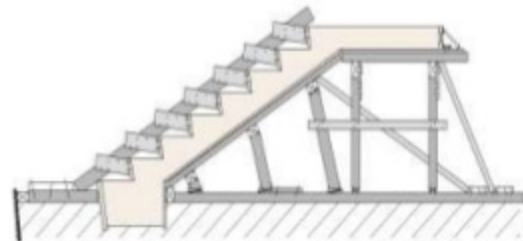


FORMWORK

A STUDY OF ITS VARIOUS TYPES, MATERIALS AND
CONSTRUCTION TECHNIQUES



INTRODUCTION TO FORMWORK

What is Formwork?

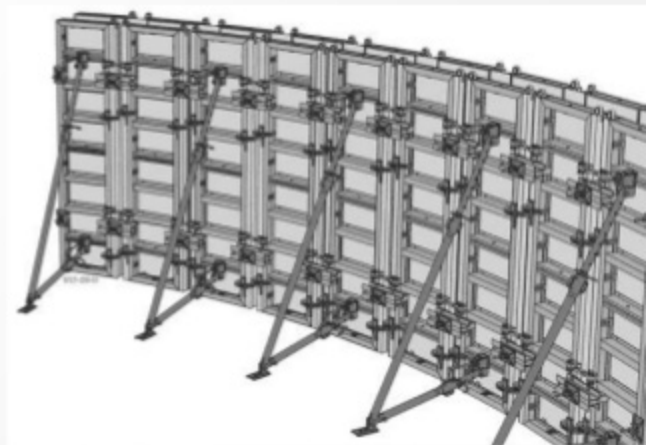
Formwork in construction is the use of support structures and moulds to create structures out of concrete which is poured into the moulds. Formwork can be made using moulds out of steel, wood, aluminium and/or prefabricated forms.

Formwork is an **ancillary construction, used as a mould** for a structure. Into this mould, fresh concrete is placed only to harden subsequently.

The construction of formwork takes time and involves expenditure up to 20 to 25% of the cost of the structure or even more.

The operation of removing the formwork is known as stripping. Stripped formwork can be reused. **Reusable forms are known as panel forms and non-usable are called stationary forms.**

Formwork is designed according to The ACI document SP-4.



➤ **A good formwork should satisfy the following requirements:**

- Strong enough to **withstand all types of dead and live loads**
- **Rigidly constructed and efficiently propped** and braced both horizontally and vertically, so as to retain its shape
- The joints in the formwork should be **tight against leakage of cement grout**
- Construction of formwork should **permit removal of various parts in desired sequences** without damage to the concrete
- Material of the formwork should be **cheap, easily available and should be suitable for reuse**
- The formwork should **be set accurately to the desired line and levels** should have plane surface.
- As **light as possible**
- Material of the formwork **should not warp or get distorted** when exposed to the elements
- Should **rest on firm base**
- The following points are to be kept in view **to effect economy in the cost of formwork:**
- The plan of the building should imply minimum number of variations in the size of rooms, floor area etc. so as to permit reuse of the formwork repeatedly.
- Design should be perfect to use slender sections only in a most economical way.
- Minimum sawing and cutting of wooden pieces should be made to enable reuse of the material a number of times. The quantity of surface finish depends on the quality of the formwork.

CATEGORIES OF FORMWORK

- **Conventional:** The formwork is built on site out of timber and plywood or moisture-resistant particleboard. It is easy to produce but **time-consuming** for larger structures, and the plywood facing has a relatively **short lifespan**. It is still used extensively where the labour costs are lower than the costs for procuring reusable formwork. It is also the most flexible type of formwork, so even where other systems are in use, complicated sections may use it.
- **Modern-Day Formworks:** This formwork systems are mostly modular, which are **designed for speed and efficiency**. They are designed to provide **increased accuracy and minimize waste in construction** and most have enhanced health and safety features built-in. The main types of formwork systems in use now are:
 1. Table form/flying form
 2. System column formwork
 3. Horizontal panel
 4. Slip form
 5. Tunnel form
- **Engineered/Pre-fabricated Formworks:** This formwork is built out of **prefabricated modules** with a metal frame (usually steel or aluminium) and covered on the application (concrete) side with material having the wanted surface structure (steel, aluminium, timber, etc.). The two major advantages of formwork systems, compared to traditional timber formwork, are **speed of construction** and **lower life-cycle costs** (barring major force, the frame is almost indestructible, while the covering if made of wood; may have to be replaced after a few – or a few dozen – uses, but if the covering is made with steel or aluminium the form can achieve up to two thousand uses depending on care and the applications).

MATERIALS USED

Formwork are mainly of two types

- Steel formwork
- Wooden formwork

Steel formwork is made of

- Steel sheets
- Angle Iron
- Tee Iron

Wooden formwork consists of

- Props
- Planks battens
- Ledgers
- Sheeting



Wooden formwork



Steel Formwork

Timber formwork:

- Most common material used for bracing the member, hence called as the traditional formwork.
- can easily be cut to size on site. Joist are replaced with engineered wood beams and supports are replaced with metal props. This makes this method more systematic and reusable.
- Various sizes of members of timber

Sheeting for slabs, beam, column side and beam bottom	25 mm to 40mm thick
Joints, ledges	50 x 70 mm to 50 x 150 mm
Posts	75 x 100mm to 100 x 100 mm



Plywood

- This is by far the most common material used for the facing panel. It is easily cut to shape on site, and if handled and stored carefully, it can be used many times.
- A standard plywood thickness on site is 18mm. This is usually sufficient for most pours.
- However, if the formwork is curved, a thinner plywood is used to facilitate bending.
- Thicker plywood may be used when the weight of concrete causes a standard thickness plywood to bow out, distorting the concrete face.



Steel formwork:

- Steel forms are stronger, durable and have longer life than timber formwork and their reuses are more in number
- Steel forms can be installed and dismantled with greater ease and speed.
- The quality of exposed concrete surface by using steel forms is good and such surfaces need no further treatment.
- Steel formwork does not absorb moisture from concrete.
- Steel formwork does not shrink or warp



Aluminium formwork

- Often used in pre-fabricated formwork, that is put together on site.
- Aluminium is strong and light, and consequently fewer supports and ties are required.
- The lighter sections will deflect more, but this can be avoided by simply following the manufacturers recommendations.



Plastic formwork

- Glass reinforced plastics (GRP) and vacuum formed plastics are used when complicated concrete shapes are required (e.g. waffle floors).
- Although vacuum formed plastics will always need support, GRP can be fabricated with integral bearers making it self supporting.
- Like steel, plastic formwork can be re-used many times, as long as care is taken not to scour the surface whilst vibrating the concrete.





PROCESS OF FORMWORK CONSTRUCTION

FORMWORK FOR VARIOUS STRUCTURAL MEMBERS

Construction of formwork:

This normally involves the following operations:

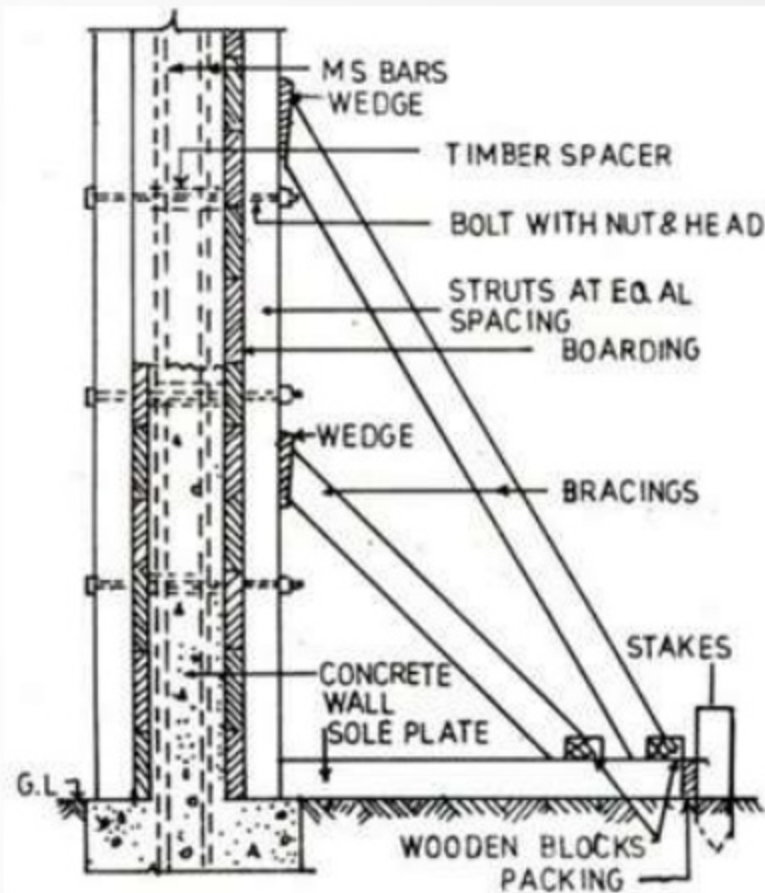
1. Propping and centering
2. Shuttering
3. Provision of camber
4. Cleaning and surface treatment

FORMWORK FOR WALL

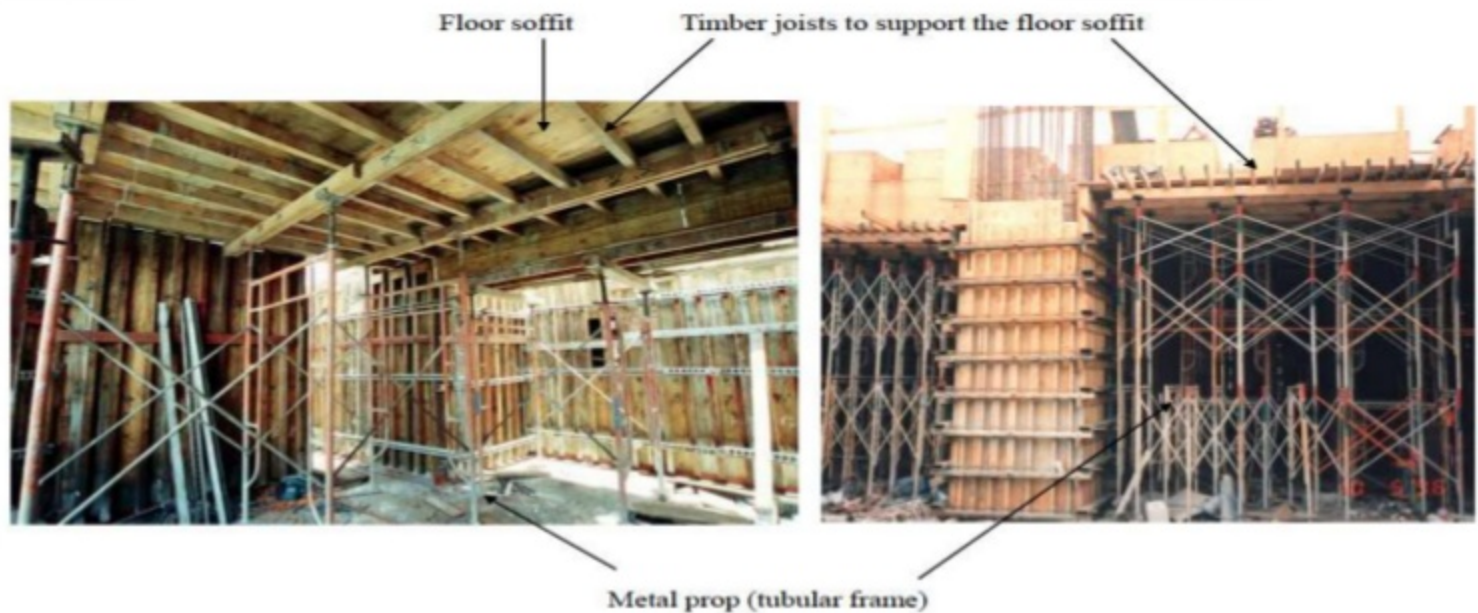
It consists of

- Timber sheeting
- Vertical posts
- Horizontal members
- Rackers
- Stakes
- Wedges

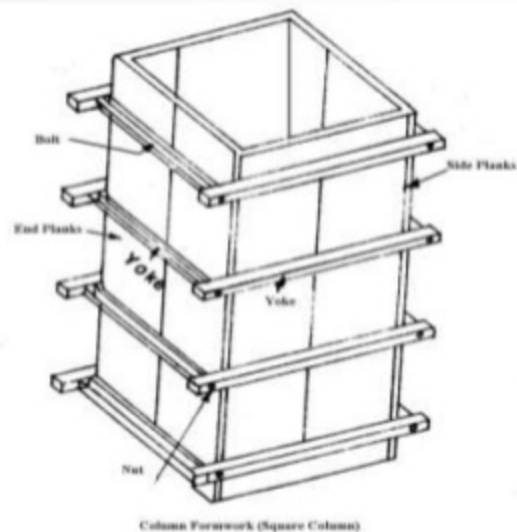
After completing one side of formwork reinforcement is provided at the place then the second side formwork is provided.



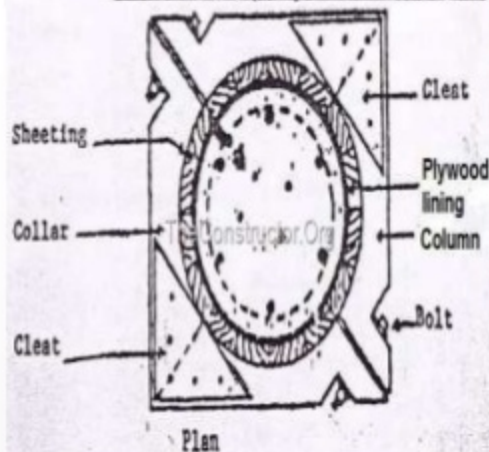
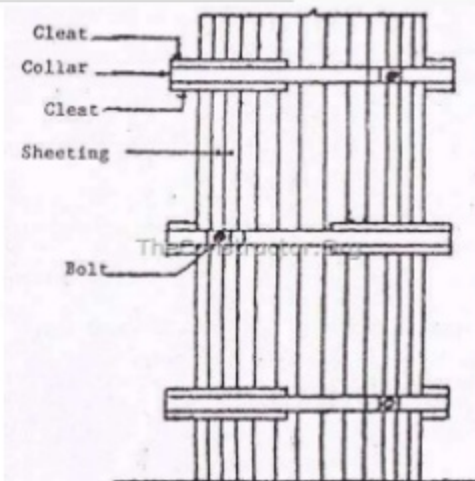
Wall Formworks and its components



FORMWORK FOR COLUMN



- It consists of the following
 - Side & End Planks
 - Yoke
 - Nut & Bolts
- Two end & two side planks are joined by the yokes and bolts.

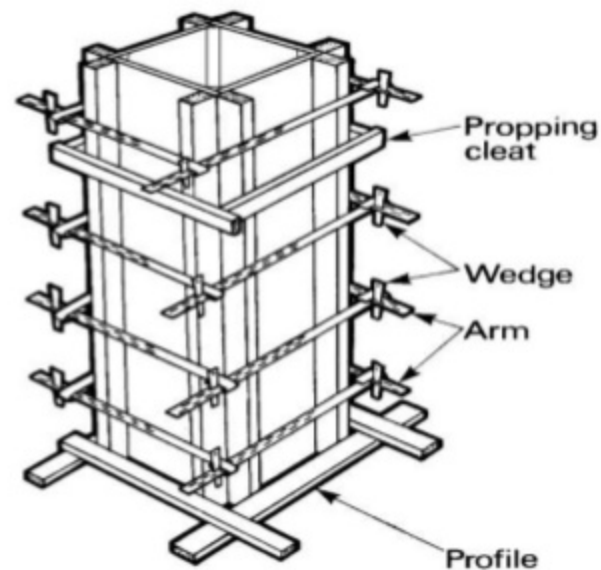


Erection sequence for a column

Prior to positioning column formwork check that steel for the column has been inspected and cleared for casting.

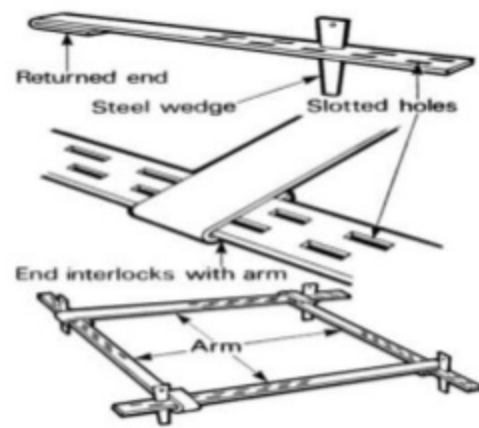
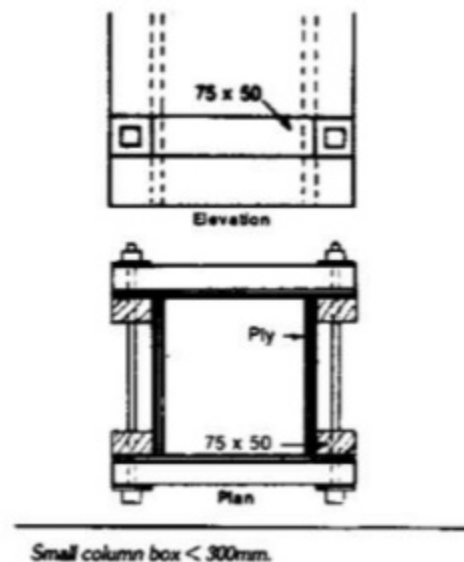
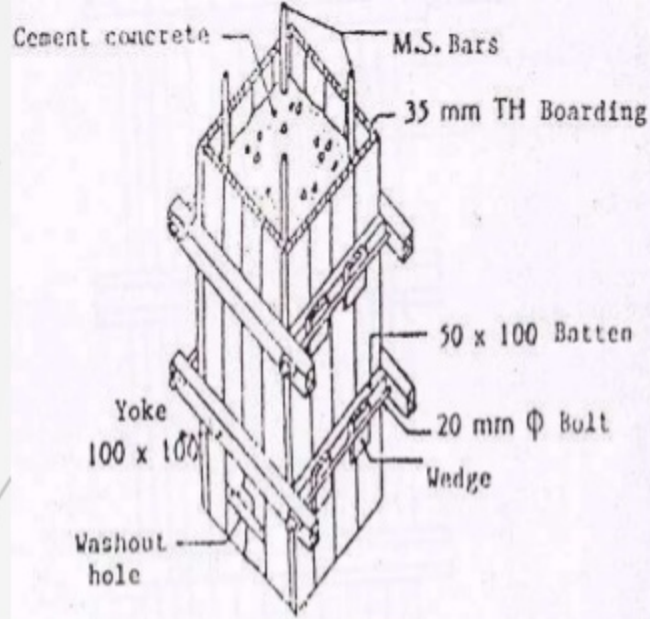
- Position formwork for the column from predetermined grids.
- Plumb formwork both ways and securely support using adjustable steel props.
- The propping angle should be 45° to the floor.
- Ensure the steel props are safely secured to the column formwork and the floor, and that adjustment for pushing and pulling is operational.
- Set out the positions of column clamps from a storey rod.
- Transfer the column clamp positions from the storey 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.

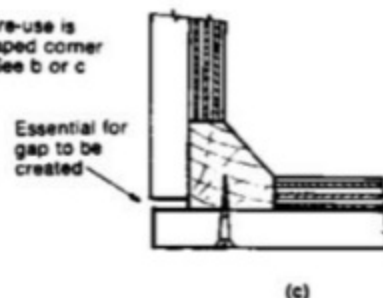
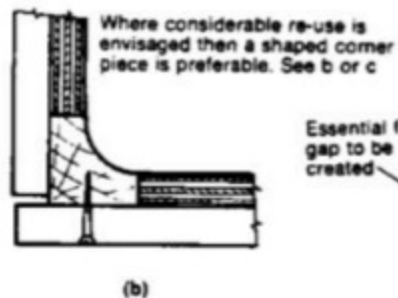
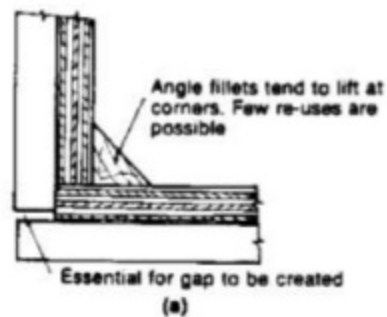


COLUMN CLAMPS IN POSITION

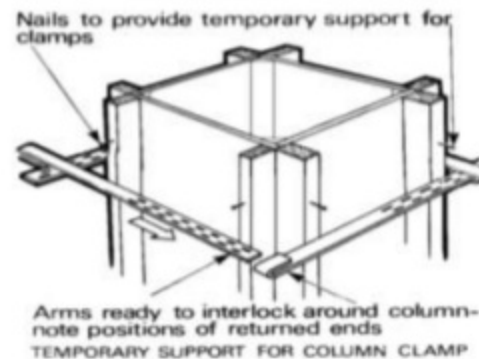
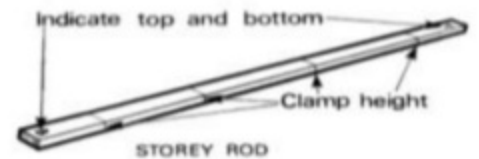
Column clamps are created to give extra external support to the formwork from avoiding circularing of the column



ADJUSTABLE STEEL CLAMPS



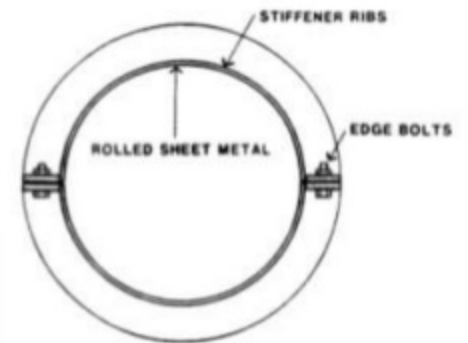
Adjustable steel clamps



Bolts through timber yokes

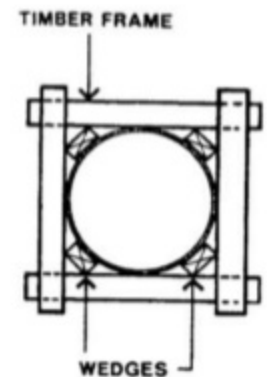
CIRCULAR AND OCTAGONAL COLUMNS

- Circular column formwork
- Fabricated steel, usually two piece, and often with a hinge.
- Fibre cement pipes which are left in place as permanent formwork.
- Timber sheathing tied with standard column clamps. Corners need to have infill pieces. Alternatively, metal strap can be used without the need for corner infills.



Fabricated steel with bolted joints.

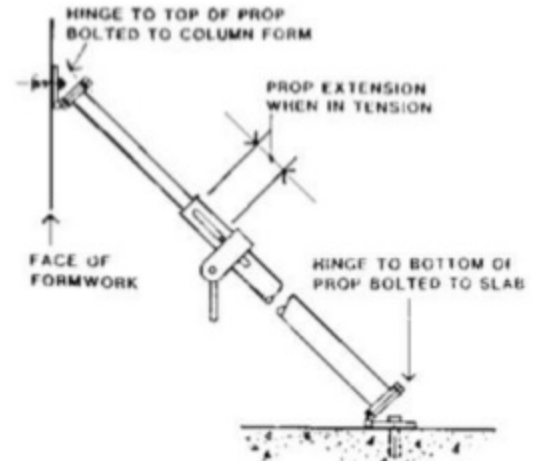
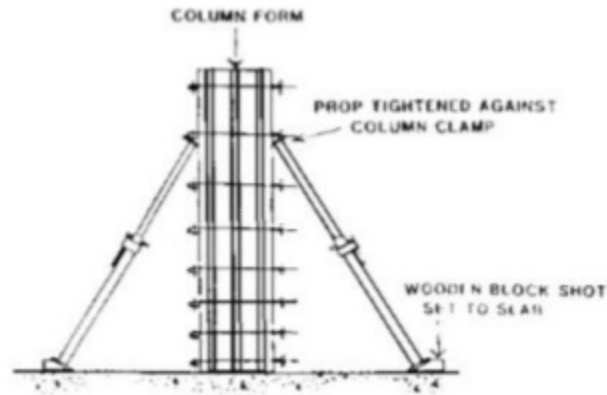
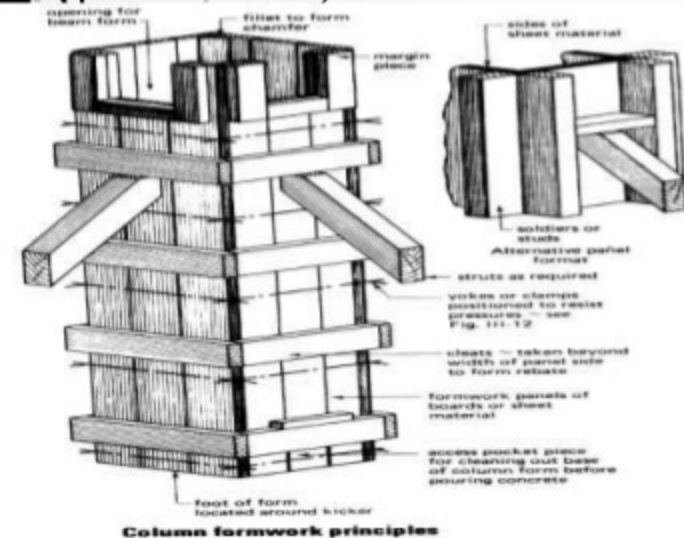
Vertical steel two piece form column



Vertical Timber sheathing column

COLUMN BRACING FORMWORK

- Column formwork bracing performs two functions:
- It must maintain the accuracy of the column form position and plumb so that it is within tolerance.
- Withstand results of forces acting on either the column formwork or the bracing. The forces may be wind or impact. These impact forces can occur from the collision of concrete buckets or cranes hoisting materials

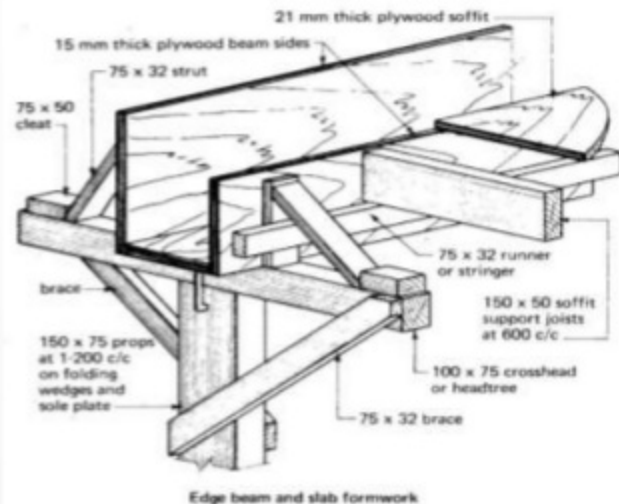
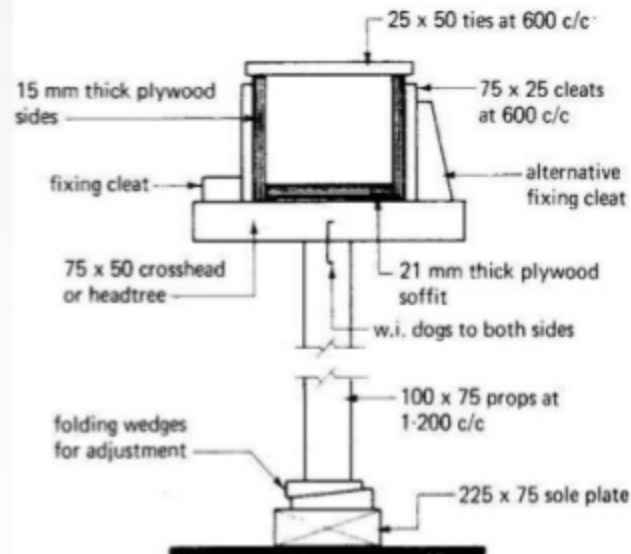


FORMWORK FOR BEAM

- Beam soffit must be thickened timber or strengthened plywood.
- Beam sides 18mm plywood or 25mm boards, with studs (cleats) at 500 to 600mm centres.
- Deep beams (over 600mm) should have walkers and ties.
- Use angle fillets in the beam side to soffit joint where possible.
- Allowance must be made for height adjustment of the props or falsework.

Erection sequence for constructing beam formwork includes

- Position of sole plates;
- Marking out and setting heights for falseworks;
- Assemble and position props, adjustable head jacks, falseworks, bearers and Spreaders;
- Construct and erect side walls and beam soffit.
- Position of sole plates



Typical beam formwork

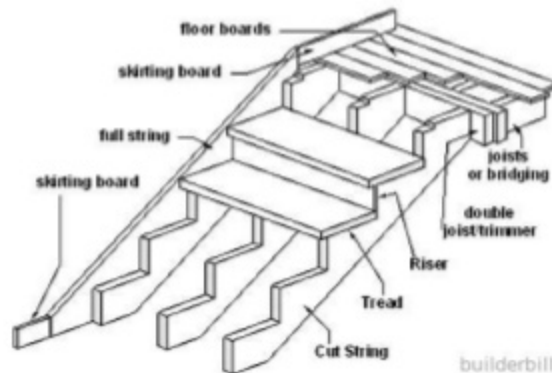
FORMWORK FOR STAIRCASE

- Points to consider when designing stair form work :

Stair formwork must support the weight of concrete. The weight of the throat of the stair and the steps will have to be supported.

Because of the slope of the stair, some of the force is transmitted sideways. All formwork must be well tied together to prevent sideways movement.

Consider the finish of the stair treads and type of nosing. Space may have to be left for purpose made nosing.



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