

Innovative Construction Technology



Learning Objectives

- Be able to explain the innovativeness of the following construction technology / method
 - Top Down Construction
 - Pre-stressed concrete
 - System Formwork

Top Down Construction

- In this method, basement concrete slabs act as lateral bracing for the perimeter wall system.
- Ground level and first basement slabs are poured, with access holes left to allow excavation beneath.
- As each subsequent subgrade level is completed, the floors act as lateral bracing for the perimeter wall system.

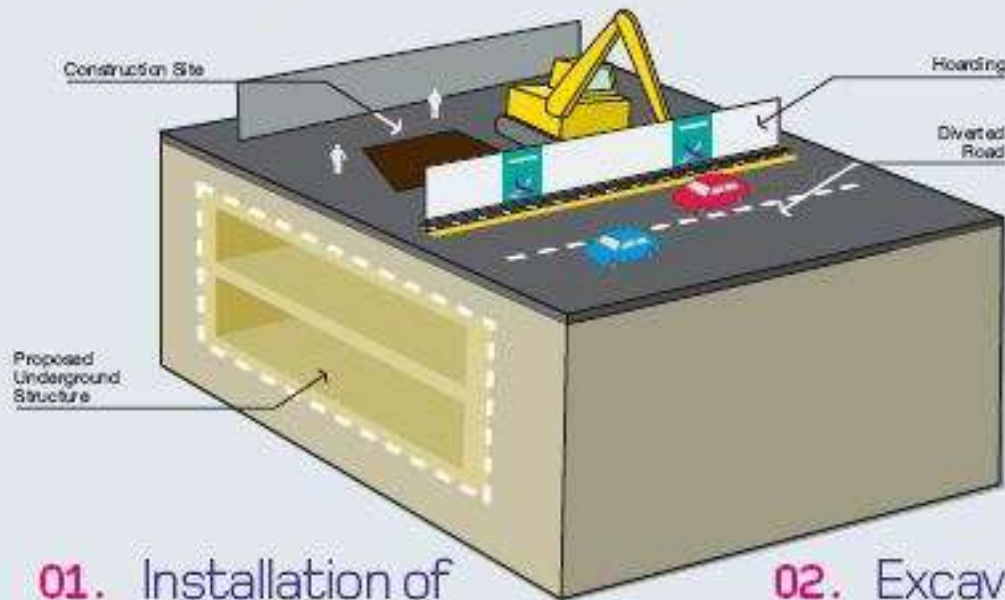
Top Down Construction

- Use of diaphragm wall as the side support for the earth
- Construction progress upwards and downwards at the same time
- Savings in construction time

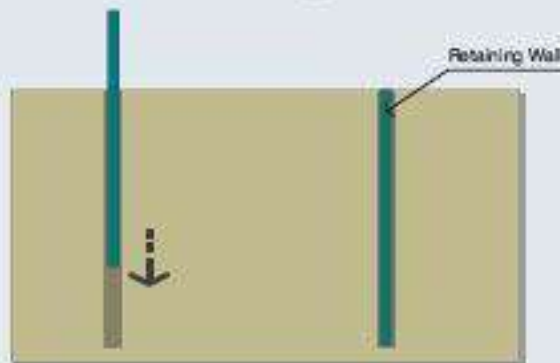




TOP-DOWN CONSTRUCTION METHOD

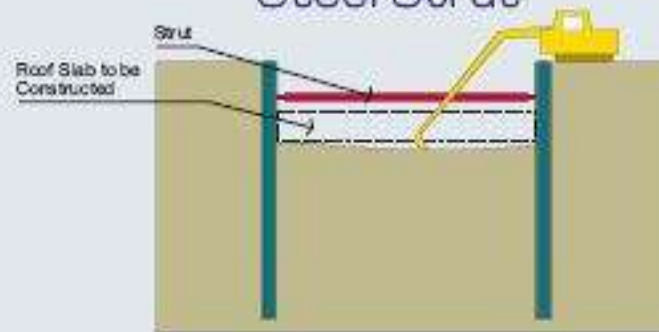


01. Installation of Retaining Wall



The underground retaining wall, which is usually a concrete diaphragm wall, is installed before excavation commences.

02. Excavation & Installation of Steel Strut

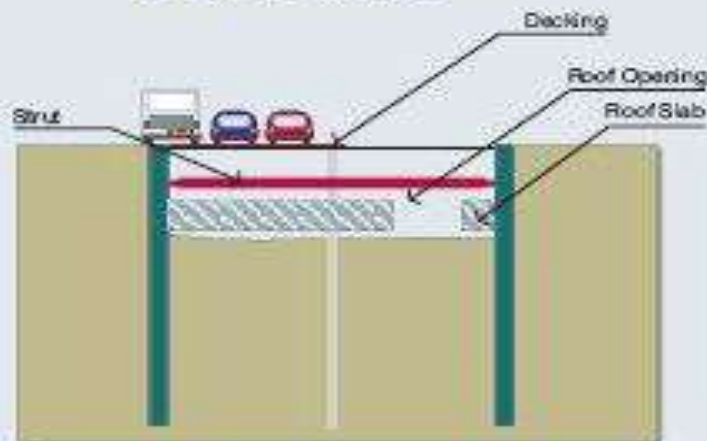


The soil is excavated to just below the roof slab level of the underground structure. Struts are installed to support the retaining walls, which in turn support the soil at the sides.

Top Down Construction

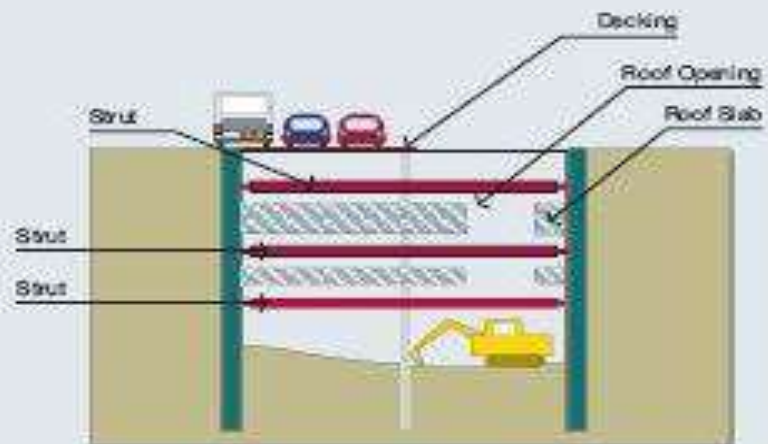


03. Construction of Underground Structure



The roof slab is constructed, with access openings provided on the slab for works to proceed downwards. The roof slab not only provides a massive support across the excavation, it also acts as a noise barrier.

04. Construction of Underground Structure



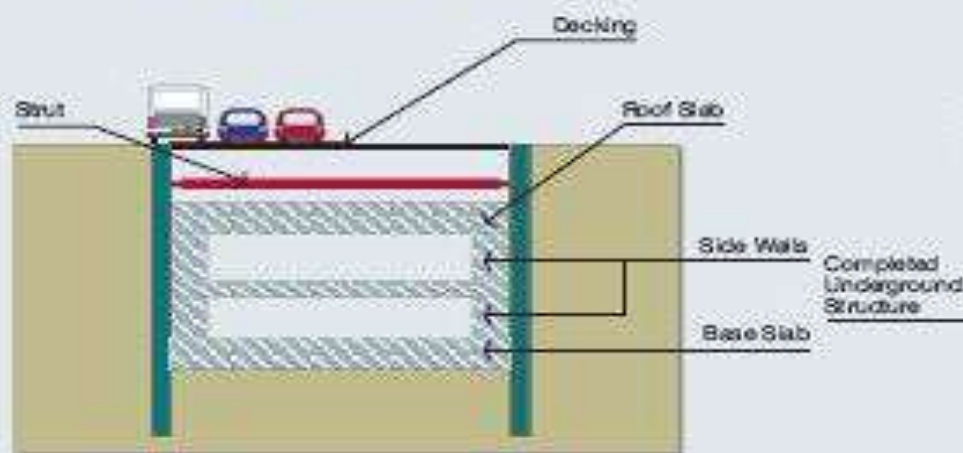
The next level of slab is constructed, and this process progresses downwards till the base slab is completed.

05. Construction

06. Backfilling &

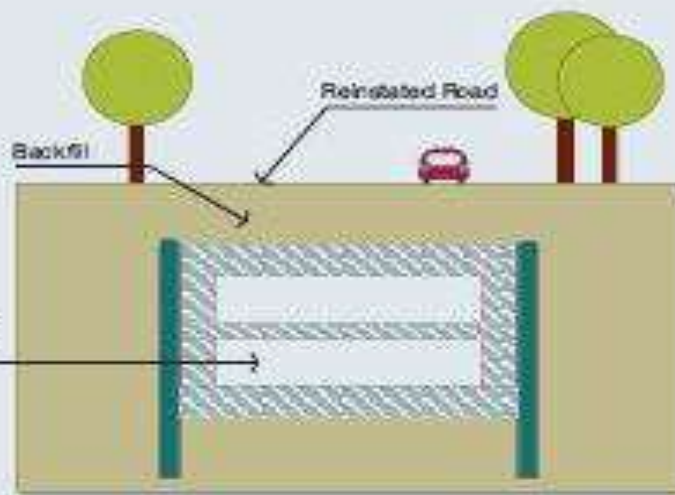
across the excavation, it also acts as a noise barrier.

05. Construction of Underground Structure



The side walls are constructed upwards, followed by removal of the intermediate struts. The access openings on the roof slab are then sealed.

06. Backfilling & Reinstatement

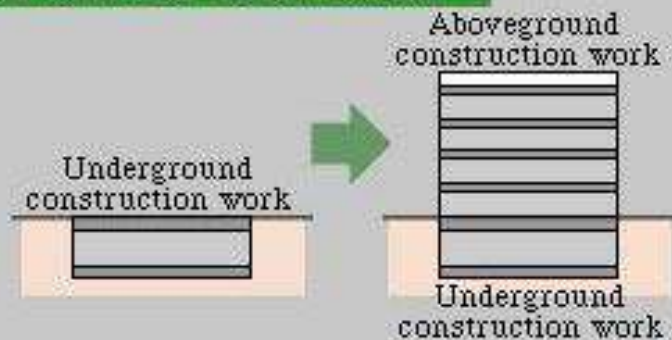


After the underground structure is completed, the soil is backfilled to the top strut level before the strut is removed. This is followed by completely backfilling the top of the underground structure and finally reinstating the surface areas.

• Top-Down Construction Method

Instead of the order in conventional construction plans in which work on floors above ground starts after underground work has been completed, the top-down construction method enables work to be undertaken above ground while digging underground, which makes it possible to shorten construction schedules.

Conventional construction

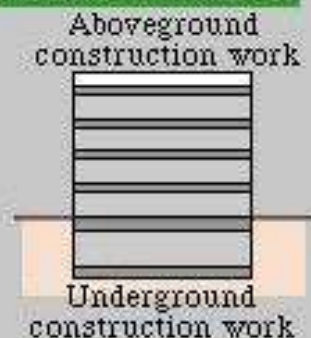


Construction schedule

Underground construction work Aboveground construction work



Top-down construction method



Aboveground construction work

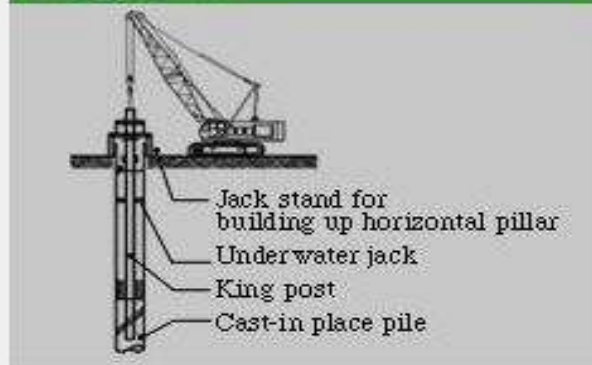
Underground construction work

Shortening of construction schedule

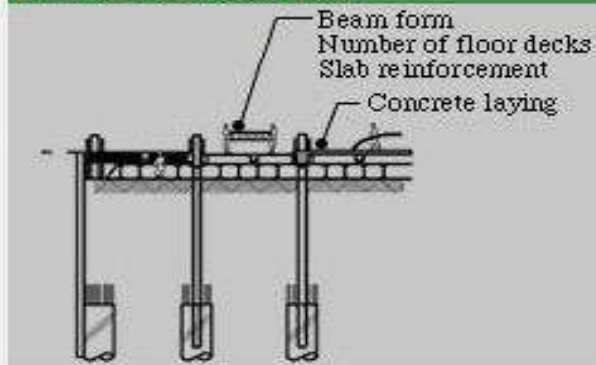
● Details of Top-Down Construction Method

Firstly piles are driven, which is followed by building the 1st floor of the building. Then, while using the 1st floor as a work floor, underground construction work is carried out, while at the same time erecting the columns connected to the piles in underground floors, before undertaking work on the upper floors.

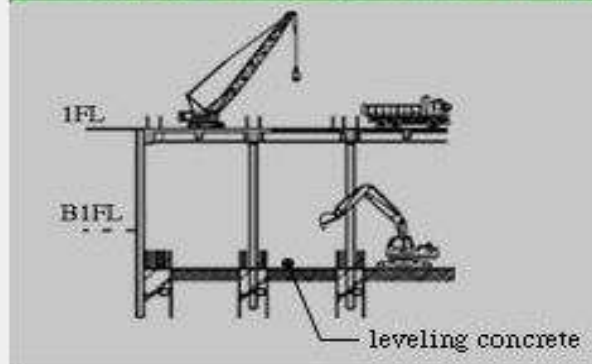
STEP1
King post work



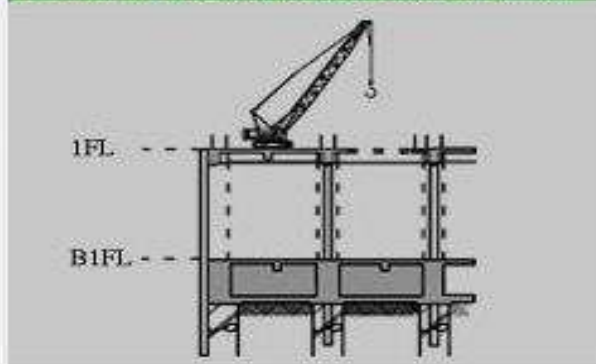
STEP2
1st floor reinforcement, form and concrete work



STEP3
Mounting of secondary excavation floor



STEP4
Pressure-resistant base, foundation beams, floor of 1st basement, 1st floor columns





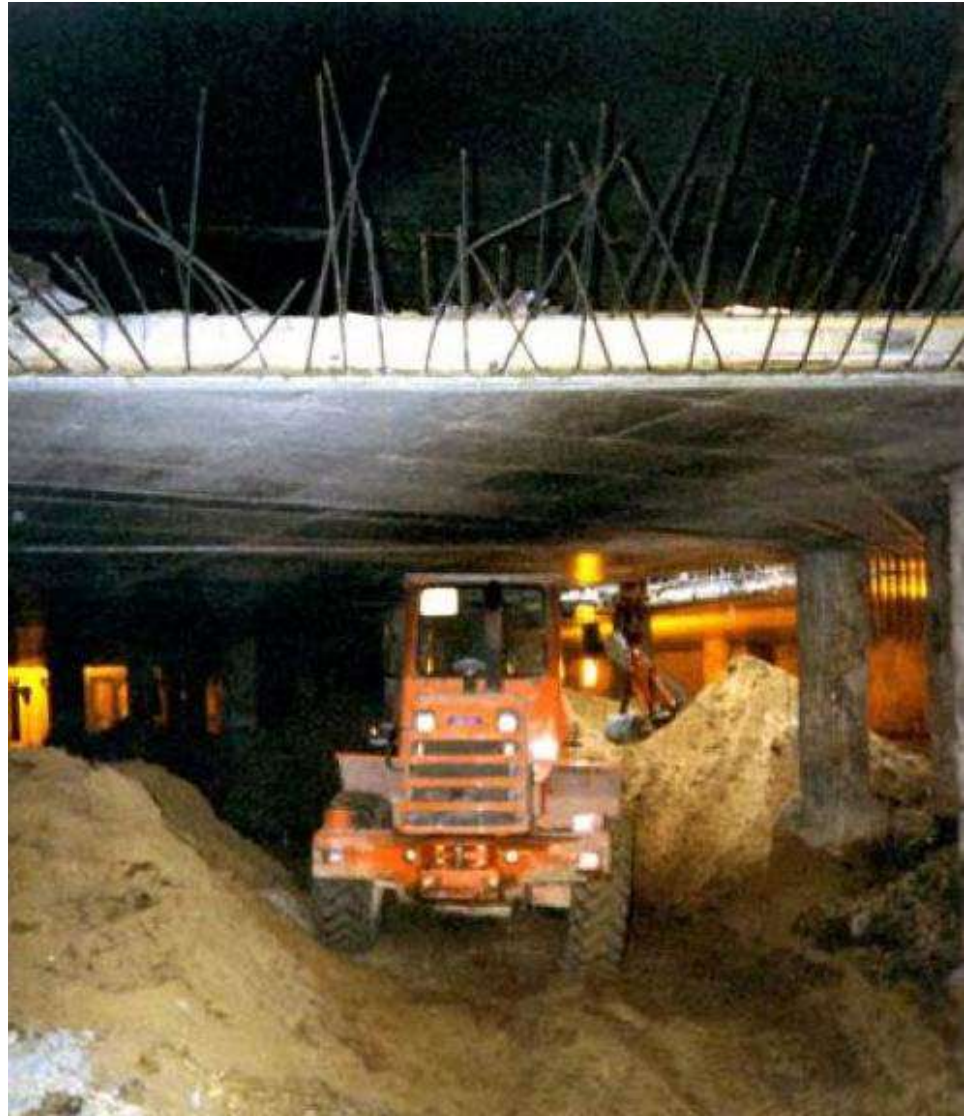
Top Down Construction

- Compaction and levelling of basement slab for reinforcement and concrete works



Top Down Construction

- More excavation work in progress



Top Down Construction

CONCLUSION

- Need careful consideration use- risk and safety
- Ideal for 5 basements or more
- May need some soil improvement techniques and good dewatering system
- Equipment for these works may not be readily available – need long arm excavator
- Handling of excavated soil material require planning, keeping in mind marine clay at upper level and silty sand at lower level

Pre-stressed Concrete

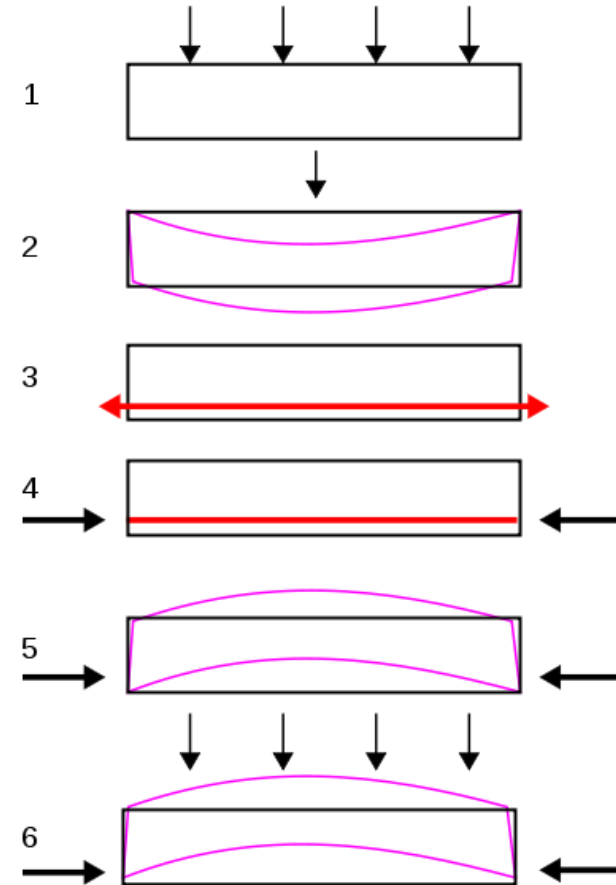
CONCRETE

- Concrete is strong in compression weak in tension.
- Steel is strong in tension
- Reinforced concrete uses concrete to resist compression and to hold bars in position and uses steel to resist tension.
- Tensile strength of concrete is neglected (i.e. zero)
- R.C beams allows crack under service load.

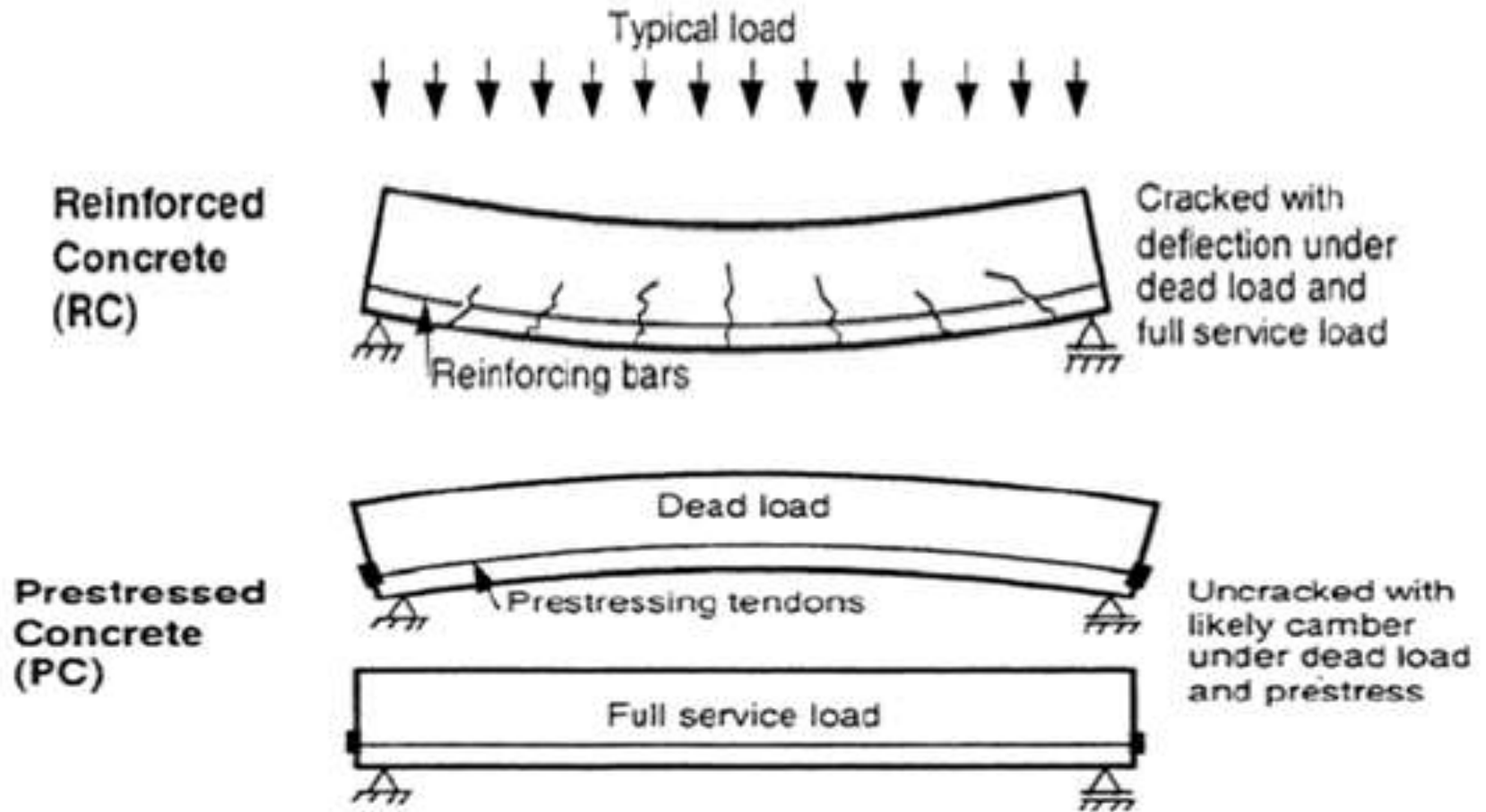
Pre-stressed Concrete

What is Pre-stressed Concrete?:

- Internal stresses are induced to counteract external stresses.
- In 1904, Freyssinet attempted to introduce permanent acting forces in concrete to resist elastic forces under loads and was named “Pre stressing”.



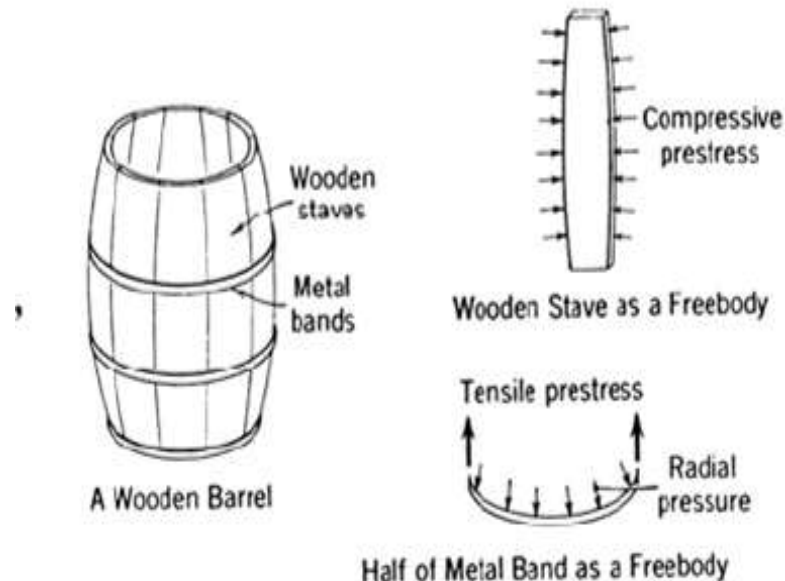
Pre-stressed Concrete



Pre-stressed Concrete

CONCEPT OF PRE-STRESSED CONCRETE

- The concept of pre stressing was invented years ago when metal bands were wound around wooden pieces to form barrels.
- The metal bands were tighten under tensile stress which creates compression between the staves allowing them to resist internal liquid pressure.



Pre-stressed Concrete

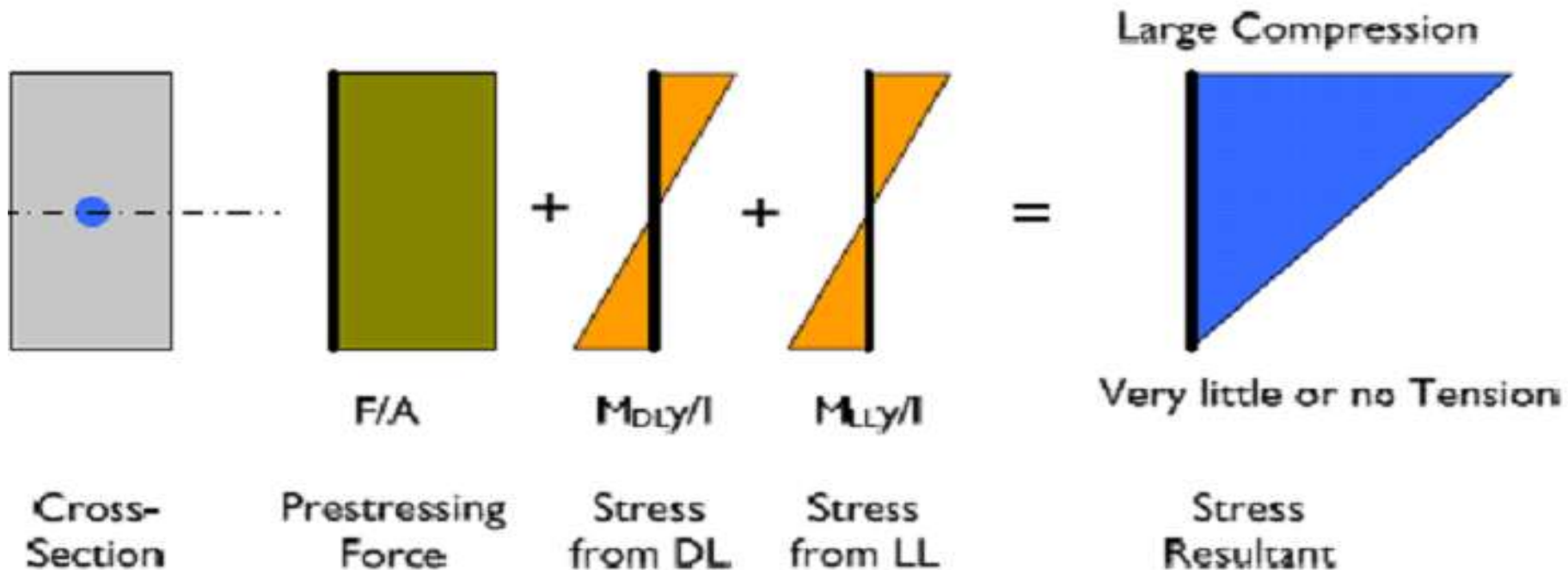
PRINCIPLE OF PRE-STRESSING

- Pre-stressing is a method in which compression force is applied to the reinforced concrete section.
- The effect of pre stressing is to reduce the tensile stress in the section to the point till the tensile stress is below the cracking stress. Thus the concrete does not crack.
- It is then possible to treat concrete as a elastic material.
- The concrete can be visualized to have two compressive force
 - Internal pre-stressing force.
 - External forces
- These two forces must counteract each other.

Pre-stressed Concrete

PRINCIPLE OF PRE-STRESSING

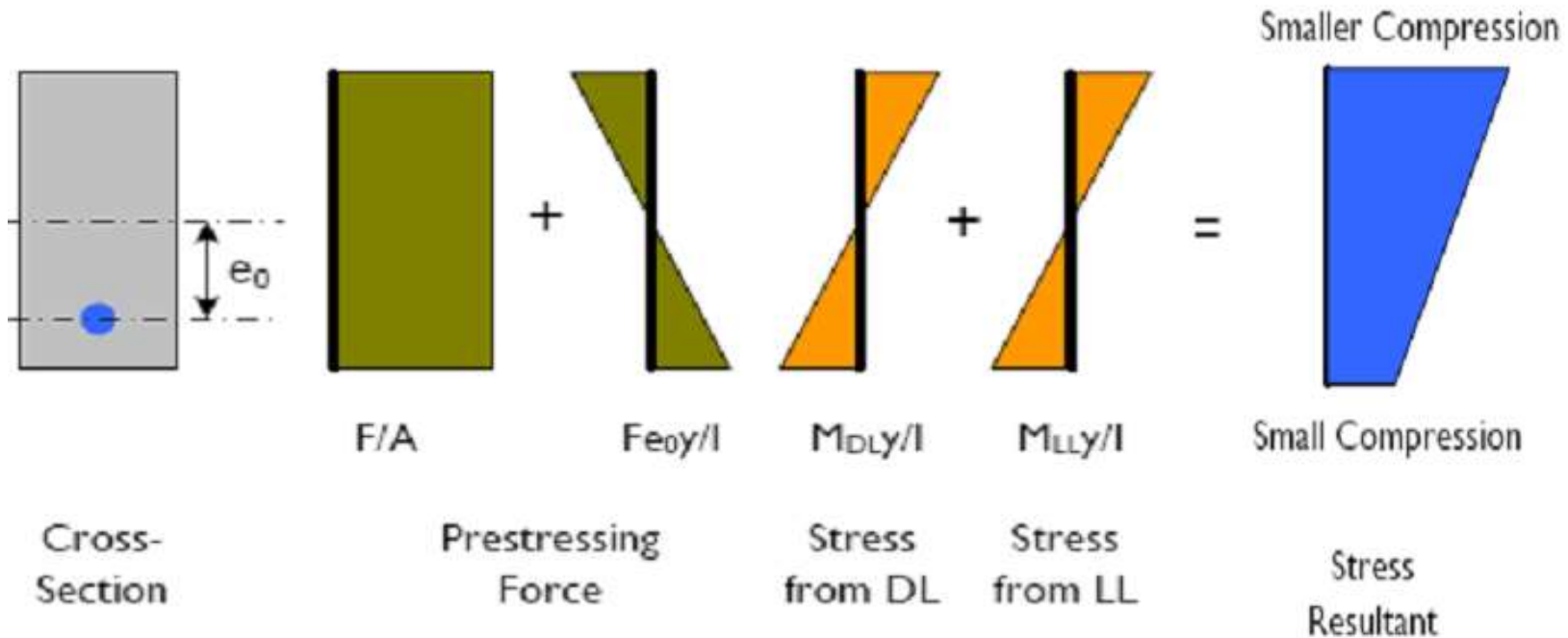
- Stress in concrete when pre stressing is applied at the c.g of the section



Pre-stressed Concrete

PRINCIPLE OF PRE-STRESSING

- Stress in concrete when pre stressing is applied eccentrically with respect to the c.g of the section .



Pre-stressed Concrete

PRE-STRESSED CONCRETE METHOD

There are two basic methods of applying pre-stress to a concrete member

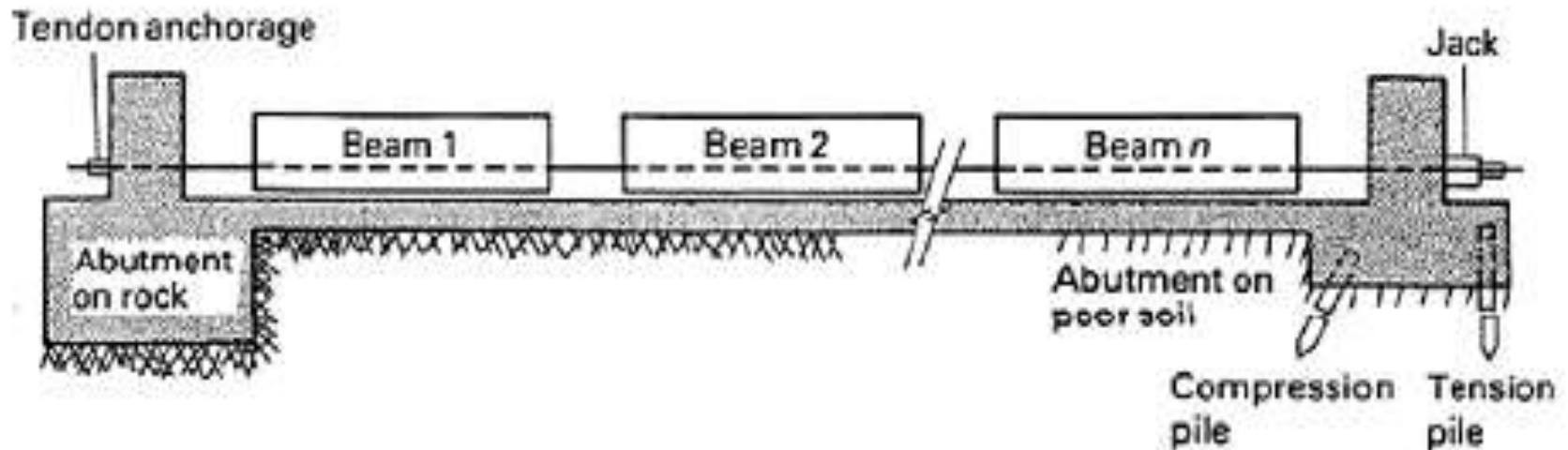
- Pre-tensioning – most often used in factory situations
- Post-tensioning – site use

Pre-stressed Concrete

TYPES OF PRE-STRESSING

Pre-tensioning

- In Pre-tension, the tendons are tensioned against some abutments before the concrete is placed. After the concrete has hardened, the tension force is released. The tendon tries to shrink back to the initial length but the concrete resists it through the bond between them, thus, compression force is induced in concrete. Pretension is usually done



Pre-stressed Concrete



Pretensioned Prestressed Concrete
Casting Factory

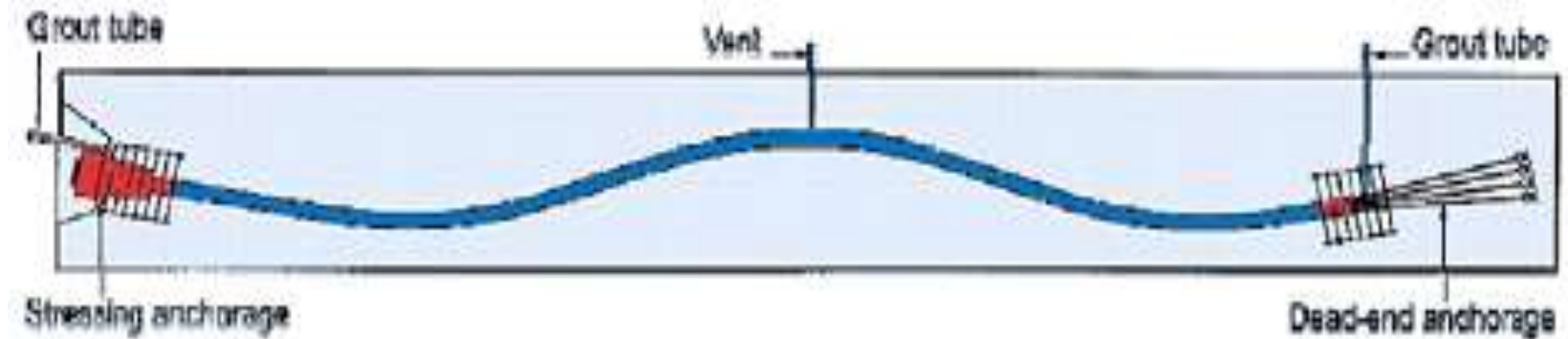
Concrete
Mixer



Pre-stressed Concrete

POST TENSIONING

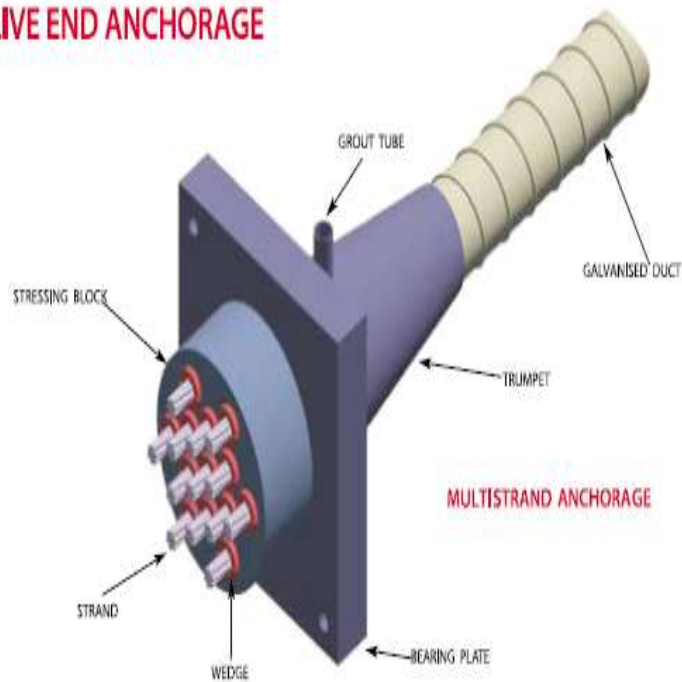
- In Post tension, the tendons are tensioned after the concrete has hardened.
- Commonly, metal or plastic ducts are placed inside the concrete before casting.
- After the concrete hardened and had enough strength the tendon was placed inside the duct, stressed, and anchored against concrete.
- Grout may be injected into the duct later
- This can be done either as precast or cast-in-place.



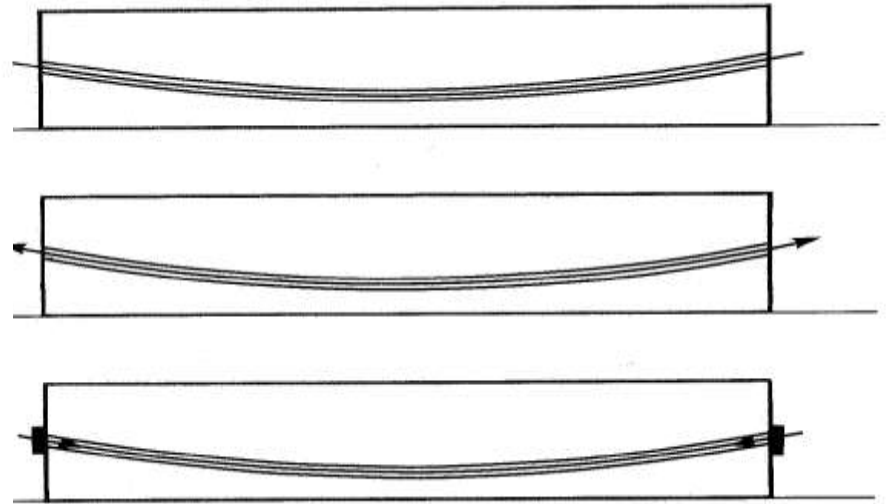
Pre-stressed Concrete

- Post tensioning

LIVE END ANCHORAGE



Stage 1



Pre-stressed Concrete



Precast Segmental
Girder to be
Posttensioned In
Place

Pre-stressed Concrete

ADVANTAGES

- Take full advantages of high strength concrete and high strength steel
- Need less materials
- Smaller and lighter structure
- No cracks
- Use the entire section to resist the load
- Better corrosion resistance
- Good for water tanks and nuclear plant
- Very effective for deflection control
- Better shear resistance

Pre-stressed Concrete

DISADVANTAGES (compared with in-situ concrete)

- Need higher quality materials
- More complex technically
- More expensive
- Harder to re-cycle

Pre-stressed Concrete

APPLICATIONS

- Bridges
- Slabs in buildings
- Water Tank
- Concrete Pile
- Thin Shell Structures
- Offshore Platform
- Nuclear Power Plant
- Repair and Rehabilitations



System Formwork

- System formwork has the standard prefabricated modular components with large casting panel.
- Consists of modular components through different combination with the aid of CAD design
- Subsequently assembly on site, the system formwork can suit the required shape of concrete structures.
- Minor conventional formwork to complement the deficiency of the system formwork is still required on site.

System Formwork

- System formwork has good casting quality, speedier erection and more recycle times compared to the conventional formwork.
- However, the initial investment of system formwork is higher than the conventional one.
- Therefore, the more cycle times the system formwork is to be used, the more economical it will be. A good example is the repeated typical floors of a highrise building.

System Formwork

- System formwork is a specialised kind of job.
- It supports the in-situ RC contractors by providing services of design, delivery, site support and buy-back after job completion.
- The main components of the system formwork include plywood, beam, waler, falsework, joint parts, bracing and operation platform.

System Formwork

- Jumpform or climbform is one type of the system formwork for vertical structures which needs the crane to lift it up for each cycle.
- The slipform, on the other hand, is usually using its own hydraulic power to lift itself up against the previously completed structures and is suited for no-change section of the tall structure, for example, chimney and silo.

System Formwork

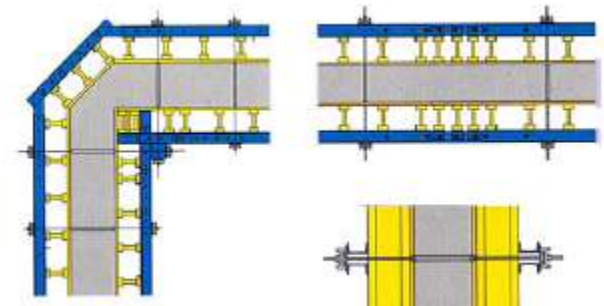
- In Singapore, the major players are Doka and Peri, among others. Both are German companies
- Peri has more proprietary factors in its components.

System

- Jump form



System Formwork



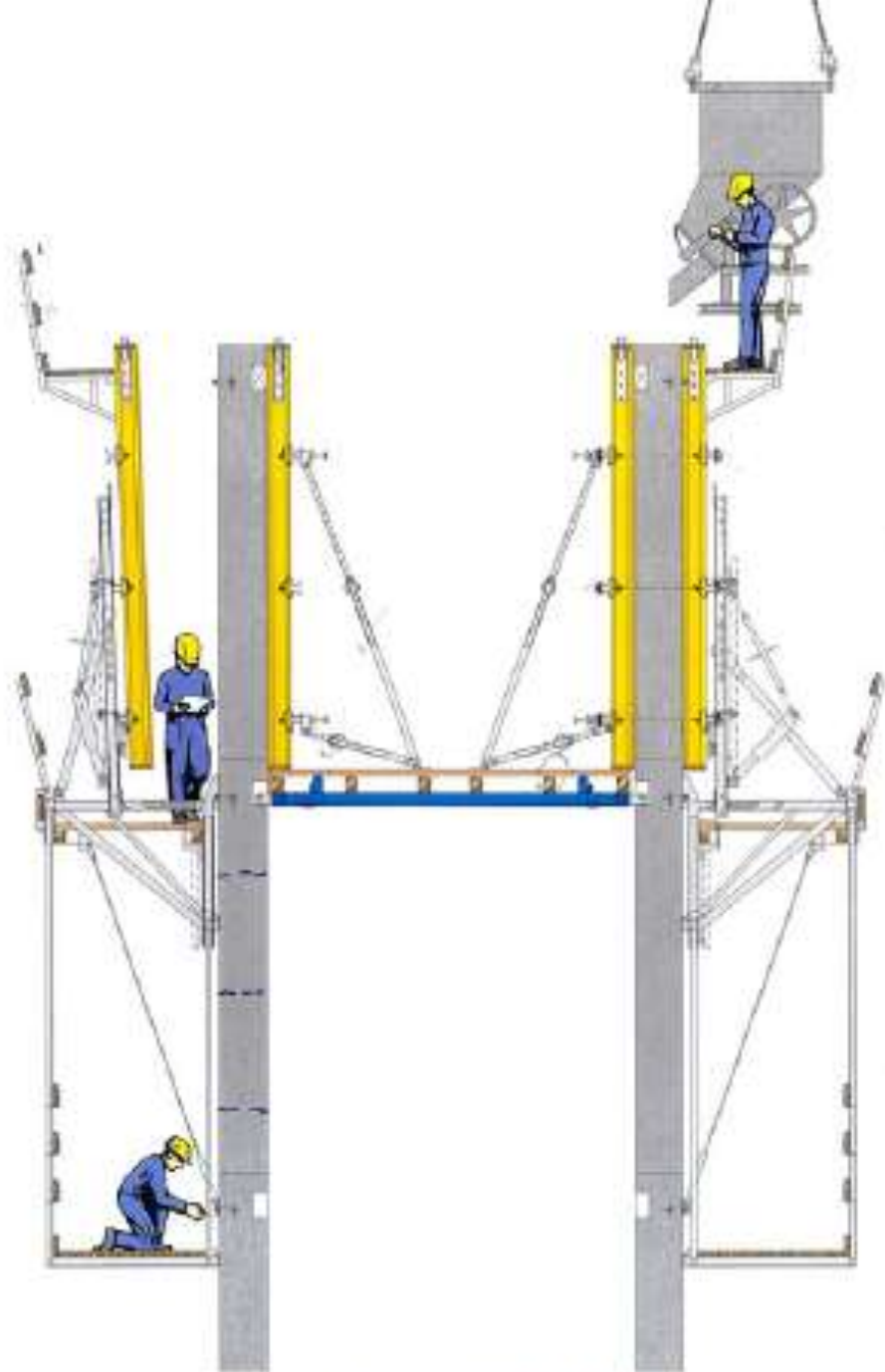
Wall Formwork Detail

System Formwork

- Lift core formwork

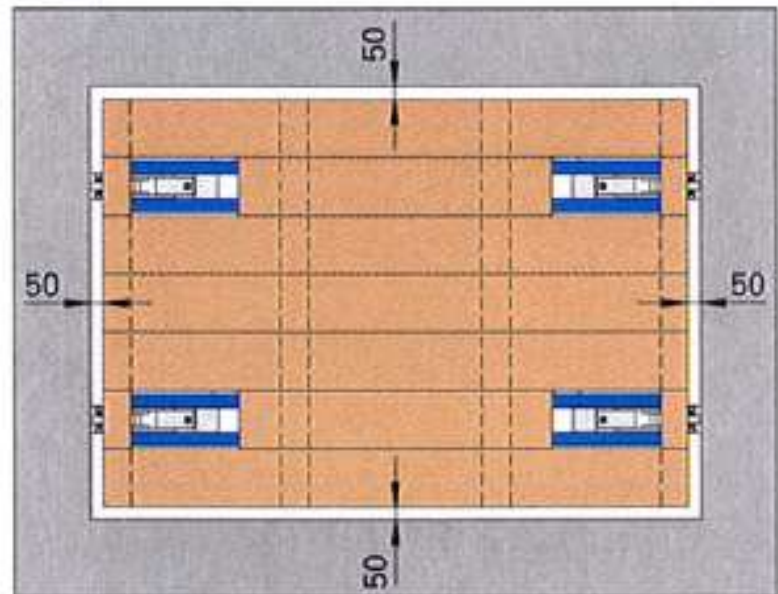
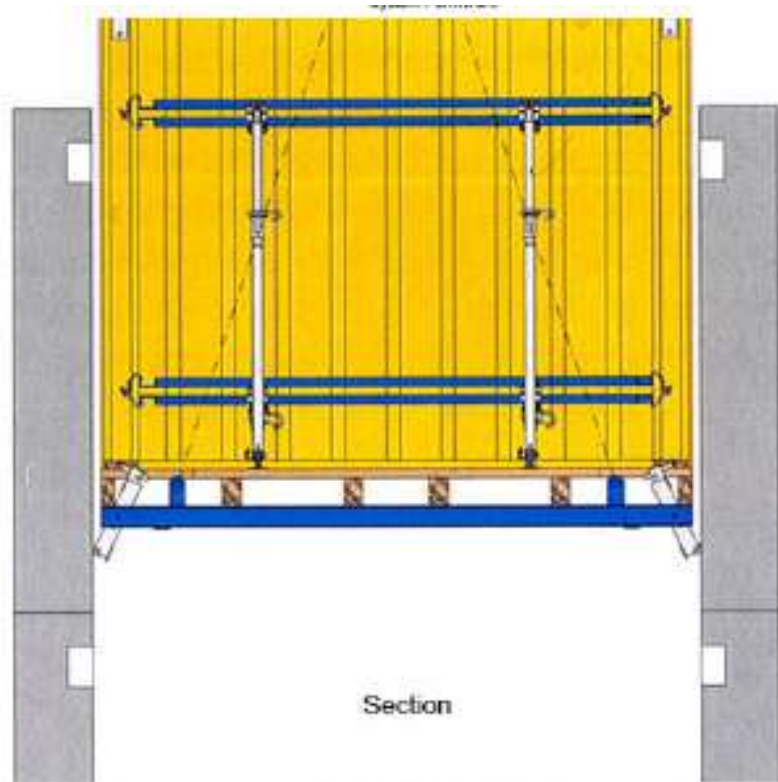


System Formwork

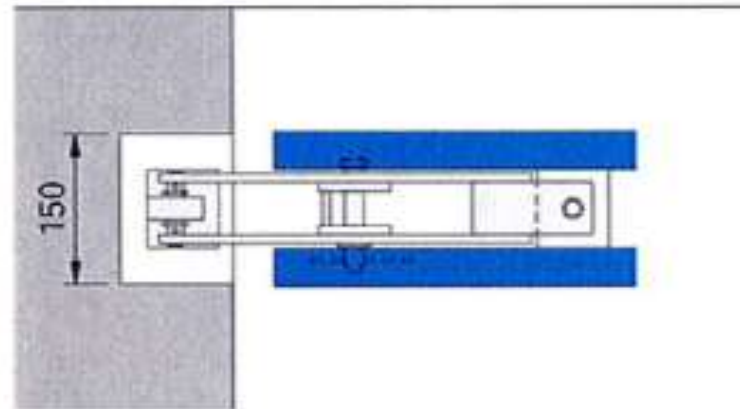
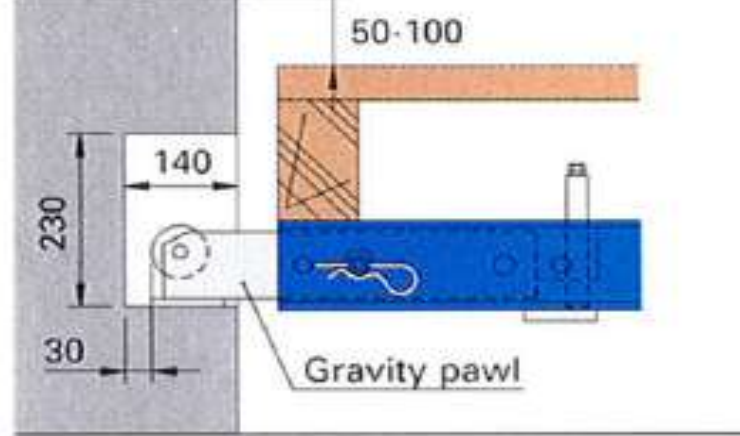


Lift core formwork working mechanism

System Formwork



System Formwork



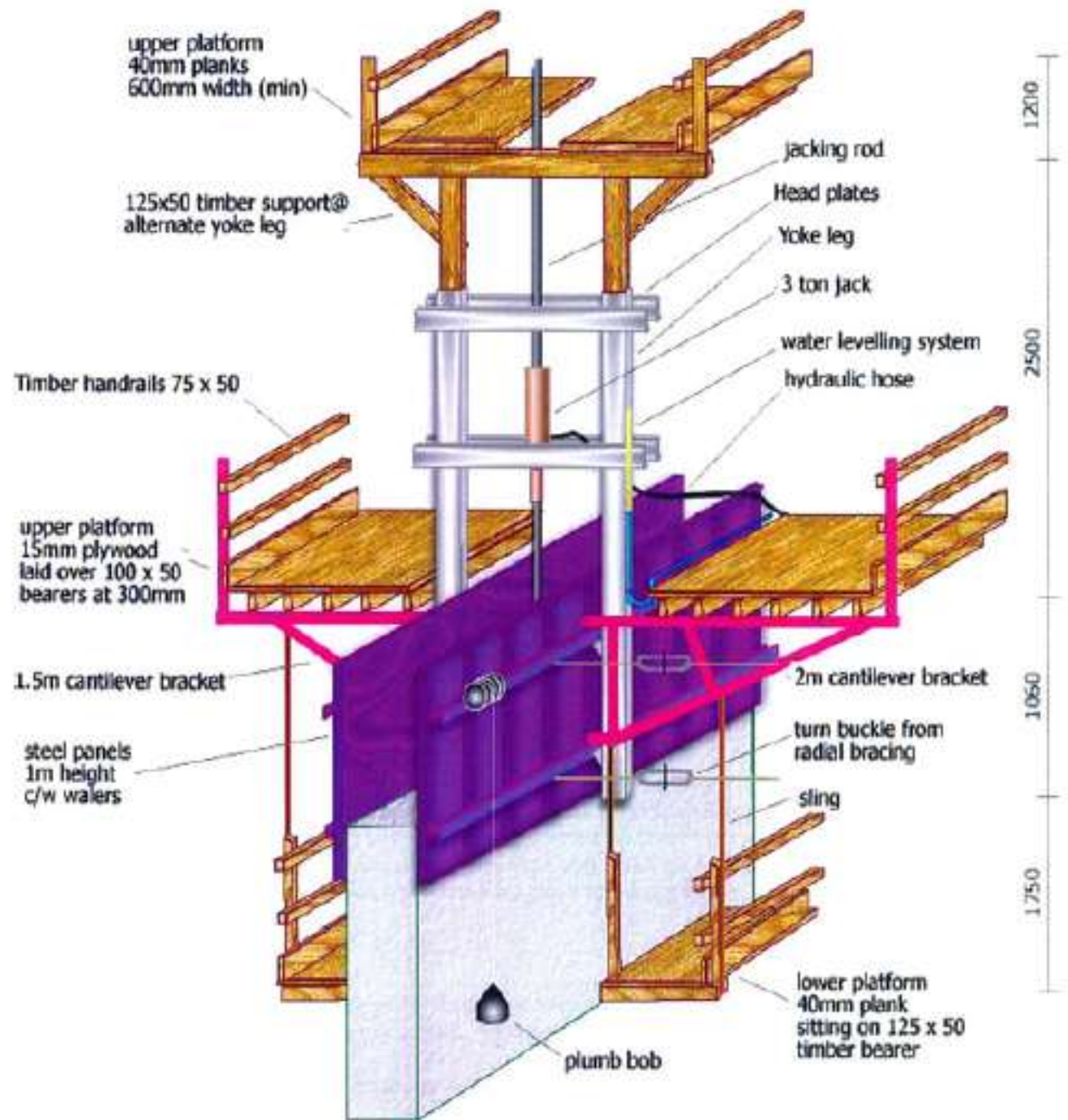
Support Detail



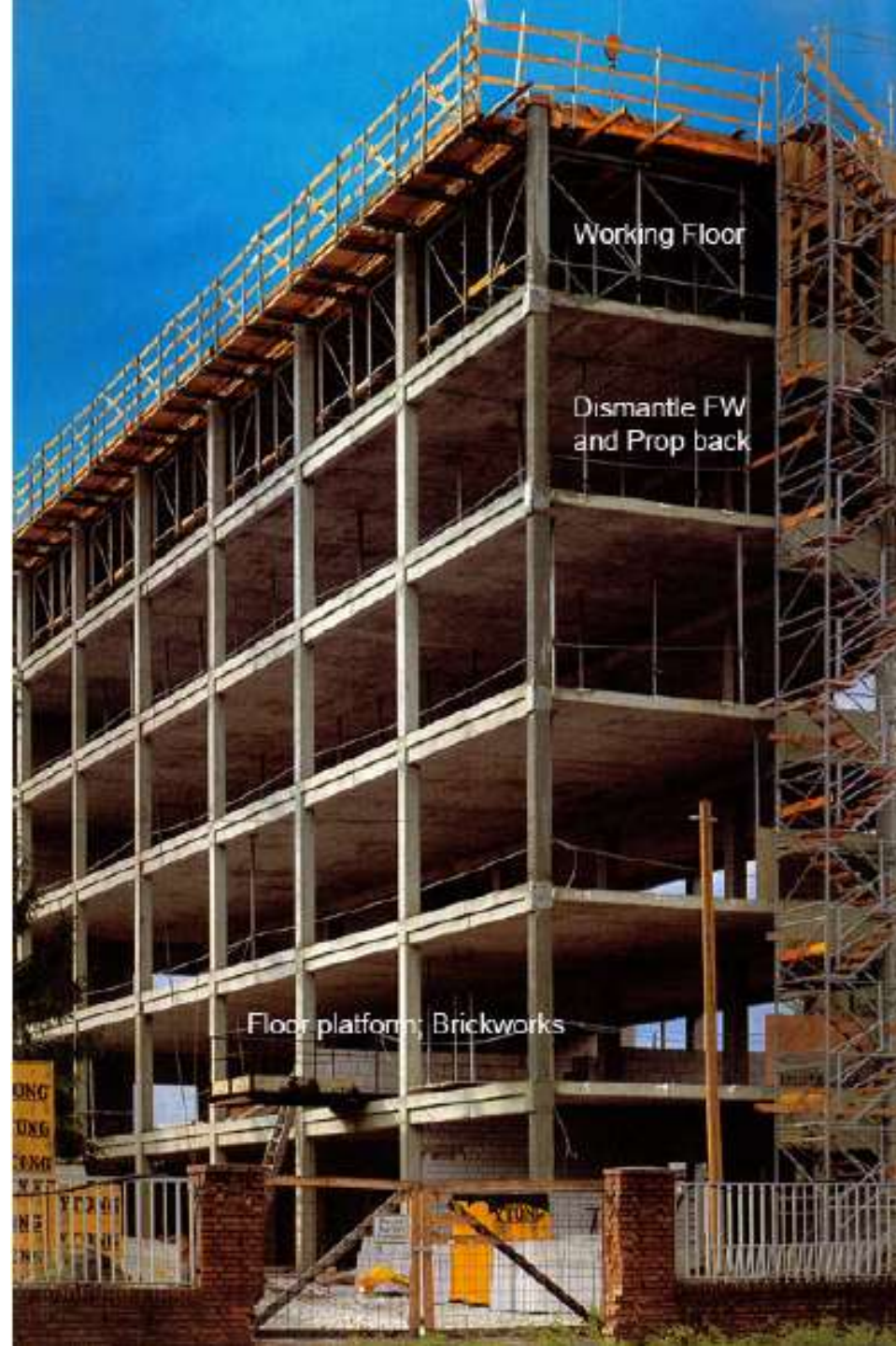
Isometric View

System Formwork

- Slip Form Formwork

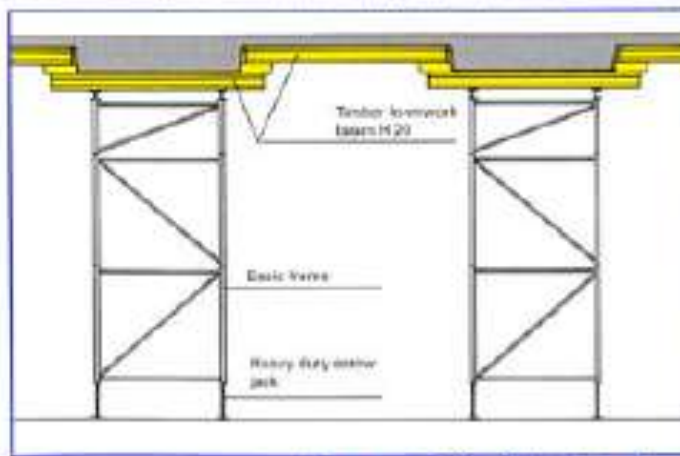


System Formwork



System Formwork

- Formwork for flat slab with drop panel



Formwork for flat slab with drop panel

System Formwork

