TOPIC 9

Construction in Civil Engineering

Construction in Civil Engineering

- **Construction** is a process that consists of the building or assembling of infrastructure. Far from being a single activity, large scale construction is a feat of multitasking. Normally the job is managed by the project manager and supervised by the construction manager, design engineer, construction engineer or project architect.

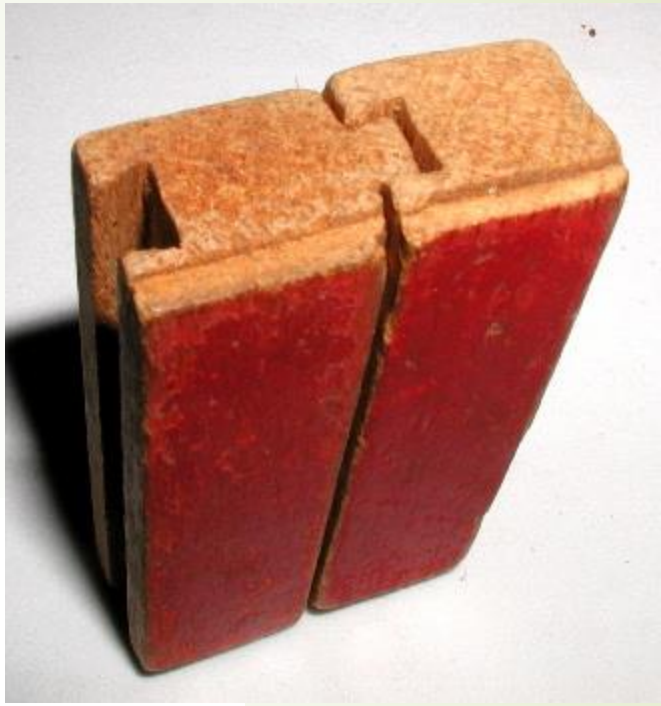
- For the successful execution of a project, effective planning is essential. Those involved with the design and execution of the infrastructure in question must consider the environmental impact of the job, the successful scheduling, budgeting, site safety, availability of materials, logistics, inconvenience to the public caused by construction delays, preparing tender documents,

1. BUILDING TECHNOLOGY

a. Conventional or Traditional method

b. Modern or Industrialized methods

➔ Interlocking brick



Construction Industry Group

Divided into :-

1. Building (Vertical Construction)
   - Buildings and heavy construction

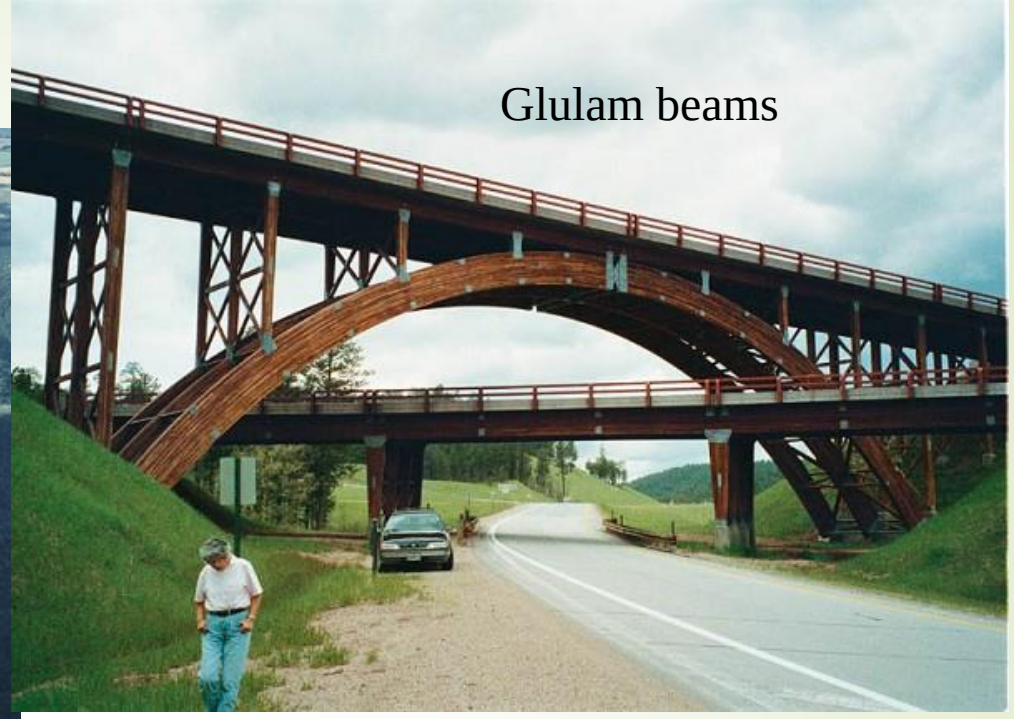
Construction Industry Group

2. Civil Engineering (Horizontal construction)
   - Highways
   - Airports
   - Railroads
   - Bridges
   - Canals
   - Dams
   - Other major public works

- Different construction technique, technologies and equipments

bridge


Southern France


Glulam beams


Donghai bridge


Navajo bridge

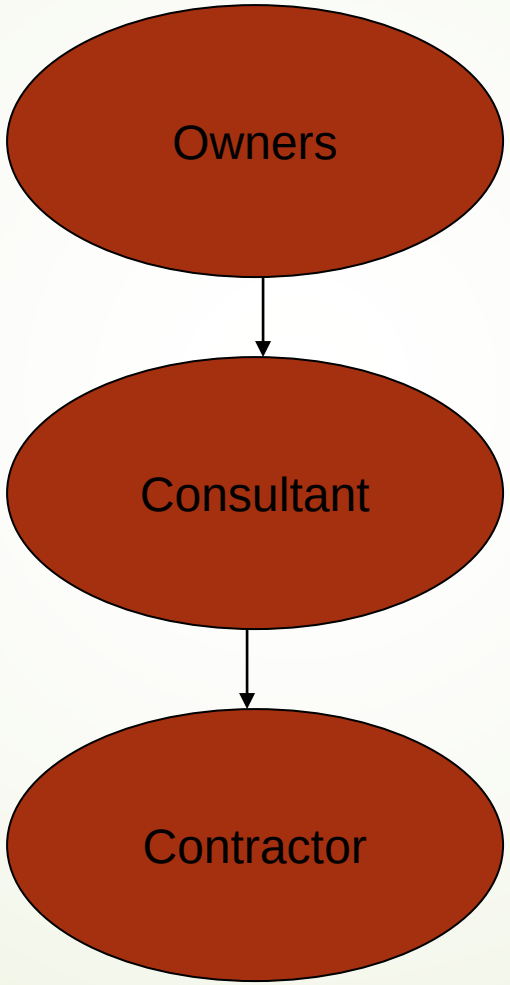
Types of construction projects

In general, there are three types of construction:

- Building construction
- Heavy/civil construction
- Industrial construction

Each type of construction project requires a unique team to plan, design, construct, and maintain the project.

Construction people



Owner

Owner is the people that have exclusive rights and control over property.
Owner can be:-

Government

Private sector

Cooperate sector

Individual

Developer

Consultant

- A **consultant** is a professional who provides advice in a particular area of expertise.
- ***A consultant is usually an expert or a professional in a specific field and has a wide knowledge of the subject matter.***
- A consultant usually works for a consultancy firm or is self-employed, and engages with multiple and changing clients.

Contactor

- **Contractor** may refer to:

  Organization or individual that contracts with another organization or individual (the owner) for the construction of a building, road or other facility.

Contractor can be:

1. Main contractor
2. Sub contractor

CONSTRUCTION PROCESS

In general (differs from small to big project):-

- Recognizing the need for the project
- Determining the technical and financial feasibility
- Preparing detail plans, specifications and cost estimation
- Obtaining approval from regulatory agencies such as zoning regulations, building codes and environmental.
  Needs, idea, conceptual design, financial and legal considerations.
- Details design, budgeting and contract document.
- Tendering, project offer and construction works

Stages for construction (Buildings only)

1. Site works and setting out
2. Accommodation, storage and security
3. Detail building stages

1. Site works and Setting Out

- Contractors responsibility after being given possession and site layout plan and detail drawings necessary
- Commencing tasks:-
  a. Clearing the site
  b. Setting out the building
  c. Establishing a datum level

LEVELING

The land surveyor will determine the original ground level for the land and mark a survey peg for drain, pipes, cables and main sewerage treatment plant (MSTP)

Land surveyor determine the OGL

Clearing the Site

- May involve:-
  - Demolition of existing buildings (by experienced contractor)
  - Grubbing out bushes and tress (by manual or mechanical means, or by specialist for the large tress)
  - Removal of soil to reduce levels

Topography of the site and some common material on site

Removal of tree trunks

Grubbing of trees, shrubs and roots

Site clearing work carried out

Excavator heaping up top soil

Earthwork operation

a) SITE BOUNDARY

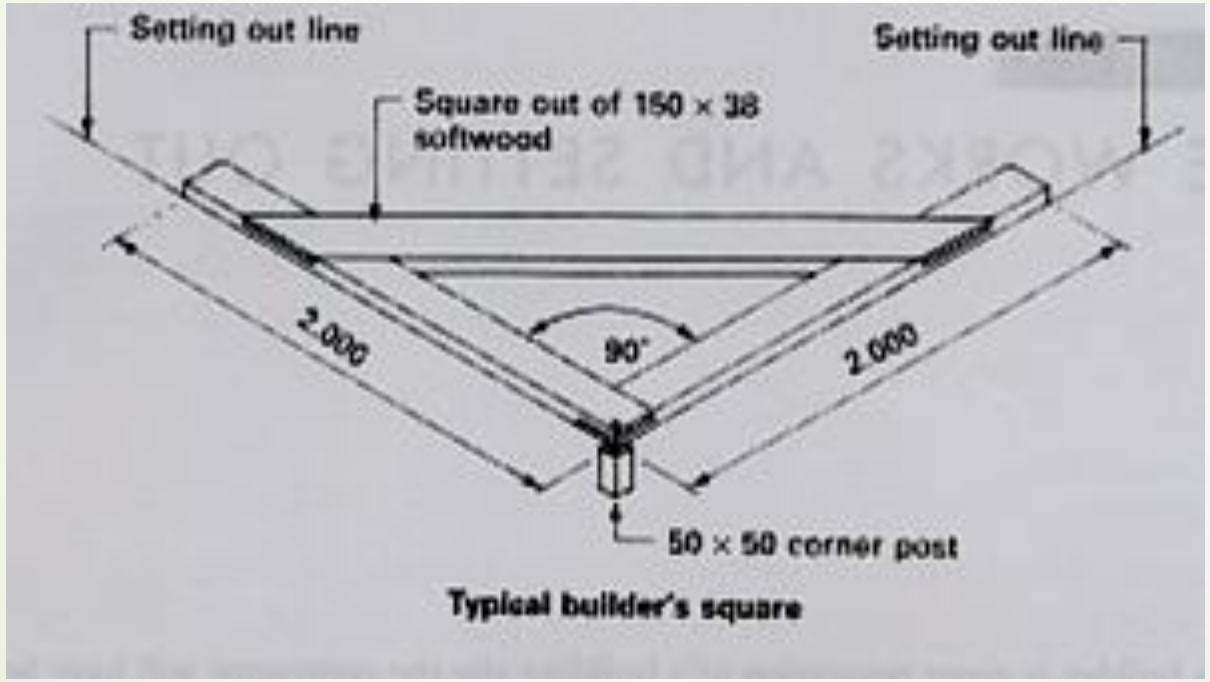
The surveyor must determine the site boundary of the construction area to avoid trespass to another construction area.

The boundary had determine

Setting Out the Site

1. Establish a base line from which the whole of the building can be set out.
   - Marked on site clearly so that it can be re-established at any time
   - Using steel tape (30 meters and not stretchable is more suitable)
   - Marked each corner with a stout peg
   - Check on the right angle and correct lengths (advisable using different method)

Typical builder square



Typical builder's square

Setting out and checking methods

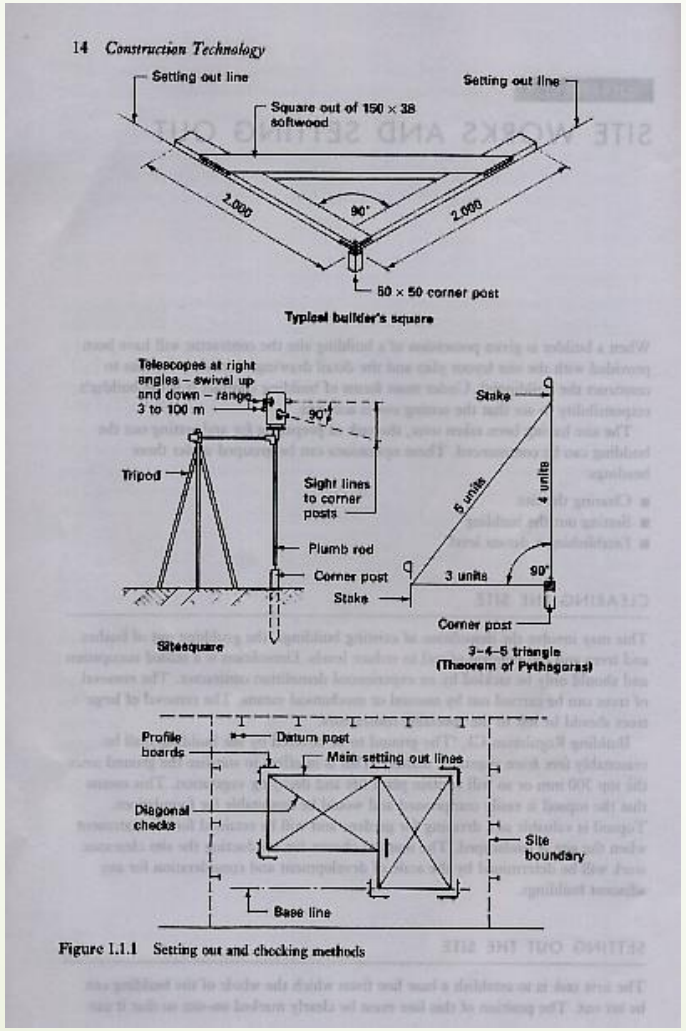
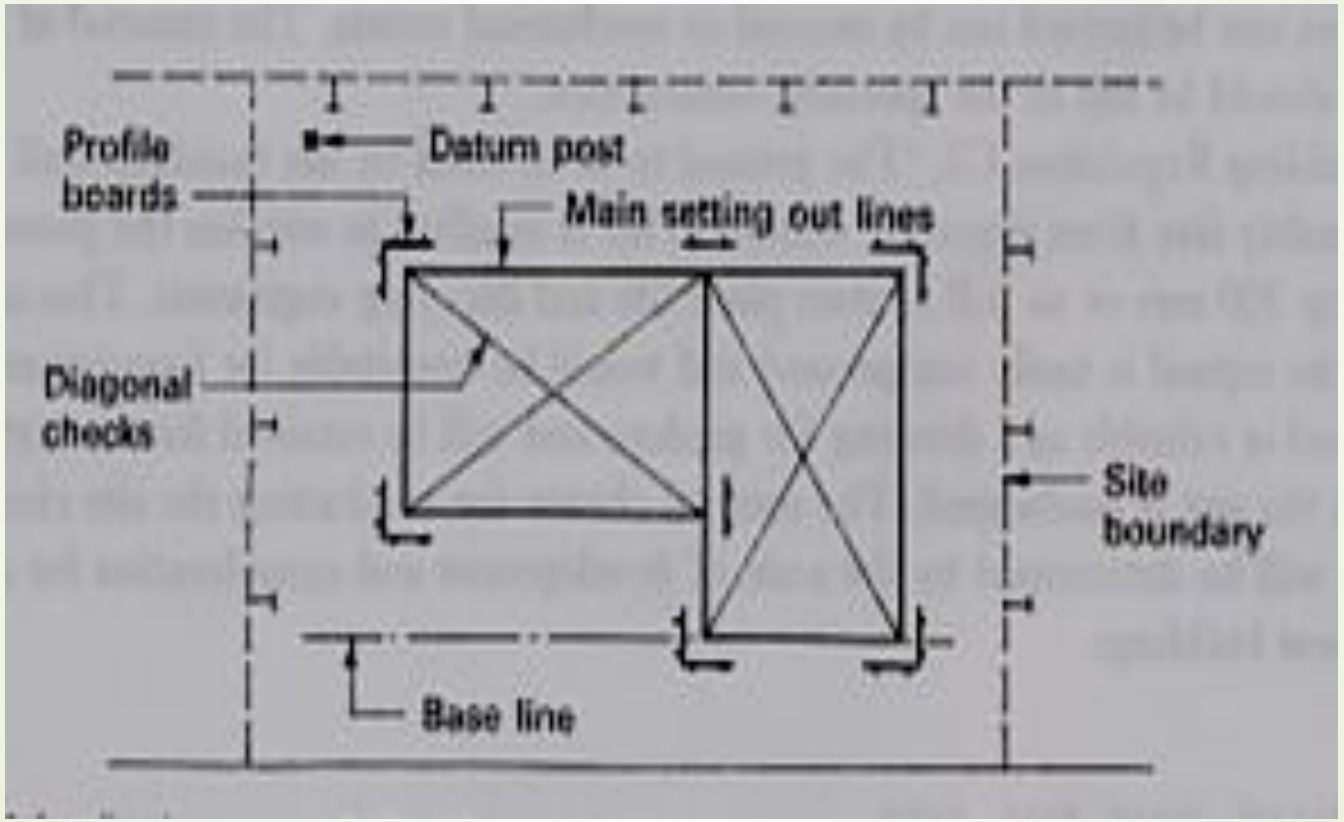


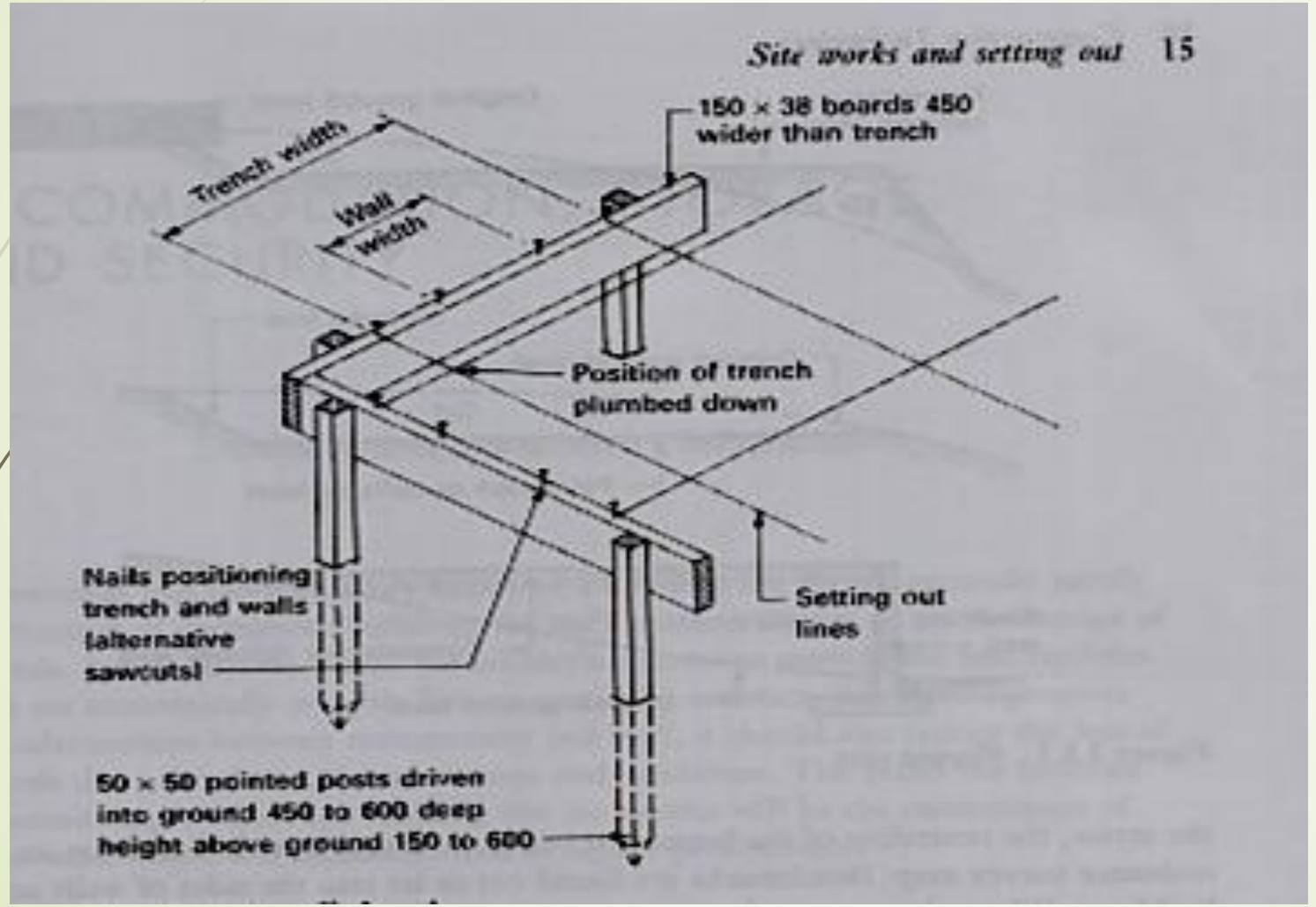
Figure 1.1.1 Setting out and checking methods


Profile boards
Datum post
Main setting out lines
Diagonal checks
Site boundary
Base line

Setting Out the Site

2. Set up profile board-after the main building lines
   - Should set up clear of the foundations trench positions to locate the trench, foundations and walls
   - Required at all trench and wall intersections

Typical profile board



Establishing a Datum Level

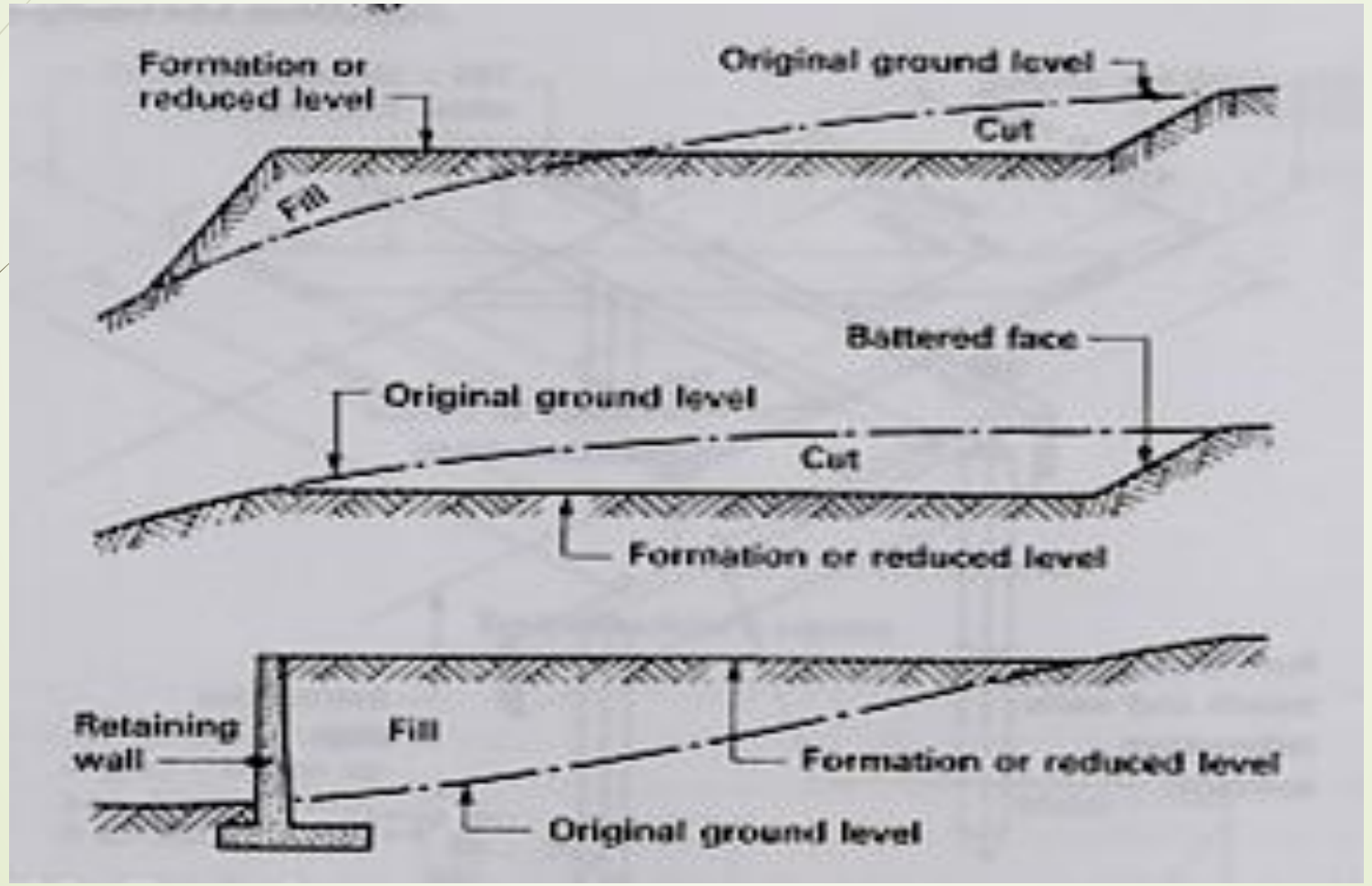
- All levels in a building are taken from a fixed point called a ‘datum’
- Should establish after the setting out and related to ordnance benchmark
- An arrow with a horizontal mark above the arrow
- The centerline of the horizontal being the actual level indicated on an ordnance survey maps

Sloping Sites

Three methods in reducing levels:-

1. **Cut and Fill** - usual method, the amount of cut will equal the amount of fill
2. **Cut** – Advantages of having undisturbed soil over the site, but having disadvantages of cost of removing the spoil from the site
3. **Fill** – Not to be recommended, deep foundation would be needed, the risk of settlement and the amount of fill should be limited to 600 mm

Sloping sites



BUILDING STAGES

Order of construction

- Excavation and timbering
- Foundations
- Concrete floors
- Reinforced concrete frames
- Roofs
- Brickwork
- Internal fixtures and fittings
- Insulation
- Plumbing and wiring
- Painting and decorating

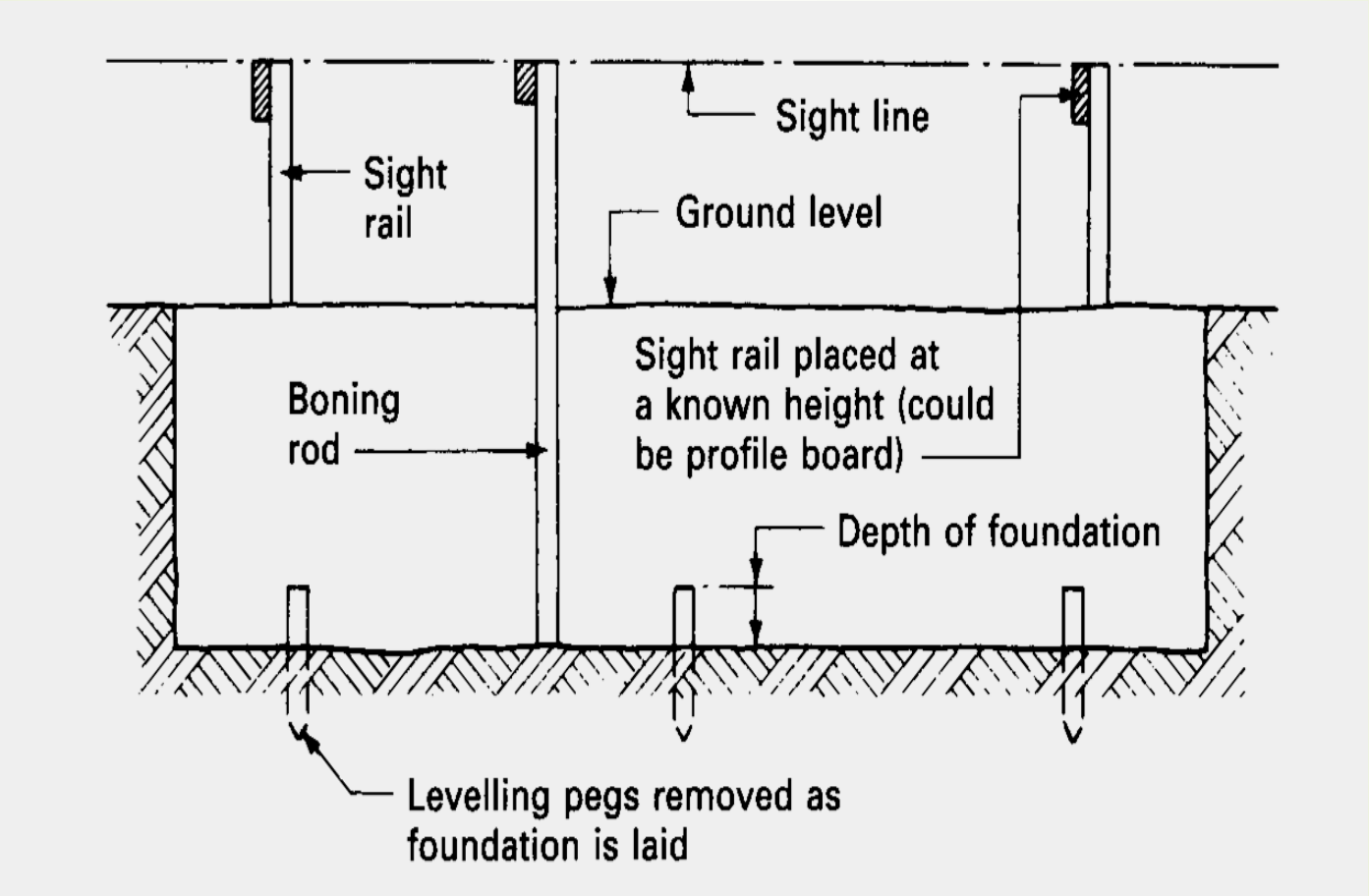
Excavation and Timbering

- Before a foundation can be laid, it is necessary to excavate a trench of the required depth and width (by hand or mechanical excavator)

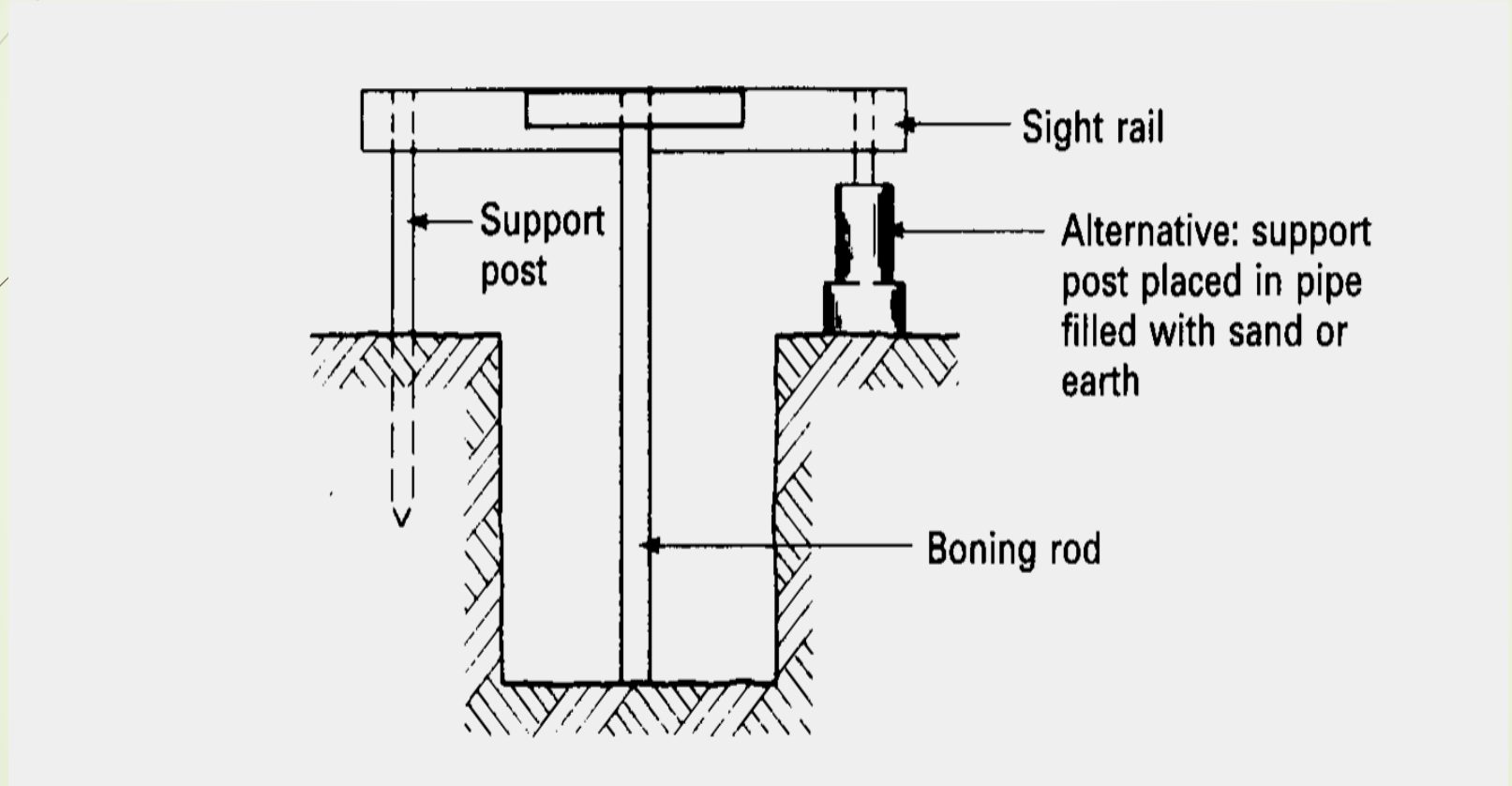
Timbering – term used to cover temporary supports to the sides of excavations and is sometimes called planking and strutting

- Type and amount – depend on the depth, nature of subsoil, weather conditions and duration

Typical example of trench excavations



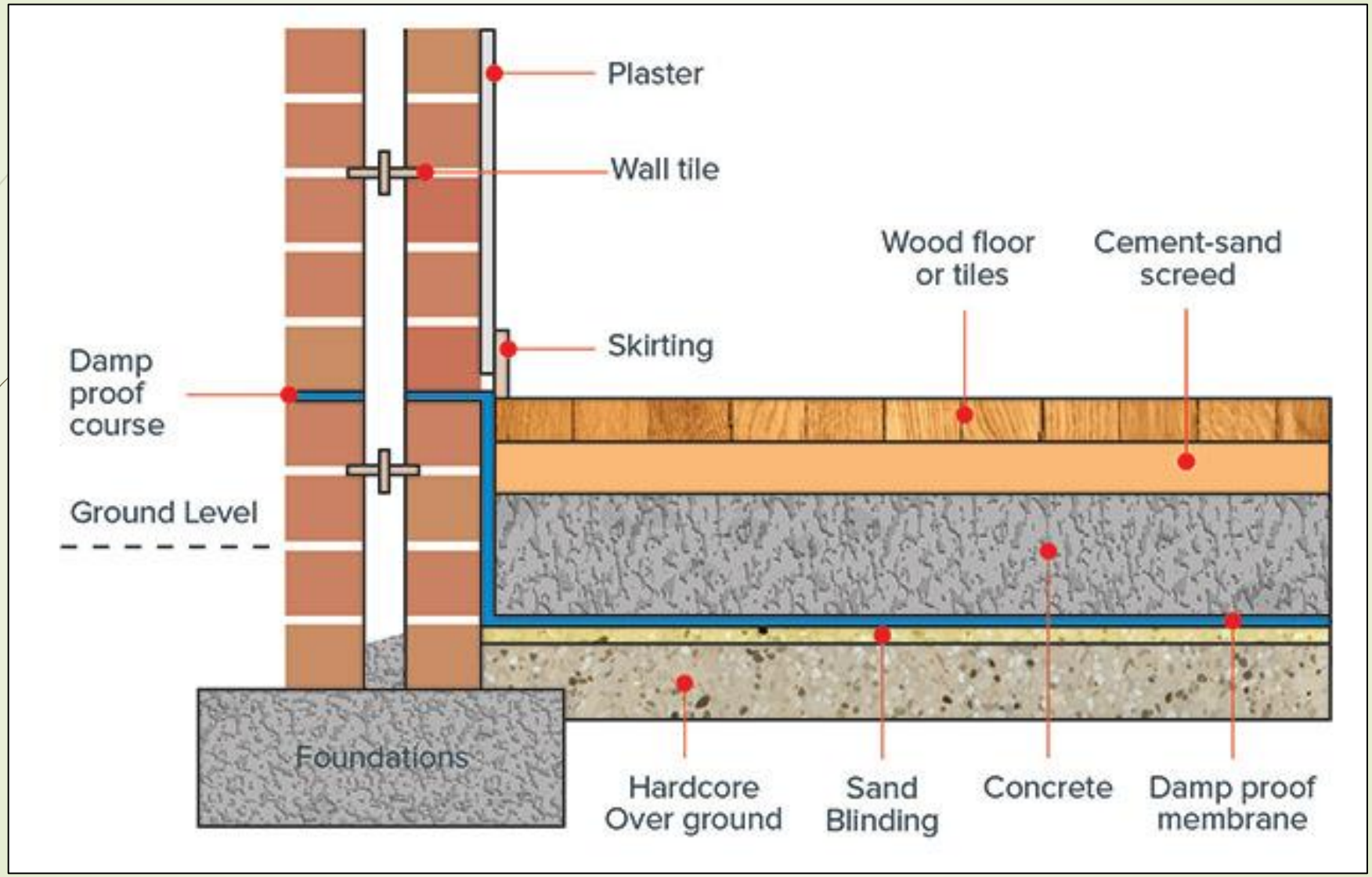
Trench excavation



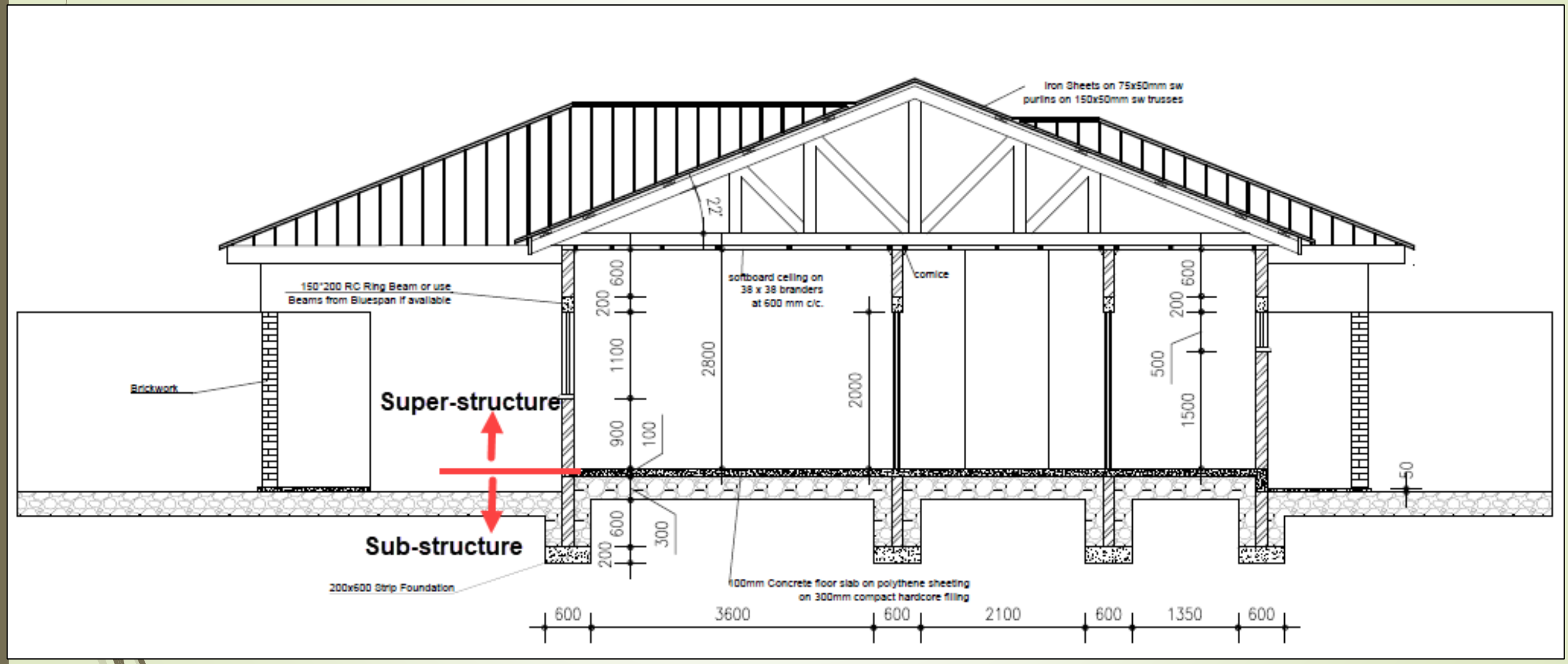
FOUNDATIONS

- Foundation is the base on which a building rests and its purpose is to safely transfer the load of a building to suitable subsoil
- **Building regulations :-**
  - **Safely sustain and submit to the ground the combined dead and imposed loads so as not to have any settlement or other movement in any part of the building or of any adjoining buildings or works**
  - Be a such a depth, or be so constructed, as to avoid any damage by swelling, shrinkage or freezing of the subsoil
  - Be capable of resisting attack by deleterious material, such as sulphates, in the subsoil

FOUNDATIONS - SUBSTRUCTURE



TYPICAL CROSS - SECTION ELEMENTS



CONSTRUCTION PLANTS

- Principles and factors of plant selections
- Types, functions and capabilities of moving machines

CONSTRUCTION PLANT

- THREE PINCIPLE CONSIDERATIONS:-
  - Technical efficiency
    - Ability
    - Requirement
    - Correct specification
    - timeframe
  - Commercial and financial ability
    - Cost
  - Availability
    - Supplier (location and numbers of supplier)
    - within the timeframe

Factors Selecting Equipment

1. The function to be carried out
2. Standard or special types of equipment
3. Capacity of the equipment
4. Method of operation
5. Replacement of parts
6. Maintenance and repairs
7. Investment costs
8. Operating cost

Types of Construction Equipments

- Used to ground leveling and bulk earthmoving. Divided into two :-
  - Moving Machines-
    - Bulldozers, loaders, scrapers, graders and trenching machines
    - The excavated material is removed transported and deposited
    - For removal of large of earth

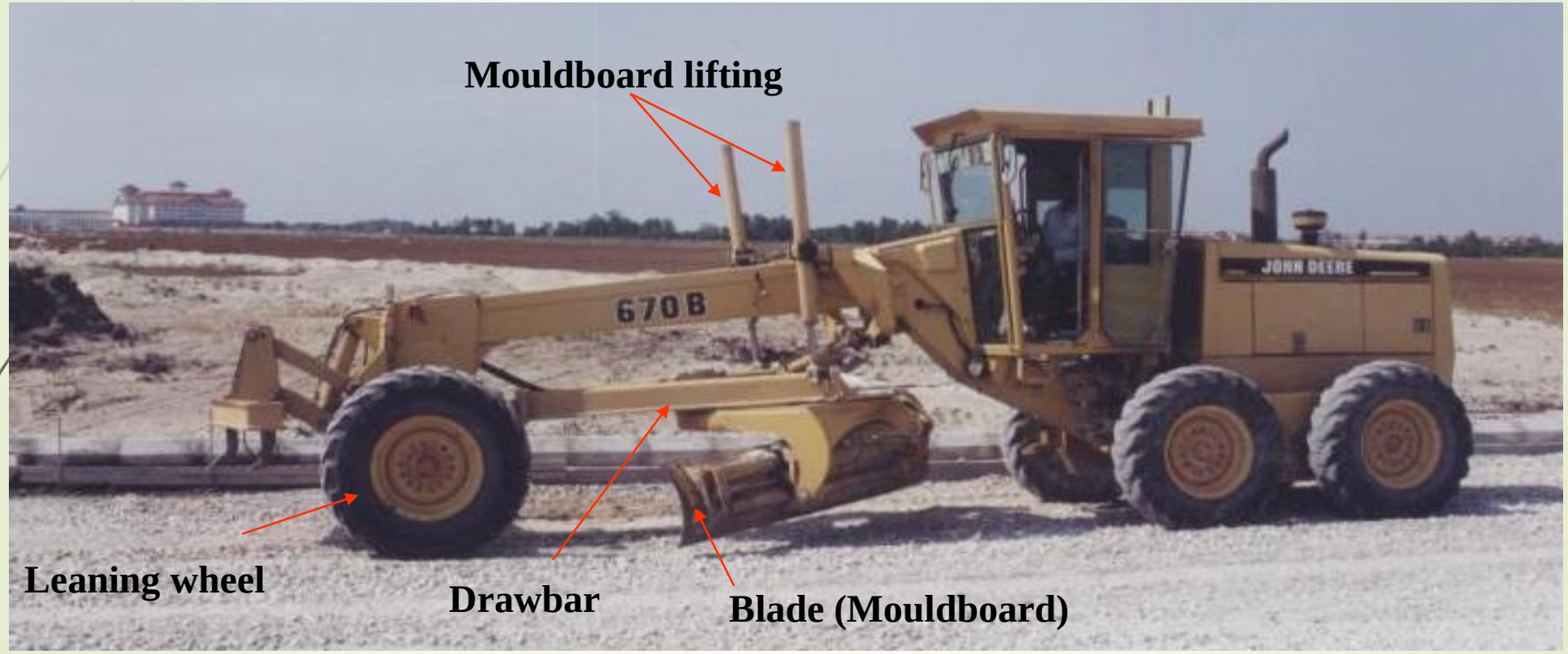
- Stationary machines
  - Face shovels, backhoes, draglines and grabs
  - The excavator loosens the soil and loads without changing position
  - Loss of mobility compared to scrapers and bucket loaders
  - More force may be applied

Equipment of Earthwork Plant

COMPONENTS OF WORK	APPLICABLE TYPES OF PLANT
Clearing and grubbing	Bulldozer, rake- dozer
Excavation	Shovels (power shove ,back hoe, dragline, clamshell), tractor – shovel, bulldozer, ripper, breaker
Loading	Shovels (power shovel, backhoe, dragline, clamshell), tractor-shovel, bucket wheel excavator
Excavation and loading	Shovels (power shovel, backhoe, dragline, clamshell), tractor-shovel, bucket wheel excavator
Excavation and hauling	Bulldozer, scrape-dozer ,scraper
Hauling	Bulldozer , dump truck, belt conveyer
Spreading and grading	Bulldozer, motor grader
Compaction	Pneumatic-tired roller, tamping roller, vibrating roller, road roller, vibrating compacter, rammer, tamper, bulldozer
Blasting	Drilling (crawler, pneumatic,hydraulic), air compressor, lorry

MOVING POSITION MACHINES

Six wheeled drive graders



MOVING MACHINE - Buckets for loader

Buckets for loader

STATIONARY POSITION MACHINES - BACKHOE

- Also known as pull shovel, drag shovel or simply as hoe
- Used for excavating **below the level** of the tracks, e.g. trenches, basement, foundations and for other excavation work in confine situation.

Compaction equipment

Steel cylinder roller

- Two types:-
  - Non vibrating
  - Vibrating rollers

Steel cylinder roller

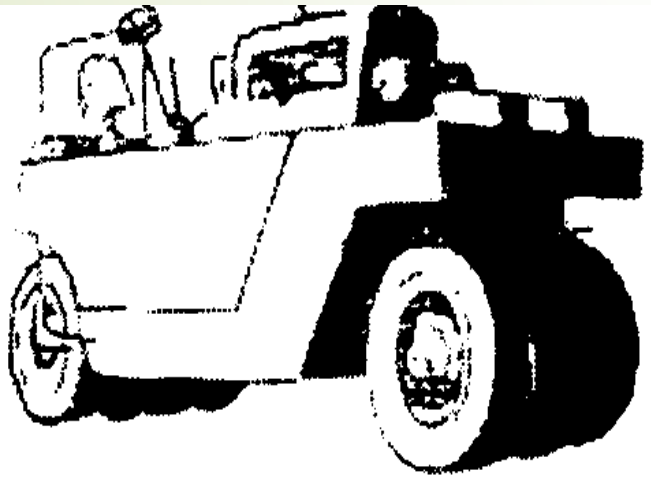
- Non vibrating
  - Two types:-
    - Tandem (two-axle)
    - Three wheeled
  - Both types are self-propelled
  - Able to be ballasted (added weight) by adding water or sand to the rolls
  - Ballast normally required when operating the roller but may be removed when it is to be transported
  - Maximum effective layer compacted is 250mm

VIBRATING ROLLER

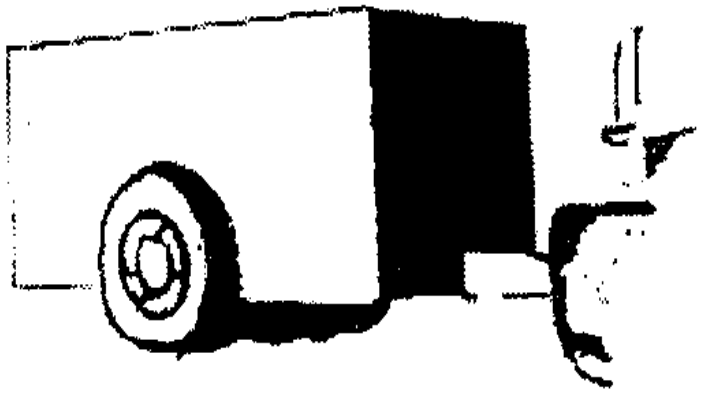
- Two major types:-
  - Vibrating smooth drum rollers
    - Tractor drawn
    - Self-propelled
  - Important factors when considering vibrating rollers:-
    - Dynamic force- force exerted by the roller. Centrifugal force generated by a revolving eccentric shaft and total dead weight of the roller frame and drum
    - Frequency of vibration – no. of revolutions per minute made by the eccentric shaft
    - Amplitude of vibration- eccentric shaft rotates, the drum assembly moves up and down. Amplitude is the total distance the drum travels vertically.

Pneumatic tired rollers

- Used on pavements such as sprayed or asphalt mix bitumen surfacing work
- Suitable when material is cohesive, such as clays, clayey gravels or loams which is free from rock



Small, multi pneumatic roller



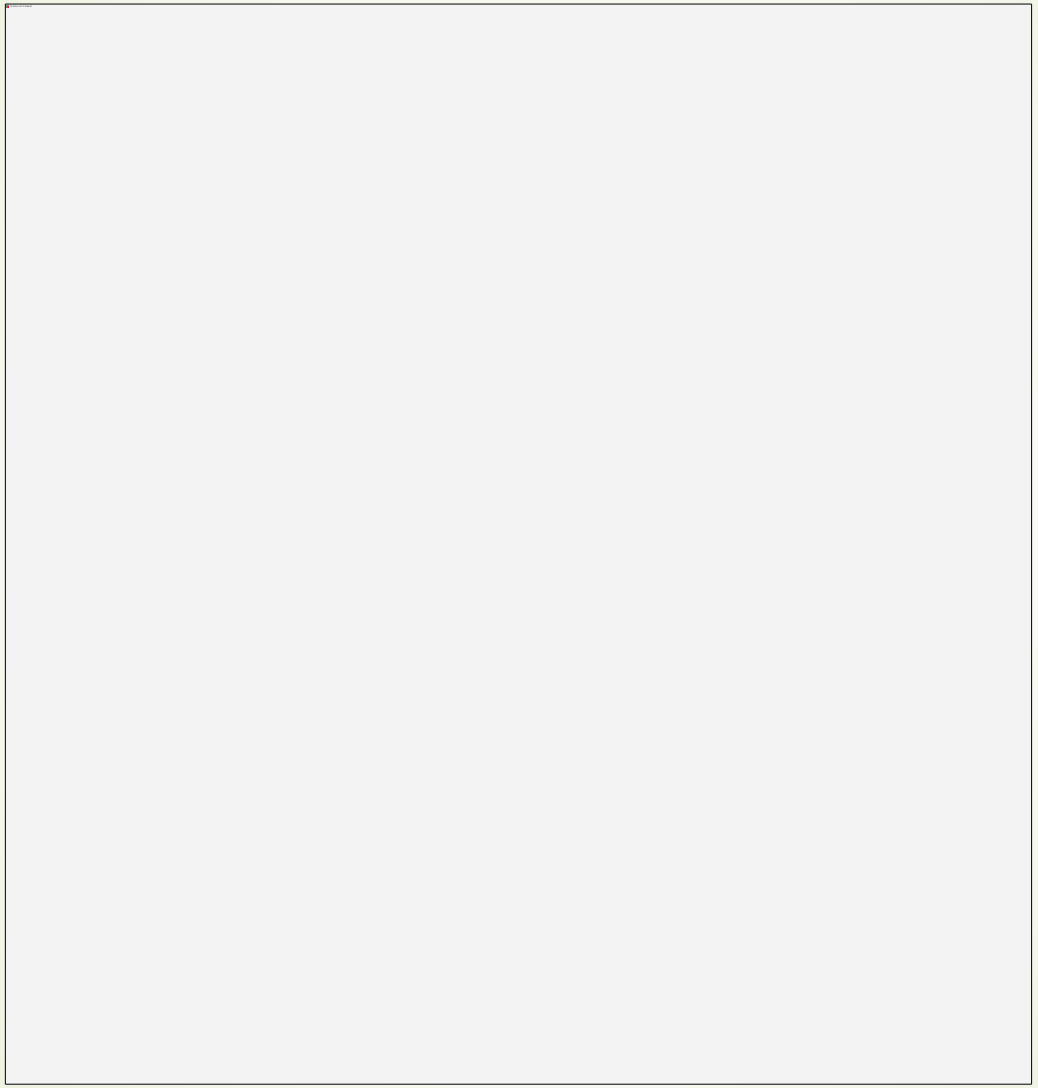
Heavy pneumatic roller

CRANE

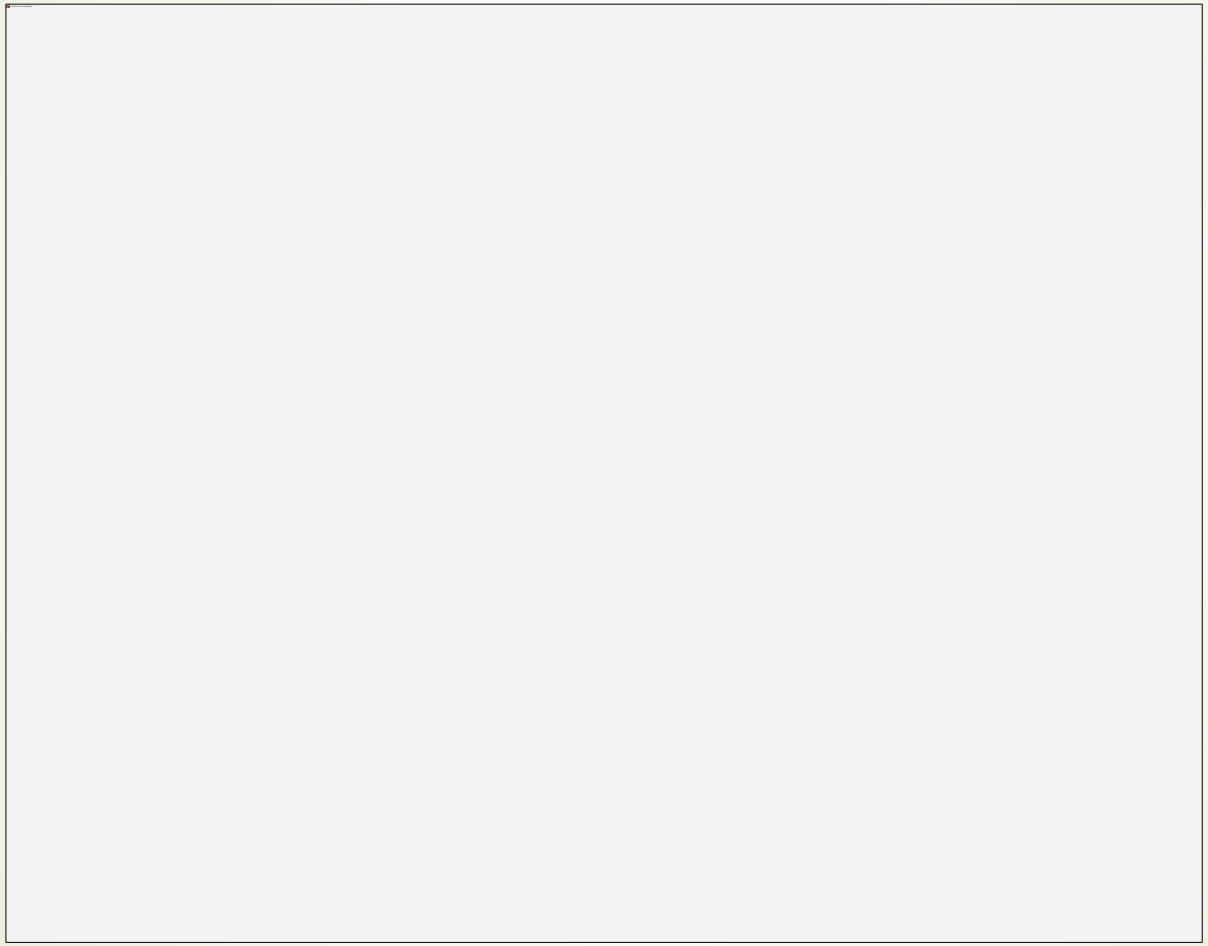
- Cranes are a broad class of construction equipment used to hoist and move loads from one location to another.

- Construction cranes are generally classified into two major types, namely mobile cranes and tower cranes. The lifting capacity and working range of a crane is important in selecting the suitable crane in performing a given task.

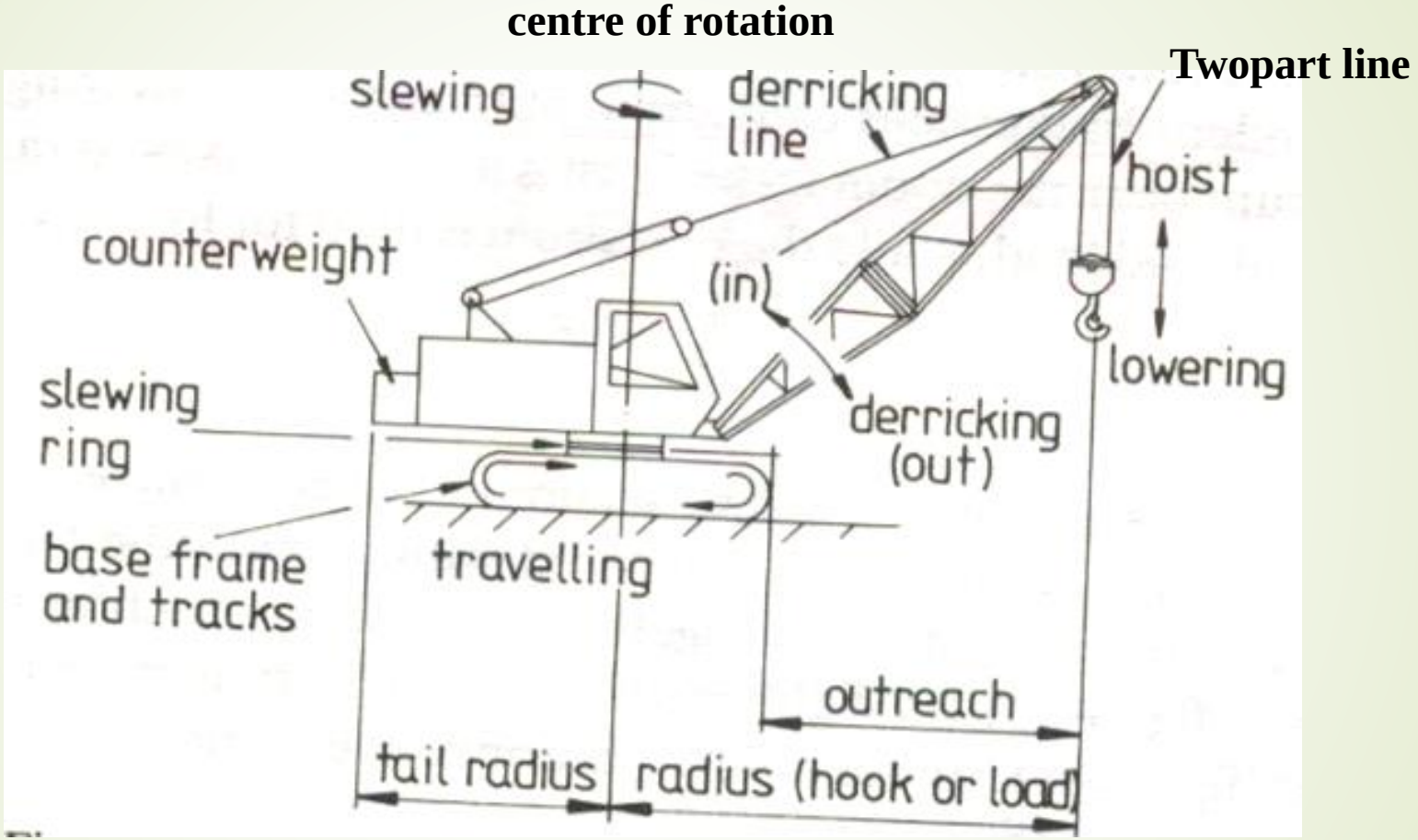
Mobile Cranes



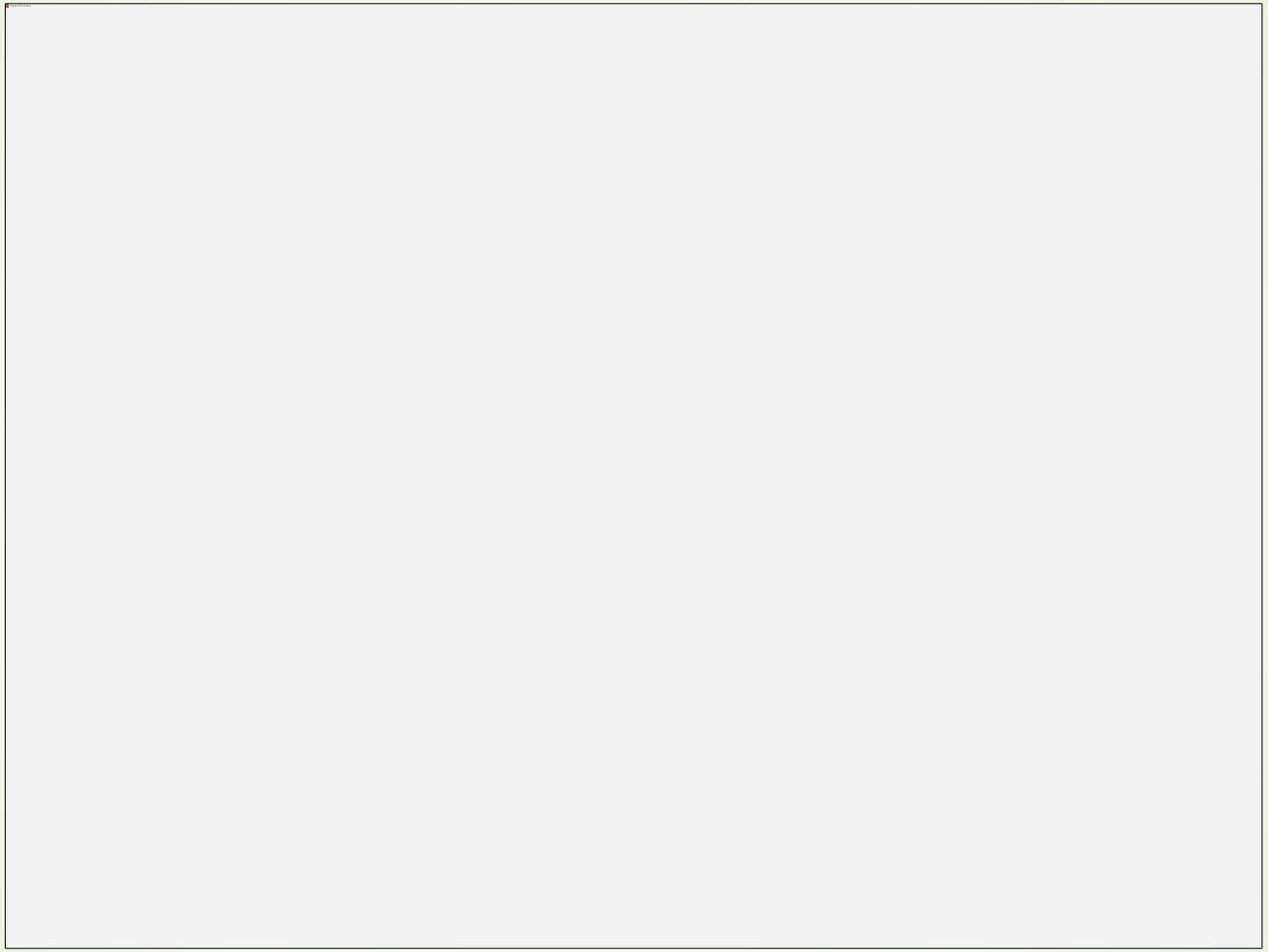
Crawler Cranes



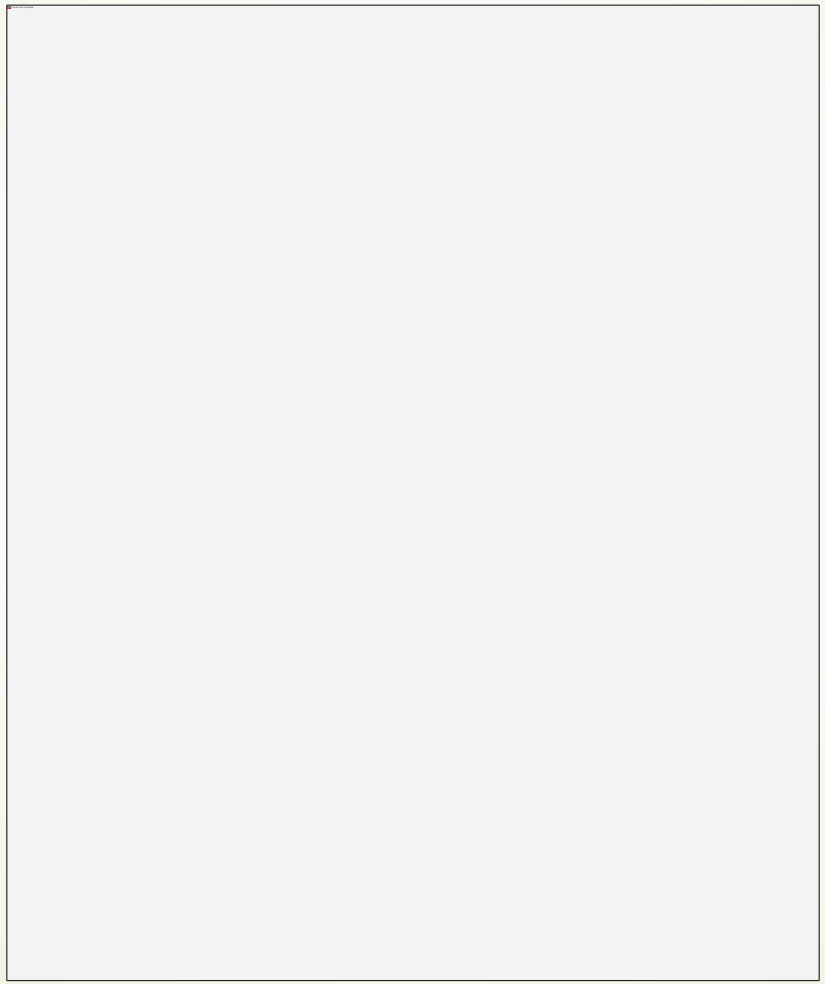
Crawler mounted crane



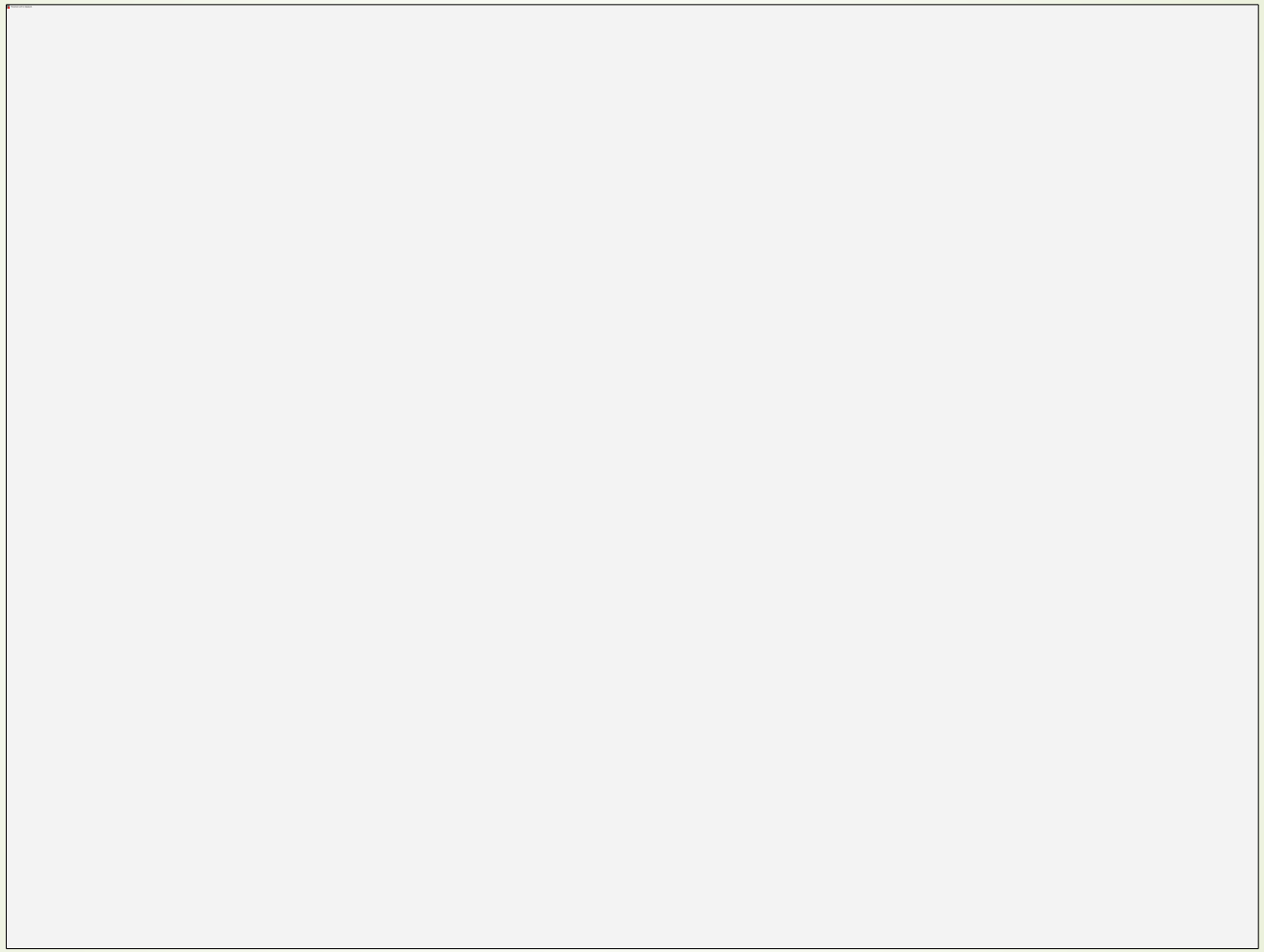
All-Terrain Cranes



Heavy-Lift Cranes



Tower Cranes



Horizontal-jib or Saddle-jib tower crane

FORMWORK

"Is a mould or box into which wet concrete can be poured and compacted so that it will flow and finally set to the inner profile of the box or mould".

FORMWORK

- Purpose – to contain freshly placed and compacted concrete until it has gained enough strength to be self-supporting
- to produce a concrete member of the required shape and size
- to produce the desired finish to the concrete
- May be describe as a mould or box

General design of formwork

1. sufficiently rigid to prevent undue deflection during the placing of the concrete
2. Sufficient strength to carry the working load and the weight or pressure of the wet concrete and to withstand incidental loading and vibration of the concrete
3. Set to line and level within the specified tolerance and include any camber (bend) which may be required

General design of formwork

4. joints should be sufficiently tight to prevent loss of mortar from the concrete
5. size of panels or units should permit easy handling
6. design should permit and orderly and simple method of erection and striking
7. Arrangement of panels should be such that they are not 'trapped' during striking and it should be possible to strike side from beams without disturbing the soffit formwork

- A worker on the project greases the joints between Boards to ensure they are grout-tight.

Extension pipe bridges with the formwork

Material for formwork

- Main requirements:-
  - Hardness
  - Permeability
  - Surface texture
- Formwork facing material:-
  - Timber
  - Plywood
  - Steel
  - Concrete
  - Glass-reinforced plastic
  - Hardboard
  - Expanded polystyrene

Formwork linings

- To obtain smooth patterned or textured for surfaces
- Inside of form can be lined with various materials such as oil-tempered hardboard, moulded rubber, moulded PVC and glass fibre reinforced polyester

Timber formwork

- Basic standard qualities:-
  - Reasonable price and availability
  - Should not be so soft
  - Should be easily worked by hand or machine and nailed easily
  - Should be stiff to avoid deflection
  - Should be stable when exposed to sun or rain
  - Should reduce defects
  - Not suitable for green timber
  - Moisture content not less than 20%

Advantages of timber formwork

- More economic
- Easy to handle and formed into required shape
- Maximum re-use
- Easy to fix insert

Disadvantages of timber formwork

- Not enough strength as compared to steel formwork to carry large pressure.
- Excessive shrinkage due to temperature changes.
- Leakage through joints and apertures.
- Easily damage during fixing and dismantling of formwork.
- The pattern of grain, knots, bad flaws will leave imprint to the face of concrete.

ADVANTAGES OF PLYWOOD FORMWORK

- Large panel
- Leakproof
- Large level surface
- No casting or cupping of surface – smooth surface
- Can be nailed to edges without splitting
- High resistance to impact loads
- Available in several thickness

Disadvantages of plywood formwork

- Grain pattern on concrete face
- Less durable
- More expensive compared to timber

Metal formwork - STEEL

- Based on manufacturer pattern
- Double uses compare to timber, i.e. 30 or 40 uses
- Produce smooth, variable colour concrete surface

ADVANTAGES

- Able to carry large concrete weight and pressure.
- Can be erected, disassembled, moved, and re-erected rapidly using proper handling equipment available.
- Leakage can be avoided.
- No shrinkage due to temperature changes.
- Easy to fix the joint with bolt and nut.
- Economic if there are enough re-uses.

DISADVANTAGES

- Limited to the shape of the structure.
- Standard steel unit are too heavy and difficult to handle.

Metal formwork

ALUMINIUM

- Selection of type and grade is important
- Based on environment
- Due to degradation and corrosion when subjected to marine environments
- Need special release agent

PLASTIC

- rigid form – when form is not suitable using timber or steel (thermo-formed)
- flexible form – for lining material for mould faces
- Provide high quality surface finish
- Disadvantages – impermeable and need special release agent

GLASS FIBRE REINFORCED PLASTIC (GRP)

- Strong and light weight
- Use to produce a high quality surface finish, eg. Sculpture profile and repetition
- Comprises of polyester resin reinforced with glass fiber
- Thickness varies from 5 to 16 mm
- Can be used more than 100 times if handle with care
- Disadvantages similar with plastic formwork

Common failures of formwork

- Dimensional inaccuracy
- Lifting of single faced forms
- Inadequate of props
- Loss of material –ties or props incorrectly spaced
- Surface blemishes

Types of formwork

- Foundation
- Column
- Beam
- Slab
- Wall
- Climbing
- Sliding
- Permanent
- System
- Table

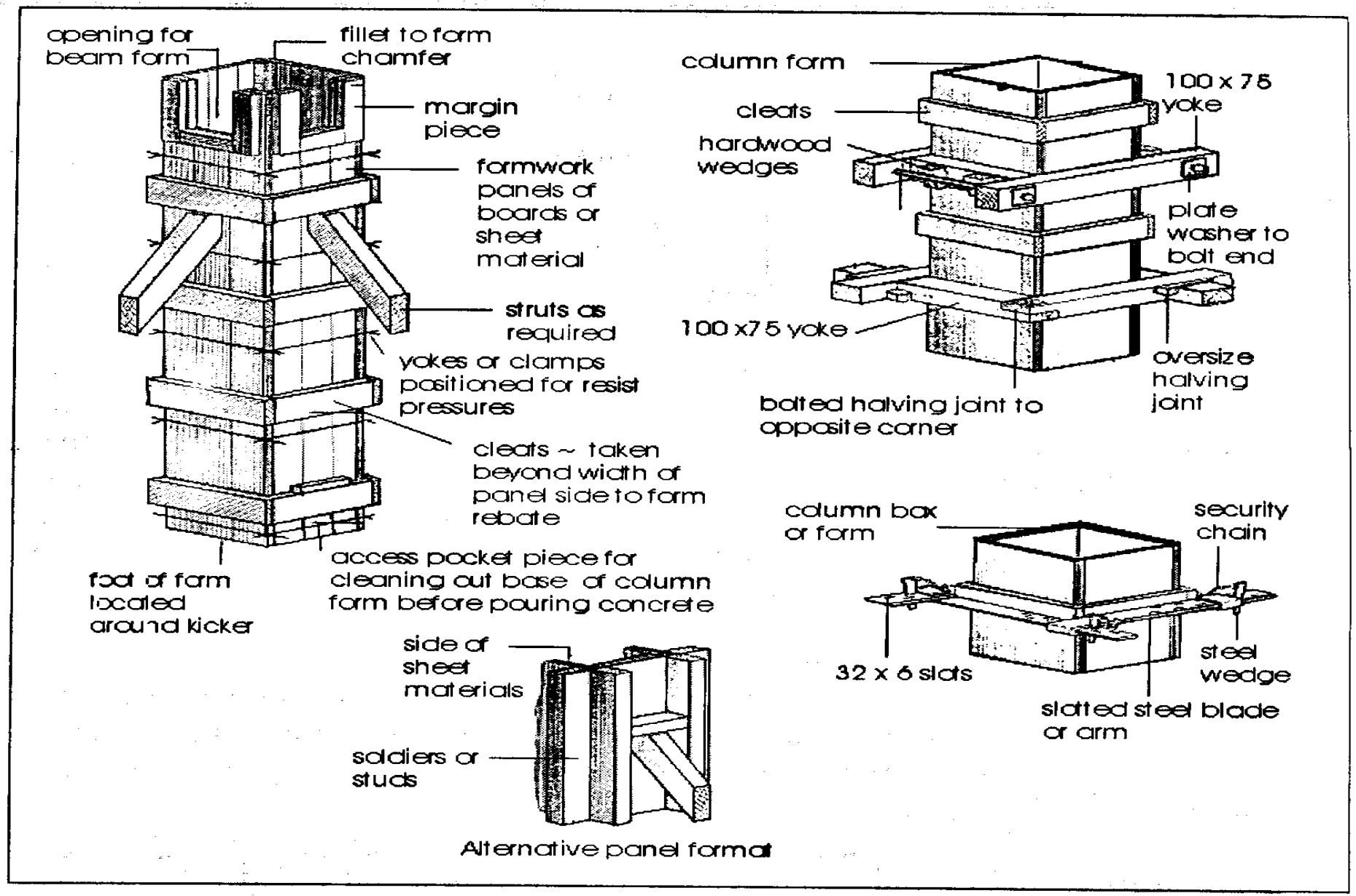
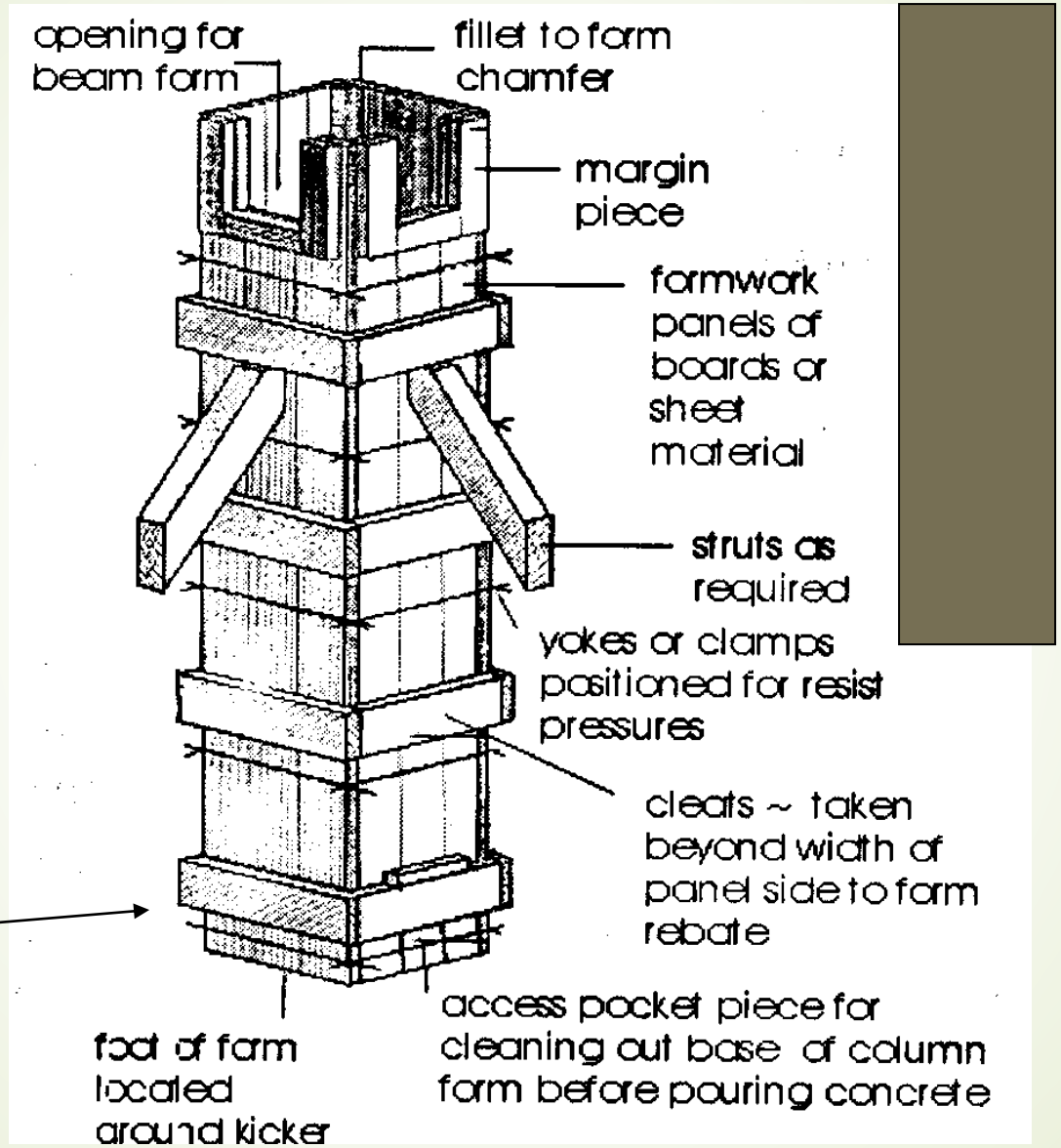


Figure 2.1 **Typical Arrangement of Column Formwork**



75 mm high kicker

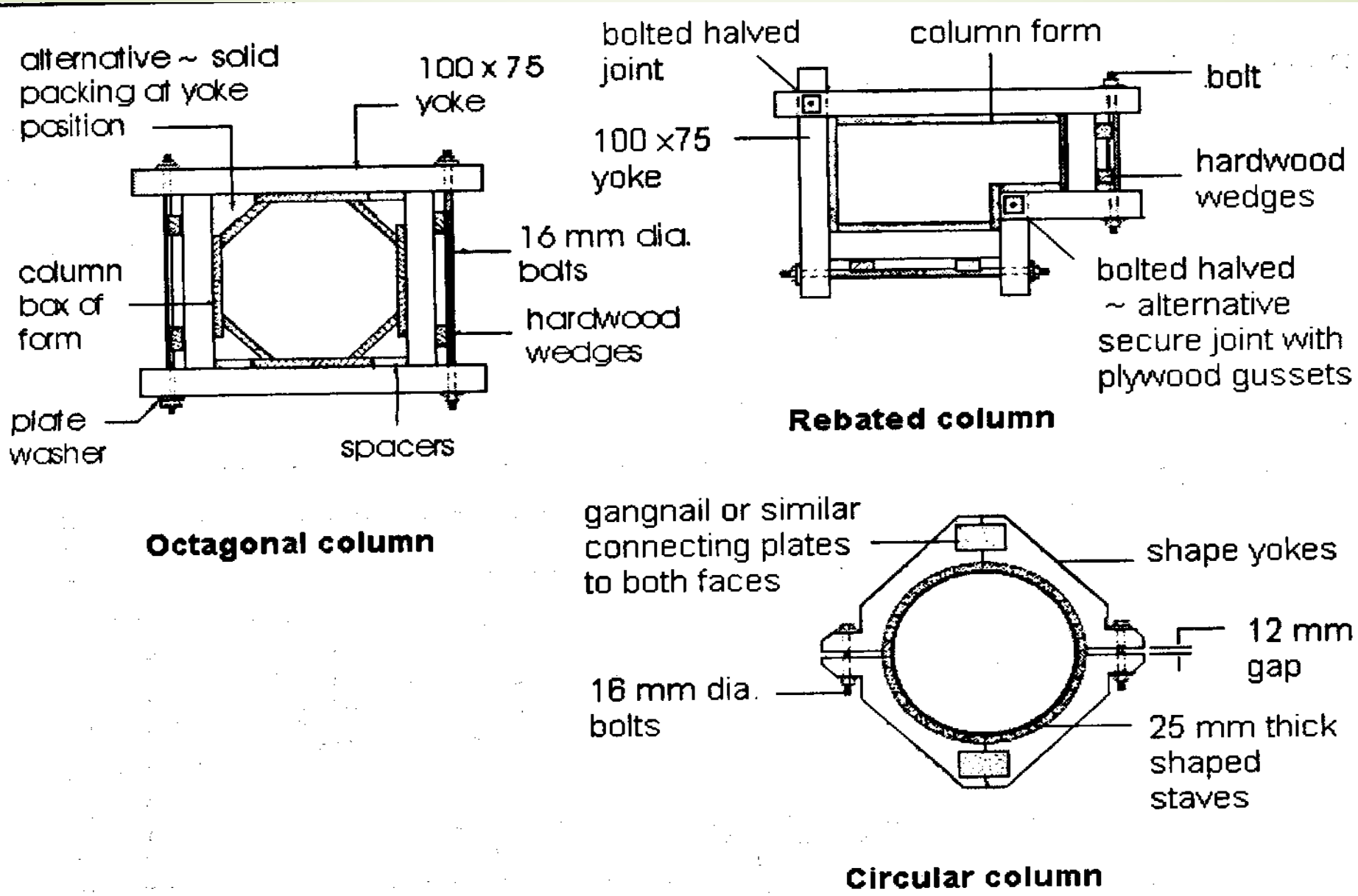
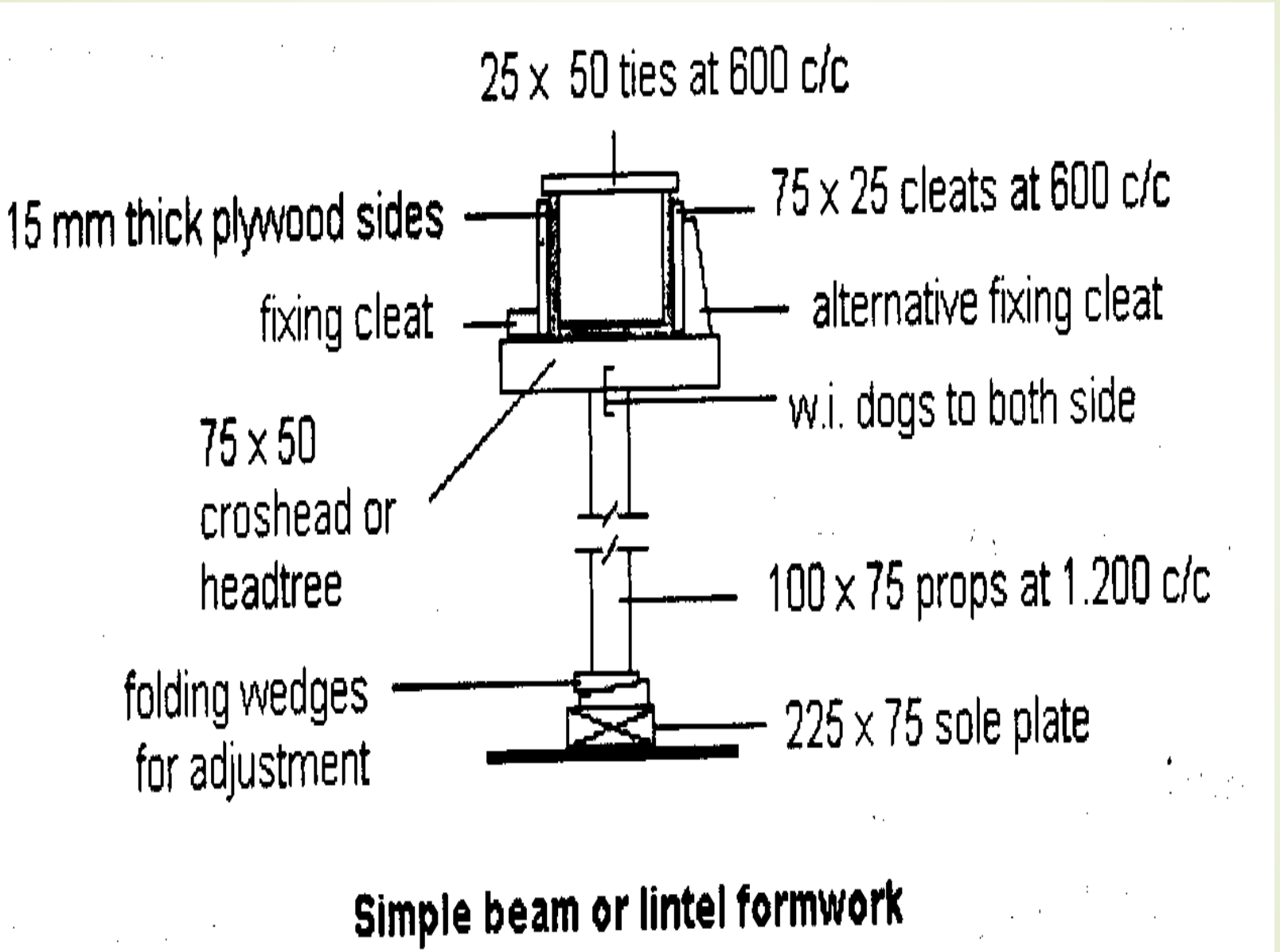


Figure 2.2 **Shaped column forms**



Simple beam or lintel formwork

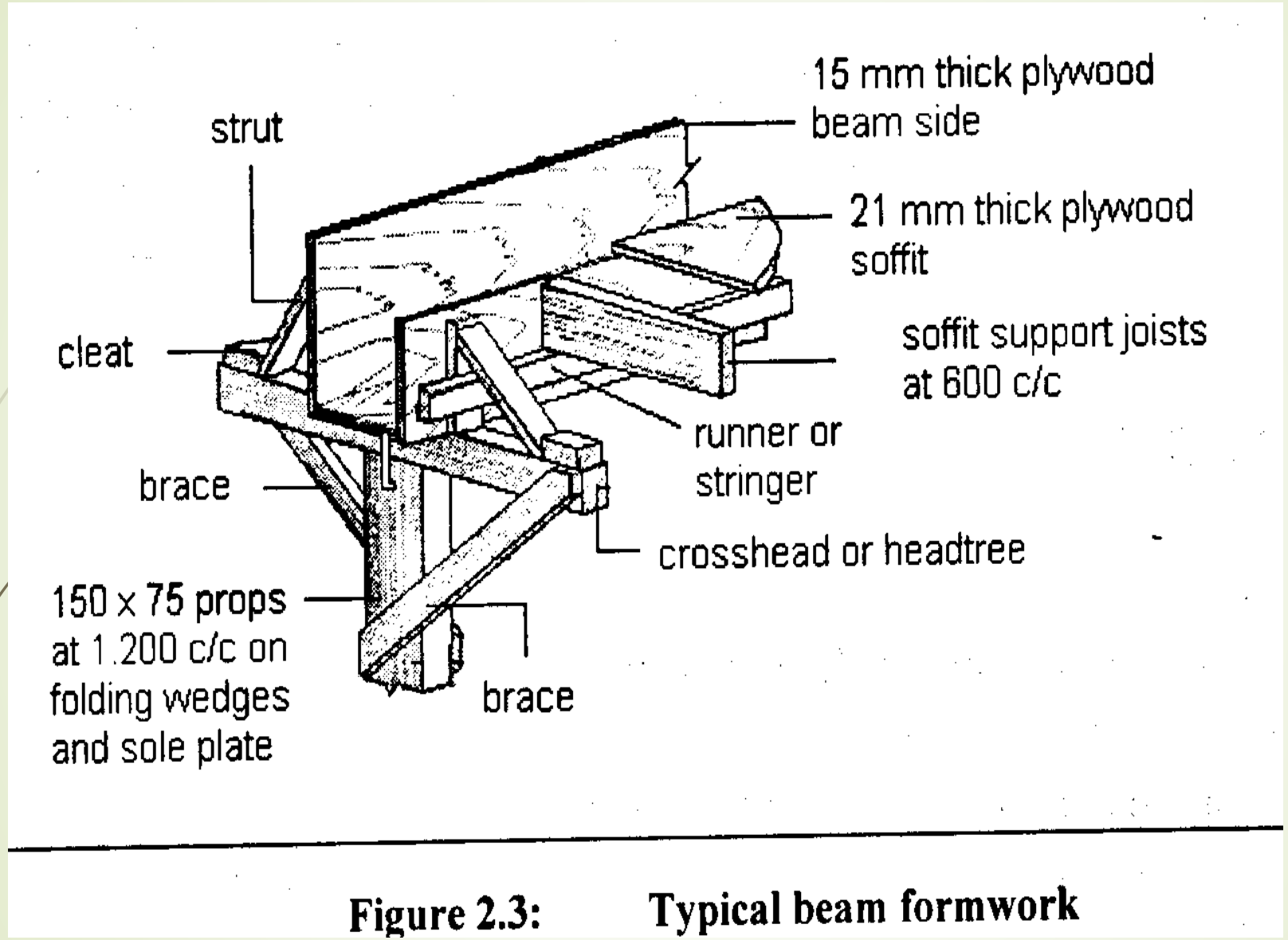


Figure 2.3: Typical beam formwork

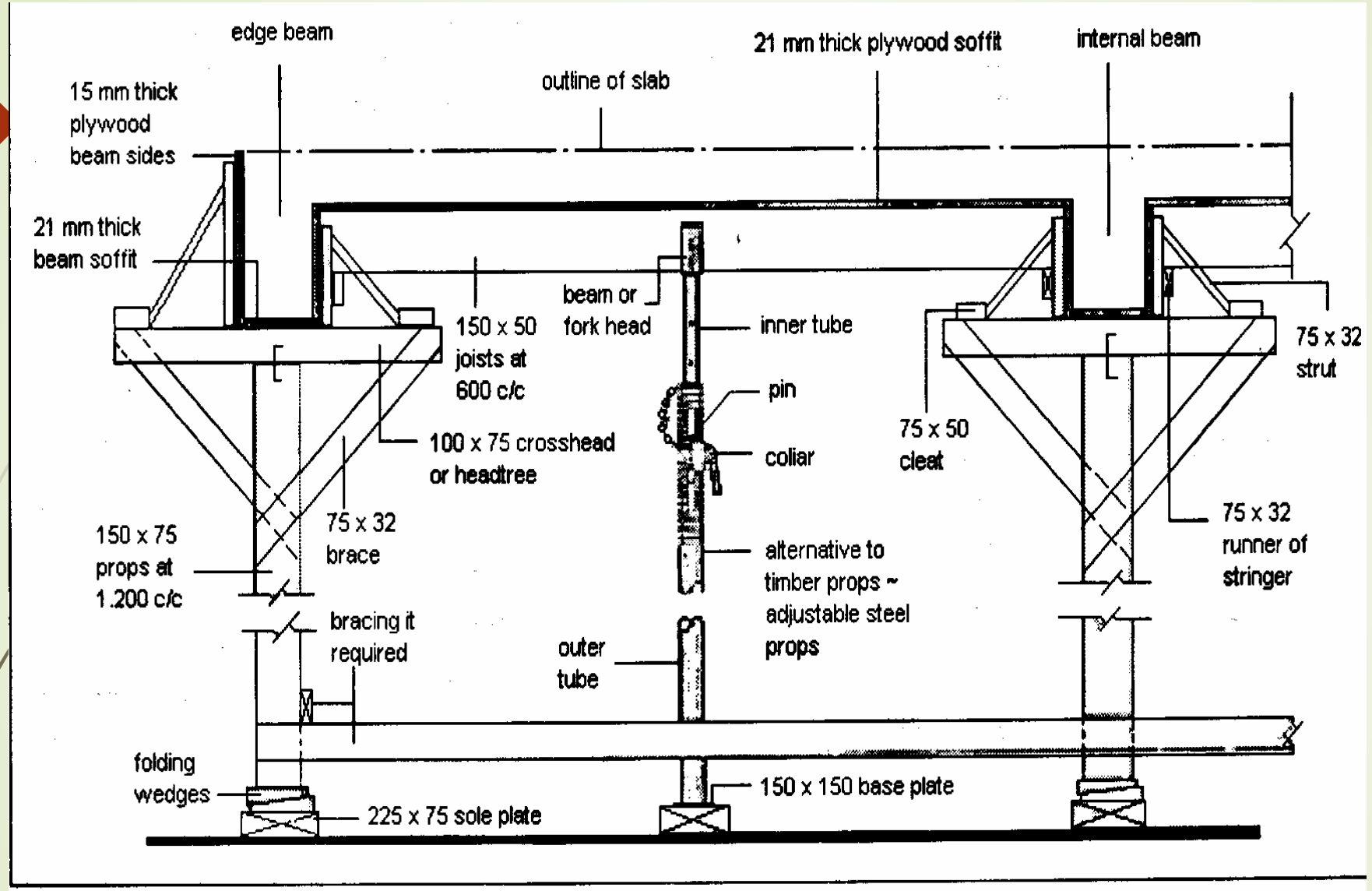


Figure 2.4: Typical beam and slab formwork

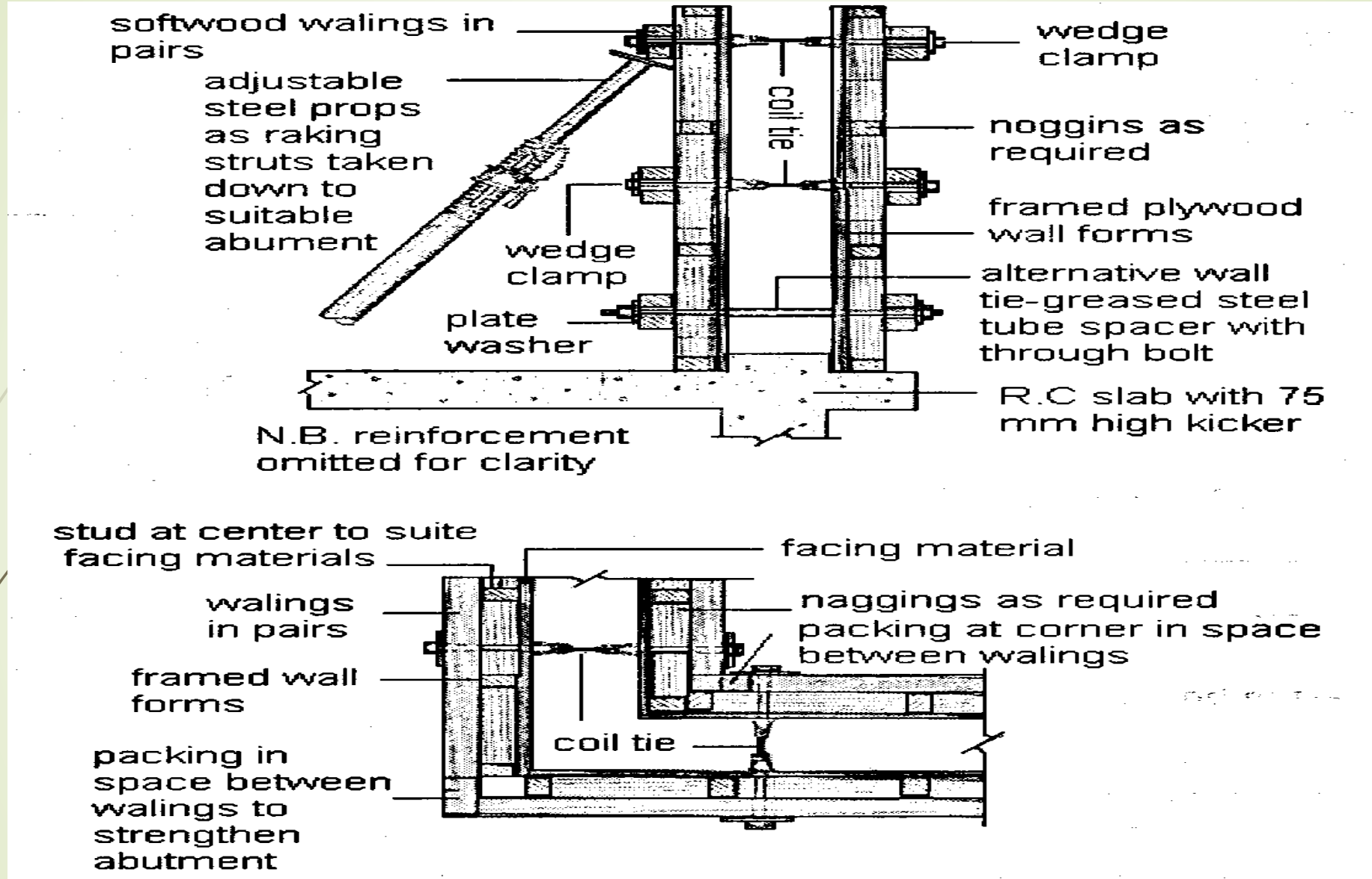


Figure 2.5: Traditional wall framework

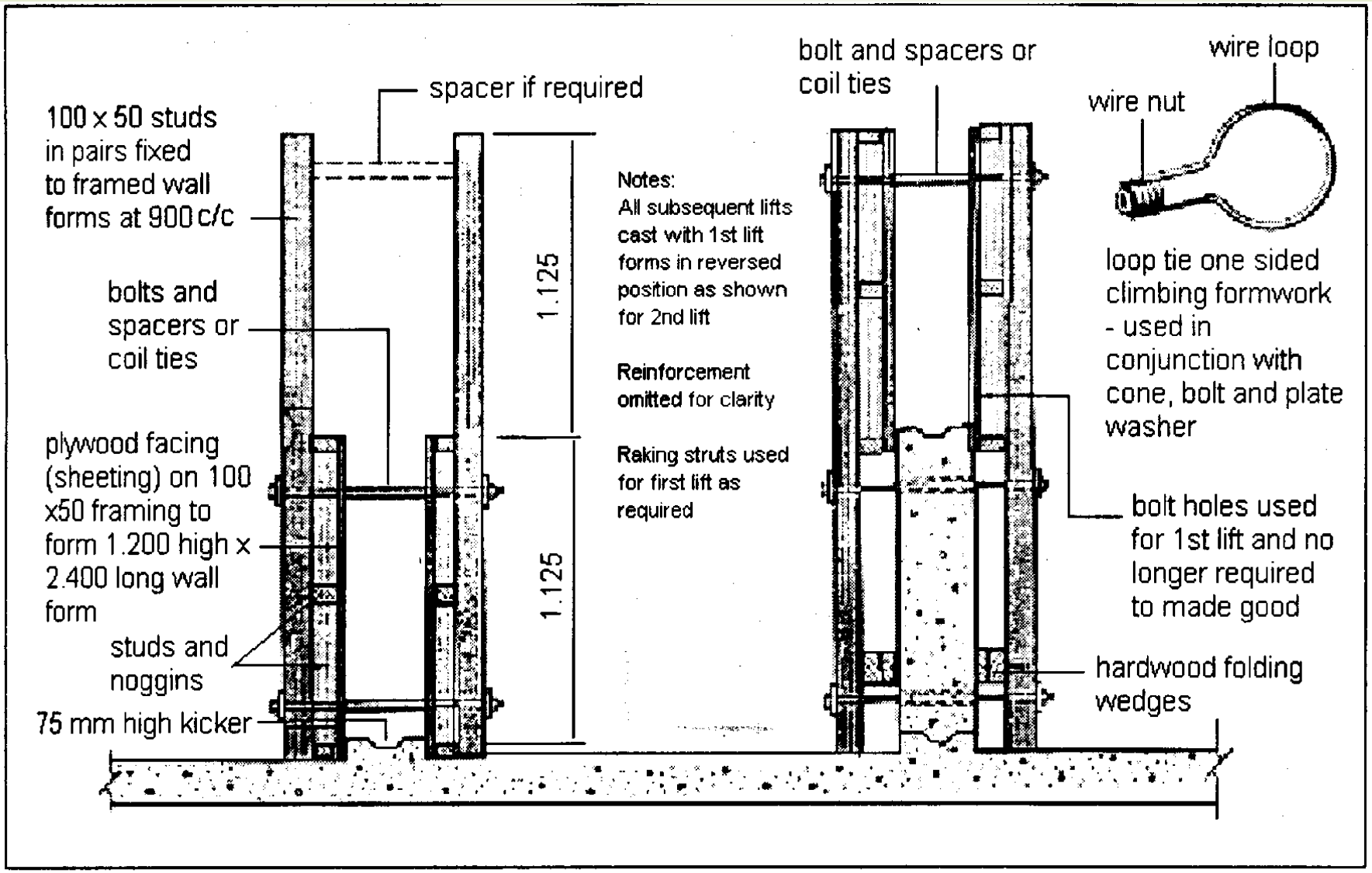


Figure 2.6: Typical climbing formwork arrangement

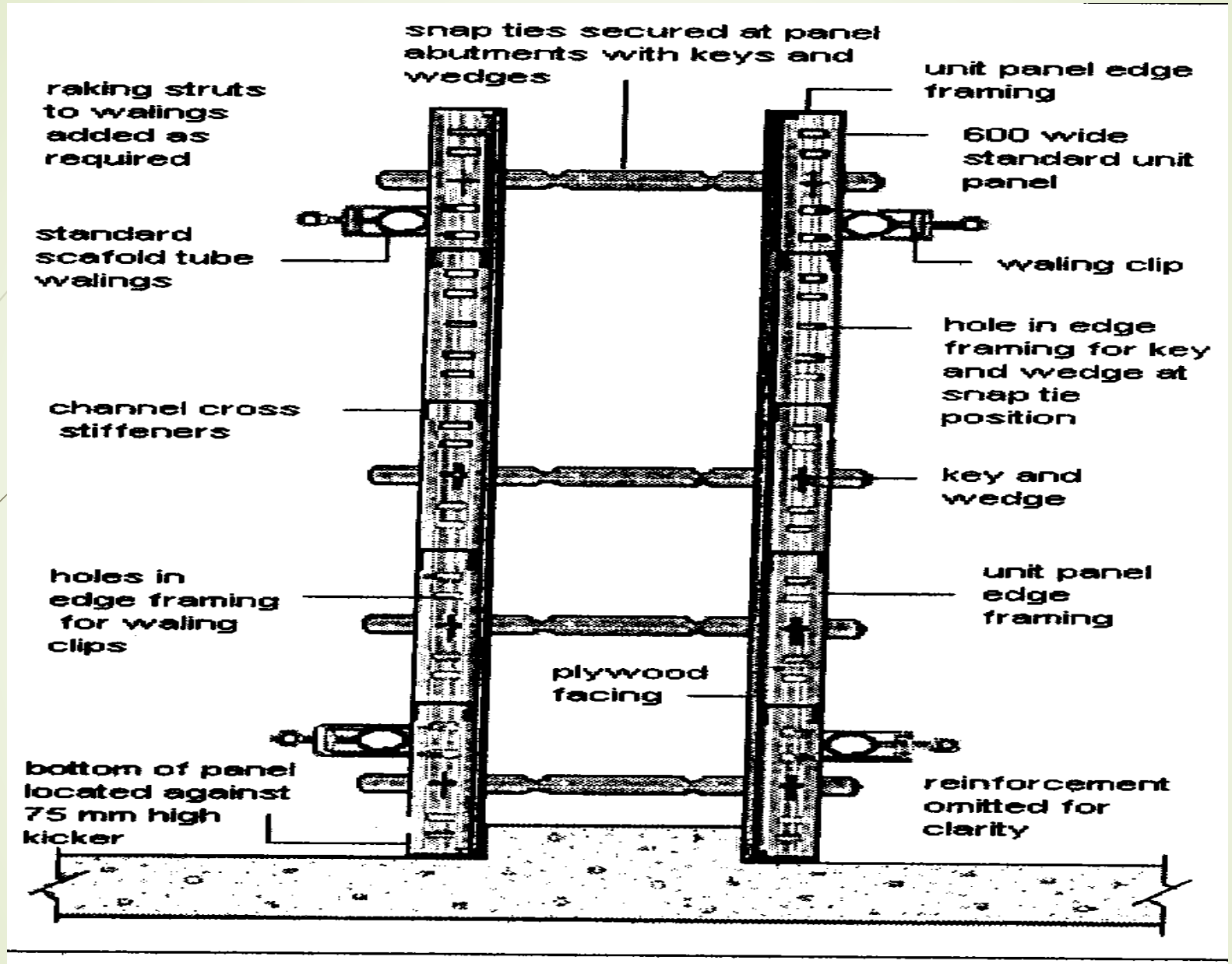


Figure 2.9 (iii): System formwork - walls

skydeck slab formwork

Duration for f/work removing

location	Surface or air temperature of concrete	
	16°C	17°C
Vertical f/work	12 hrs	18 hrs
Slab soffit (props left under)	4 days	6 days
Removal of props	10 days	15 days
Beam soffit (props left under)	10 days	15 days
Removal of props	14 days	21 days

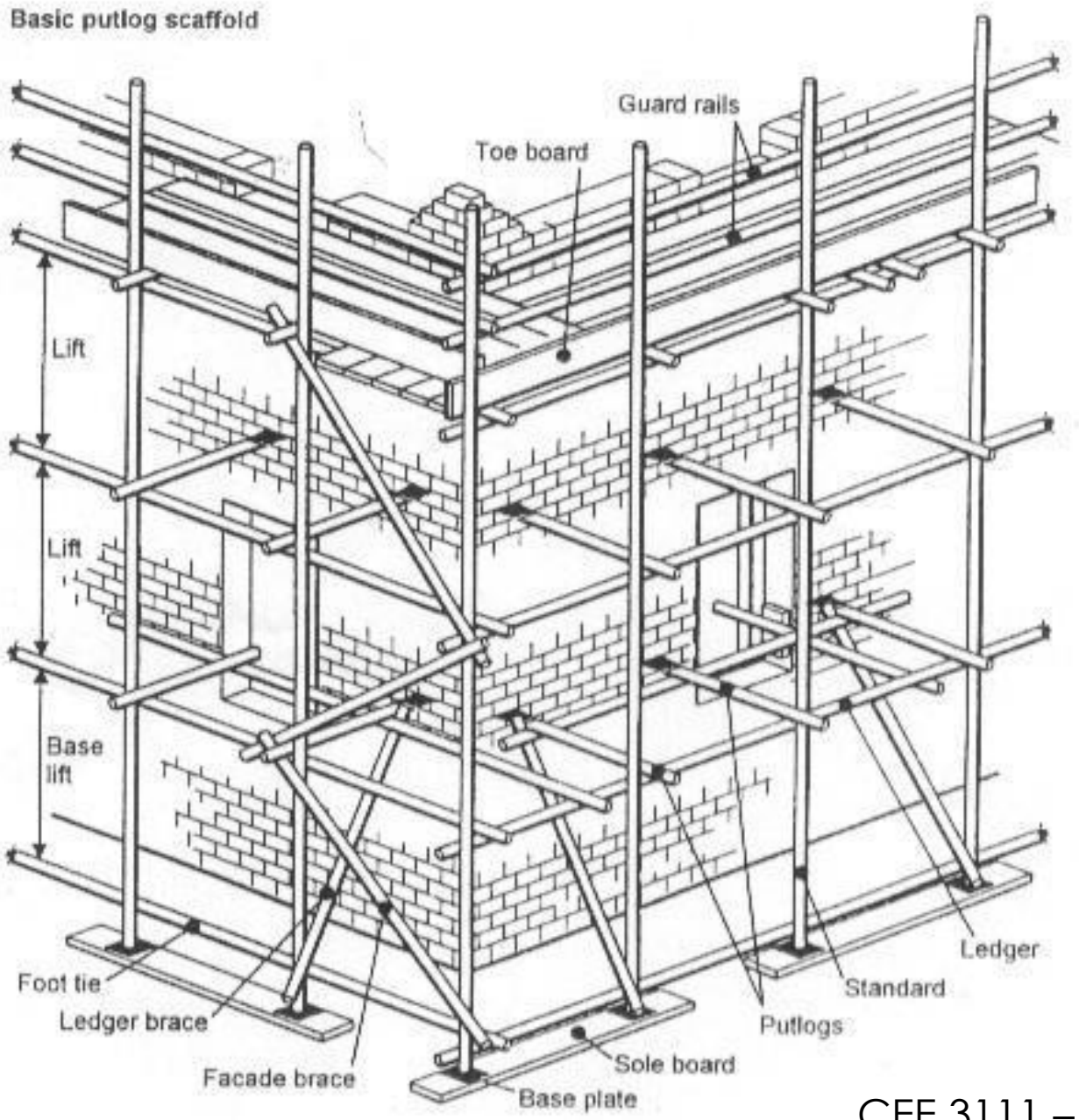
SCAFFOLDING

A temporary structure from which persons can gain access to a place of work in order to carry out building operations, its includes any working platforms, ladders and guardrails.

Four (4) forms of scaffolding:

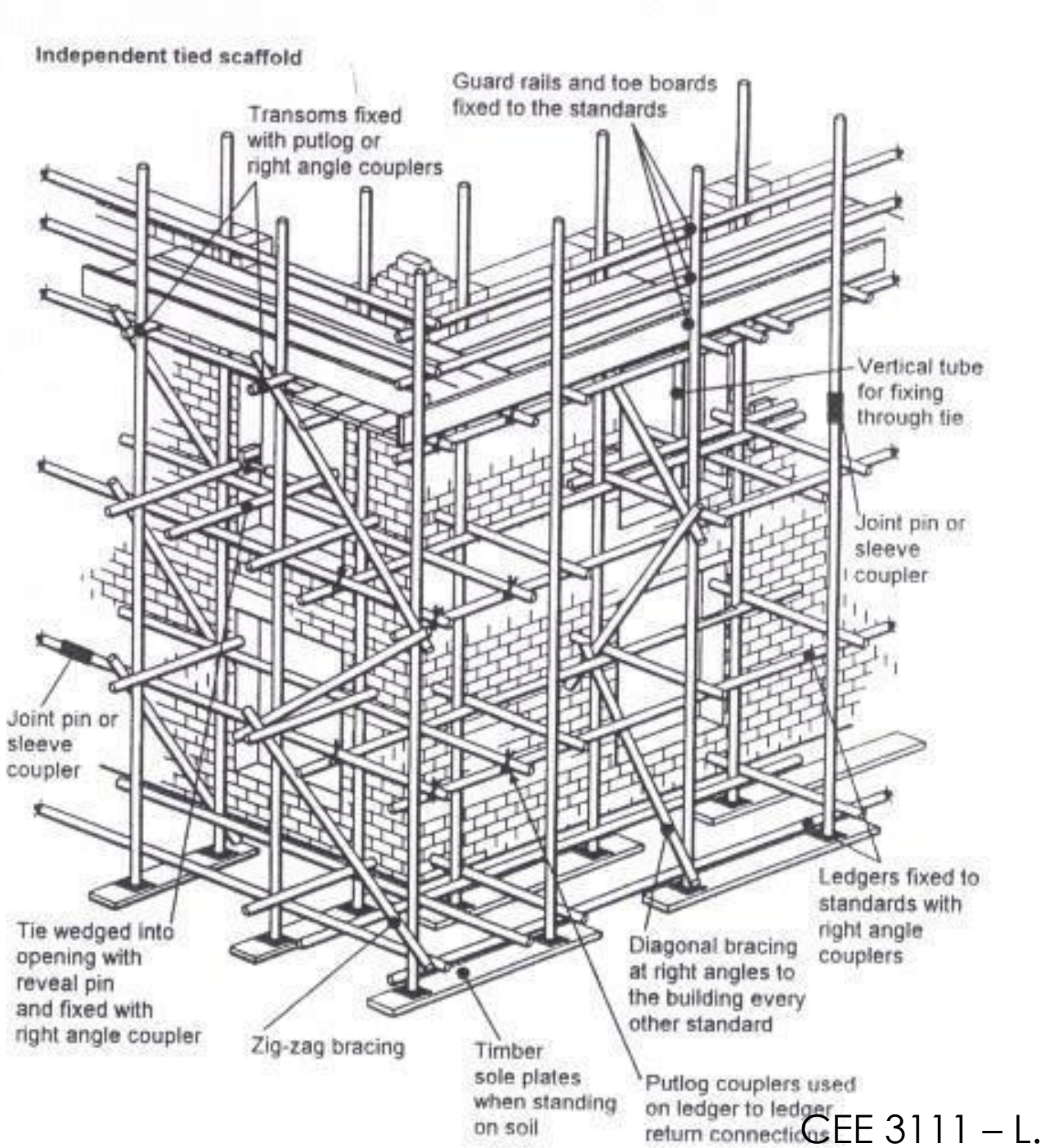
1. Putlog scaffolds
2. Independent scaffolds
3. Scaffold Towers & Birdcage Towers
4. Roof Saddle & Stack Scaffolds

Putlog Scaffolds



http://www.tubitt.com/

Independent Tied Scaffolds



http://www.tubitt.com/

MOBILE TOWER SCAFFOLDS

SUSPENDED SCAFFOLDS

MATERIALS FOR SCAFFOLDING

- Tubular steel
- Tubular aliminium alloy
- Timber

SCAFFOLDING FITTINGS

1. Double coupler
2. Swivel coupler
3. Putlog coupler
4. Base plate
5. Split joint pin
6. Reveal pin
7. Putlog end

http://www.scaffoldingmaterial.com/

SCAFFOLDING FITTINGS

1. Double Coupler
   - the only real loadbearing fitting used in scaffolding
   - used to join ledgers to standards
2. Swivel Coupler
   - Composed of two single coupler riveted together so that it is possible to rotate them & use them for connecting two scaffold tubes at any angle.
3. Putlog Coupler
   - use solely for fixing putlogs/transoms to the horizontal ledgers.
4. Base Plate
   - It is used to distribute the load from the foot of a standard on to a sole plate or firm ground.
5. Split Joint Pin
   - A connection fitting used to joint scaffold tubes end to end.
   - A centre bolt expands the 2 segments that grip on the bore of the tubes

SCAFFOLDING FITTINGS

6. Reveal Pin

   - Fits into the end of a tube to form an adjustable strut

7. Putlog End

   - A flat plate that fits on the end of a scaffold tube to convert it into a putlog

Thank You!!!