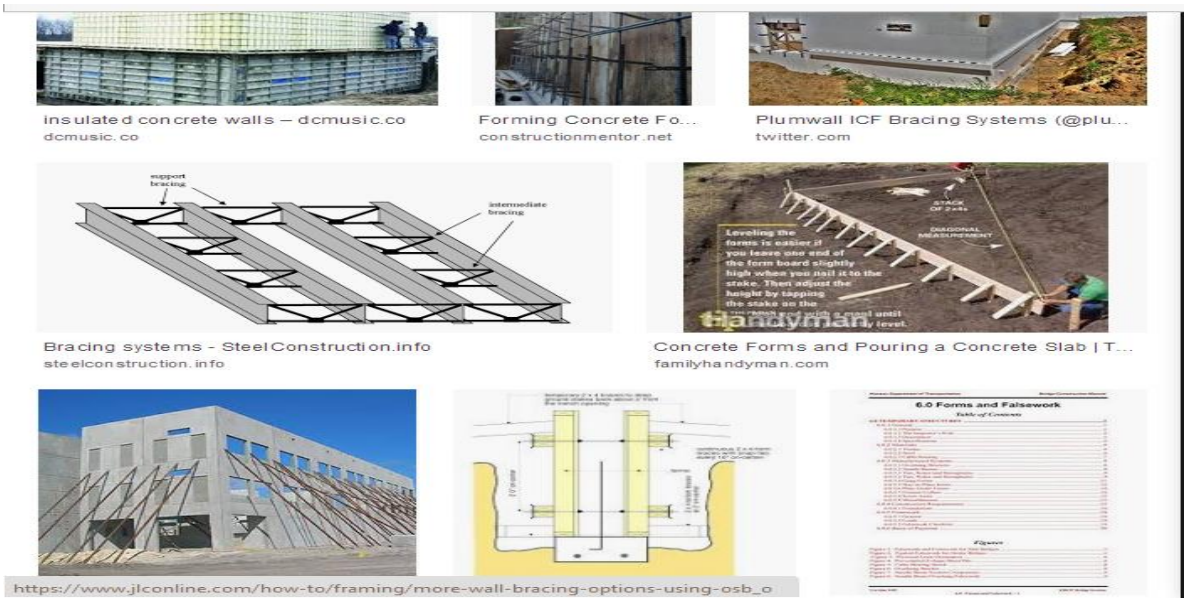


Fig 5.1.Bracing



- **Bracing**

Flying formwork: Is a designed floor formwork system that can be hoisted between levels as a unit. Forms are the molds into which concrete or another material is poured. Formwork is a system of forms connected together.

Gang forms: are large panels designed to be hoisted as a unit, and to be erected, stripped, and re-used.

Knock-down Forms: are traditional formwork supported by falsework and shoring, assembled from bulk materials, used once, and then dismantled.

Panels: are sections of form intended to be connected together.

Sheathing: is the material directly supported by wales, and against which concrete is to be placed.

Specialty formwork: is designed specifically for a particular structure or placing technique.

Strut: are vertical members of shoring that directly resist pressure from wales.

- **Wales**: are horizontal members of shoring that are placed against sheathing to directly resist pressure from the sheathing.

- **Causes of Formwork Failure**

Formwork failures are the cause of many accidents and failures that occur during concrete construction which usually happen when fresh concrete is being placed. Generally some unexpected event causes one member to fail, then others become overloaded or misaligned and the entire formwork structure collapses. Formwork collapse causes injuries, loss of life, property damage, and Construction delays

The main causes of formwork failures are:

- ✓ Improper stripping and shore removal
- ✓ Inadequate bracing
- ✓ Vibration
- ✓ Unstable soil under mudsills*,
- ✓ shoring not plumb
- ✓ Inadequate control of concrete placement
- ✓ Lack of attention to formwork details

- **Improper Stripping and Shore Removal**

Premature stripping of forms, premature removal of shores, and careless practices in reshoring can produce catastrophic results

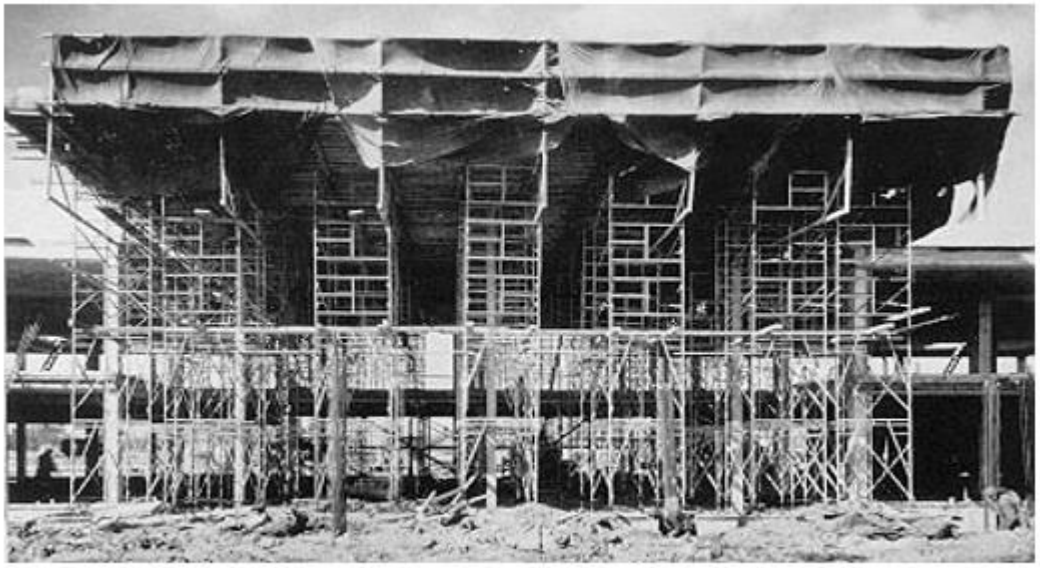
Fig 5.3. Improper Stripping

- **Inadequate bracing**

The more frequent causes of formwork failure, however, are other effects that induce lateral force components or induce displacement of supporting members.

Inadequate cross bracing and horizontal bracing of shores is one of the factors most frequently involved in formwork accidents.

Investigations prove that many accidents causing thousands of dollars of damage could have been prevented only if a few hundred dollars had been spent on diagonal bracing for the formwork support.



- Fig 5.4. **Inadequate bracing**

- **Vibration**

Forms sometimes collapse when their supporting shores or jacks are displaced by vibration caused by: passing traffic movement of workers and equipment on the formwork the effect of vibrating concrete to consolidate it.

- **Unstable soil under mud sills**

Formwork should be safe if it is adequately braced and constructed so all loads are carried to solid ground through vertical members Shores must be set plumb and the ground must be able to carry the load without settling. Shores and mudsills must not rest on frozen ground; moisture and heat from the concreting operations, or changing air temperatures, may thaw the soil and allow settlement that overloads or shifts the formwork.

Site drainage must be adequate to prevent a washout of soil supporting the mudsills.

- **Lack of attention to formwork details**

Even when the basic formwork design is soundly conceived, small differences in assembly details may cause local weakness or overstress loading to form failure.

This may be as simple as insufficient nailing, or failure to tighten the locking devices on metal shoring. Other details that may cause failure are:

- ✓ Inadequate provisions to prevent rotation of beam forms where slabs frame into them on the side.
- ✓ Inadequate anchorage against uplift for sloping form faces.
- ✓ Lack of bracing or tying of corners, bulkheads, or other places where unequal pressure is found.

Self-Check 5	Multiple Choice item

Directions: Select the correct answer and encircle the letter of your choi

1. **The main causes of formwork failures are**:

   A. Improper stripping and shore removal

   B. Inadequate bracing

   C. Vibration

   D. All are correct

2. The following terms are used in formwork construction except:

   A Braces

   B. Flying formwork

   C. Strut:

   D. None

3. One is vertical members of shoring that directly resist pressure from wales.

   A. Strut

   B. Brace

   C. Wedge

   D. All

Information Sheet 6	Installing block-outs and cast-in services

Block-outs and piping anything to be located in the wall, such as door bucks, window box outs and piping, should be placed before erecting the formwork on the opposing side. The ties, which are already in place, can be secured or connected at the same time as the forms.

We often need sleeves on walls and suspended slabs, but sleeves can increase the risk of cuts during certain phases of forming. They are often installed before reinforcing steel. This is when the hazard is greatest because the sleeve protrudes out from an otherwise smooth surface of formwork. This can lead to workers walking into or tripping over a sleeve. Workers can be injured either from bumping into the sleeve or from a fall by tripping over it. A way to prevent this is to make the sleeve a different color than the formwork it is attached to. This makes it more obvious and visible. Once the slab is cast, the void created by this sleeve is used to pass services from floor to floor.

Fig 6.1 box-out sleeve on top of the slab form

A sleeve is a sub-structure built into formwork to create a permanent void in the concrete. These holes are specifically planned for and positioned for use as door and window openings, as well as for installing mechanical, electrical, and other essential services and systems throughout the building.

Fig 6.2. Buck used to create door opening

- **Types of sleeves.**
  - ✓ **Box-out sleeve: -** This is a form within the form and is put in place to create an opening or pocket in the concrete. A box-out can be made out of form-ply, metal, plastic, concrete, or any other material strong enough to maintain its position and shape while concrete is being placed

Fig 6.3. Junction boxes and conduit serve as sleeves.

- **In-fill or solid sleeve: -** This is a solid piece of material that is installed on the formwork where the permanent opening is needed, and it completely fills the void. Unlike a box-out, an in-fill can't collapse in the concrete. Either type of sleeve, however, can be moved out of its intended position if it's not fastened properly, or if the crew is careless

during the pouring and consolidation phase. In some instances, the box-out sleeve may be the actual door frame or window frame that will remain as part of the finished project. Any stiffeners, bucks, and braces that were installed to preserve the shape of the frame during the placing and curing phase get removed with the formwork, but the frame itself stays in place. If the permanent presence of a sleeve would create a problem—such as when you're required to maintain fire separations—then the sleeve will be removed. Otherwise, some or all of it may stay in place.

The position of any major sleeve will be shown on the formwork drawings. Since a sleeve would be useless if reinforcing steel passed through it, the reinforcing must be designed to accommodate sleeve locations. Form tie placement must also accommodate sleeve locations. The location of a sleeve must be considered and accounted for when calculating the requirement for ties, and ties must be placed accordingly.

Once the form is in place, it can be difficult or impossible to see the location of bulkheads or block-outs from the outside. Take care around bulkheads, because breaking a bulkhead could lead to concrete entering a section of the form that may not be suitably braced, tied, or anchored, or a section that is unfinished. Once this happens, there is an increased risk of formwork failure—including total collapse.

To reduce this risk, clearly mark and identify the location of bulkheads and block-outs on the outside of the formwork. As well, crews placing the concrete must be trained in the proper placing techniques round bulkheads and block-outs. Workers must understand that concrete should be allowed to run up to a bulkhead, not be poured directly onto it, and that the concrete vibrator must not be held against the bulkhead. This will reduce the likelihood of damage to the bulkhead and failure of the form.

Information Sheet 7	Applying Release agents to formwork face

2.7. Applying Release agents to formwork face

Releasing agents mean coatings which are provided on the formwork surface, before starting of concreting to allow smooth detachment of the form work or shuttering. Consideration should be given on the finish surface of the shuttering as it reveals all the flaws on the 'form' surface like vibrating poker known as 'burns', changeable properties in the form-face material, marks of irregular water absorption in timber.

- There are three main types of mold release agents .These are:
  - ✓ **Internal Release Agents**. Internal release agents are directly added to the composite material being molded during mixing to provide integrated release properties.
  - ✓ **Non-Permanent Release Agents**.
  - ✓ **Semi-Permanent Release Agents** and miscellaneous

The form material, the correct choice of release mechanism is employed. This should be carried out confirming the compatibility of the release agent with the face contact material, i.e. steel, timber, phenolic / overlaid plywood, plastics, rubbers, glass fiber and concrete.

- **Benefits of Releasing Agents**
  - ✓ It allows smooth elimination of shuttering.
  - ✓ Minimize the occurrence of blow holes.
  - ✓ Supply the recommended surface finish for the concrete member cast.
  - ✓ Minimize the loss of water from the concrete caused by absorption in timber forms.
  - ✓ Minimize seepage of water and moisture throughout curing of concrete.
  - ✓ They safeguard the form work and help in reusing them if possible.
  - ✓ Minimize the cracks because internal restrains.

Fig 7.1 When applying releasing agents

Self-Check 7	Multiple Choice item

Directions: Select the correct answer and encircle the letter of your choice

1. One is not the Benefits of Releasing Agents.

A. It allows smooth elimination of shuttering.

B. Minimize the occurrence of blow holes.

C. Supply the recommended surface finish for the concrete

D, None of the above

2. What are the three main types of mold release agents?

A Internal Release Agents
B. Non-Permanent Release Agents it,
C. Semi-Permanent Release Agents
D. All are correct

3. Release agents are applied on:

A. Timber formwork

B. Metal Formwork

C. Plastic formwork

D. All

LAP Test	Practical Demonstration

Name: _____

Date: _____

Time started: _____

Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following task within 8 hours.

Task 1. Construct and erect formwork shutters / edge boxing

Reference

- Barricading and Safety Signage Procedure Version 1.0 21/08/2017 DM#11314877 Uncontrolled if printed. For the latest approved version, refer to council DM.
- STORAGE, STACKING AND HANDLING
- Formwork
- Code of Practice 20
- INDUSTRY GUIDE FOR FORMWORK
- CONSTRUCTION INDUSTRY SOUTh AUSTRAlIA JUNE 2012
- Formwork Code of Practice

Name of trainers who prepared the TTLM

N0	Name	Qualification	Region	E.mail
1	Tesfaye Assegidew	MSC in CoTM	SNNPR	tesfayeassegidew@gmail.com
2	Habtamu Wendmagegn	Bsc in Civil Eng	Dire Dawa	Joniyitna9@gmail.com
3	Yazachew Geneti	Msc in CoTM	B/G/R/S	0917858176
4	Gebresilasie Jemal	Bsc	Addis Abeba	Gebrajemal@gmail.com
5	Getachew Mohammed	MSC in CoTM	Amhara	Gerimom07@gmail.com
6	Kibryisfaw Tulema	Bsc in	Somalie	kibrutulema@gmail.com