SIGMA COLLEGE OF ARCHITECTURE

Moododu, Anducode Post, Kanyakumari District
Approved by COA & Affiliated to Anna University

CONSTRUCTION TECHNOLOGY

ANNA UNIVERSITY, CHENNAI

AR6013 R - 2013

UNIT - 1

Ar.ARKIP SCODLIN D

2018

OBJECTIVES:

• To study the advancements in construction with concrete for large span structures.
• To familiarize the students with the manufacture, storage and transportation of concrete.
• To inform the various equipment used in the construction industry and the criteria for choice of equipment.
• To familiarize the students with an overview of construction management, planning and Scheduling

OUTCOMES:

At the end of the course, the student should be able to:

- Apply the concepts for large span structures.
- Concepts of construction management, planning and scheduling: apply them with examples.
- Materials storage and equipments for construction to be known before beginning of the work.

REQUIRED READINGS:

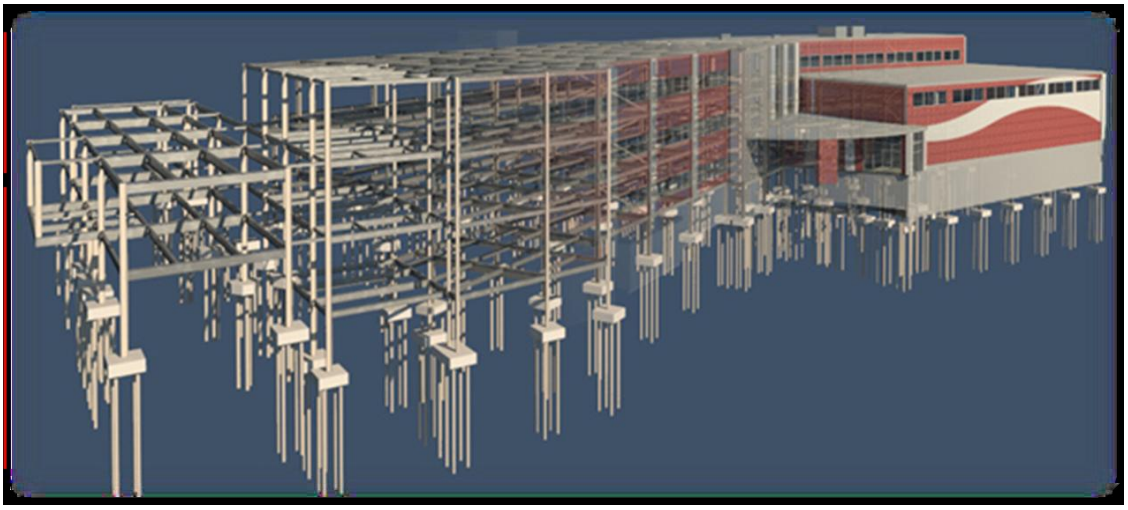
1. R. Chudley, Construction Technology, Pearson, 2005.
2. R. Barry, The Construction of Buildings, The English Language Book Society and Crosby Lockwood, Staples, London, 1976.
3. Construction Planning equipment and Methods by RL Peuriboy Tata McGraw Hill, 1979
4. Modern Construction and Management. Frank Harris John Wiley and Sons, 1983.

REFERENCES:

1. National Building Code of India, 2005 (NBC 2005)
2. Frank R. Dagostino, Materials of Construction, Details given Reston Publishing Company, nc. Virginia, 1976.
3. M. Mohsin, Project Planning and Control, Vikas Publishers, New Delhi, 1983
4. Concrete Technology – Theory and Practice, M.S. Shetty, Chand & Co, New Delhi, 2005.
5. Gurcharan Singh, “Building, Planning, Designing and Scheduling”, Standard Publications, 2009.

Construction technology

Construction technologies are the ways in which materials are combined to construct the elements of a building. They can be classified according to the mass of the system into heavyweight and lightweight construction.



Heavyweight construction
Characteristics of heavyweight construction include:

- Excellent durability
- Low maintenance
- Good thermal mass
- Most suited to climates with a large diurnal (day/night) temperature range
- Should not be used on remote sites where materials must be transported for long distances
- Generally high embodied energy
- Generally significant site impact and disturbance because of substantial foundation system requirements
- Generally quarried raw materials that cause a high impact on the landscape
- Generally require heavy lifting equipment on site.
- Often require temporary support during construction, which can increase waste.

Lightweight construction
Characteristics of lightweight construction include:

- Less durable than heavyweight construction
- Higher maintenance required than heavyweight construction
- Greater responsiveness to outdoor temperature changes – this can be beneficial by cooling
- More rapidly at night in warmer climates
- Suitable for remote sites where materials must be transported for long distances

- Generally lower embodied energy
- Generally lower site impact and disturbance than heavyweight construction
- Generally lower environmental impact, for example, sustainably sourced timber
- Able to be handled without the need for heavy machinery.

Structural systems and design: Planning

The design and implementing innovative methods and structural systems that will build a better community and push the project integration to new limits.

Planning is deciding in advance what to do, how to do it, when to do it and who to do it. It involves anticipating the future and consciously choosing the future course of action.

Nature of Planning

- Planning is goal-oriented
- Planning is a primary function
- Planning is all-pervasive
- Planning is a continuous process
- Planning is forward-looking
- Planning involves choice
- Planning is directed toward efficiency

PROCESS OF PLANNING

Step 1- DEFINE THE TASK
Step 2- IDENTIFY RESOURCES
Step 3- CONSIDER ALTERNATIVE
Step 4- CREATE THE PLANNING
Step 5- WORK THE PLAN
Step 6- EVALUATE

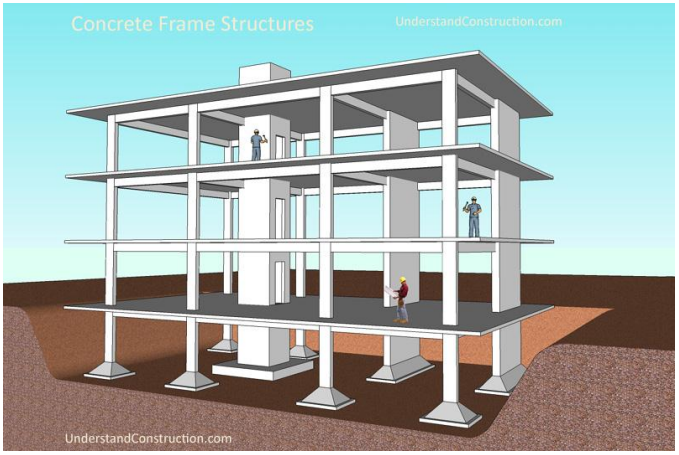
Importance of planning

- Focuses attention on objectives and result
- Reduces uncertainty and risk
- Provides sense of direction
- Encourages innovation and creativity
- Helps in co-ordination
- Guides decision-making
- Provide efficiency in operation

WHAT ARE THE VARIOUS TYPES OF BULDING CONSTRUCTION SYSTEMS?

CONCRETE FRAME STRUCTURES

Concrete frame structures are a very common or perhaps the most common type of modern building internationally. As the name suggests, this type of building consists of a frame or skeleton of concrete. Horizontal members of this frame are called beams and vertical members are called columns Humans walk on flat planes of concrete called slabs. Of these, the column is the most important, as it is the primary load carrying element of the building. If you damage a beam or slab in a building, this will affect only one floor, but damage to a column could bring down the entire building.



LIGHT GAUGE STEEL CONSTRUCTION

Light gauge steel construction is very similar to wood framed construction in principle the wooden framing members are replaced with thin steel sections. The steel sections used here are called cold formed sections, meaning that the sections are formed, or given shape at room temperature. This is in contrast to thicker hot rolled sections, that are shaped while the steel is molten hot. Cold formed steel is shaped by guiding thin sheets of steel through a series of rollers, each roller changing the shape very slightly, with the net result of converting a flat sheet of steel into a C or S shaped section.

LOAD BEARING MASONRY CONSTRUCTION

It is very rarely used today for large buildings, but smaller residential scale structures are being built. It essentially consists of thick, heavy masonry walls of brick or stone that support the entire structure, including the horizontal floor slabs, which could be made of reinforced concrete, wood, or steel members.

The key idea with this construction is that every wall acts as a load carrying element. In a load bearing structure, you cannot punch holes in a wall to connect two rooms you would damage the structure if you did so. The immense weight of the walls actually helps to hold the building together and stabilise it against external forces such as wind and earthquake.

PRE ENGINEERED BUILDINGS

Pre engineered buildings are factory built buildings of steel that are shipped to site and bolted together. What distinguishes them from other buildings is that the contractor also designs the building a practice called design & build. This style of construction is ideally suited to industrial buildings and warehouses; It is cheap, very fast to erect, and can also be dismantled and moved to another site more on that later. These structures are sometimes called 'metal boxes' or 'tin sheds' by laymen they are essentially rectangular boxes enclosed in a skin of corrugated metal sheeting.

STEEL FRAME STRUCTURES

Most steel construction is done with a type of steel called mild steel. This immense strength is of great advantage to buildings. The other important feature of steel framing is its flexibility. It can bend without cracking, which is another great advantage, as a steel building can flex when it is pushed to one side by say, wind, or an earthquake. The third characteristic of steel is its plasticity or ductility. Failure in steel frames is not sudden a steel structure rarely collapses. Steel in most cases performs far better in earthquake than most other materials because of these properties

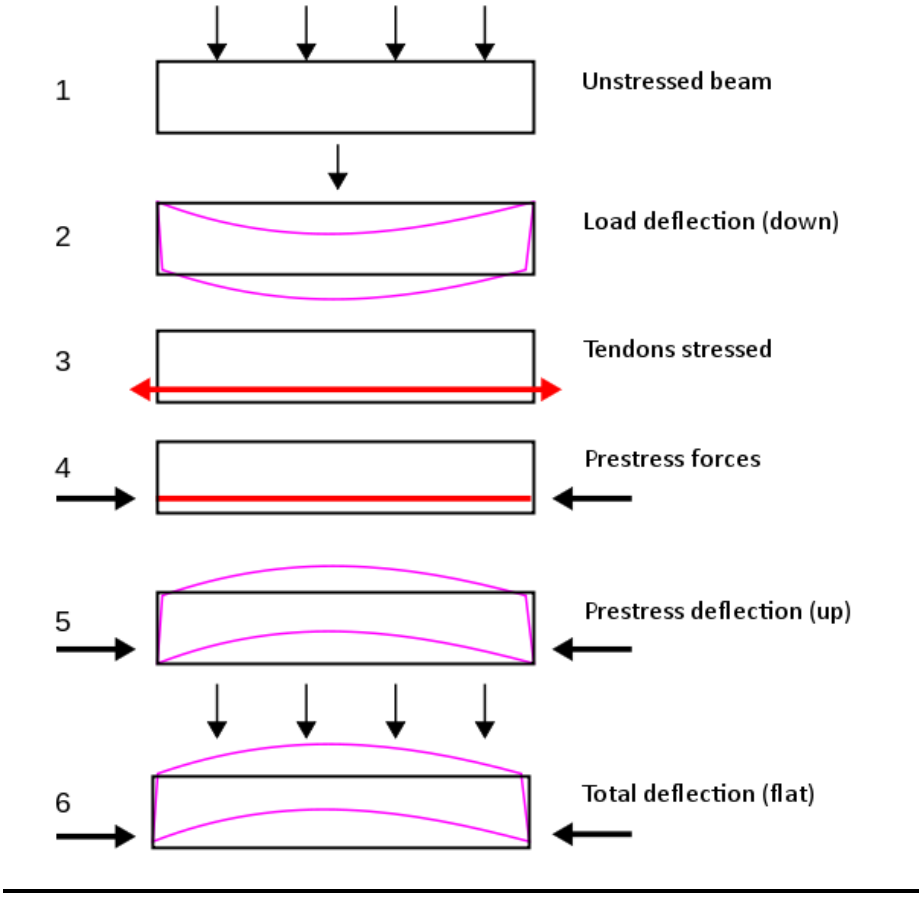
TIMBER FRAME CONSTRUCTION WOOD FRAME CONSTRUCTION

Light wood framed construction is one of the most popular types of building methods for homes in the United States and parts of Europe.

It has the following characteristics:

1. It is light, and allows quick construction with no heavy tools or equipment. Every component can easily be carried by hand a house essentially becomes a large carpentry job. The main tool is a handheld nail gun.
2. It is able to adapt itself to any geometric shape, and can be clad with a variety of materials.
3. There are a huge variety of products and systems tailored to this type of construction.

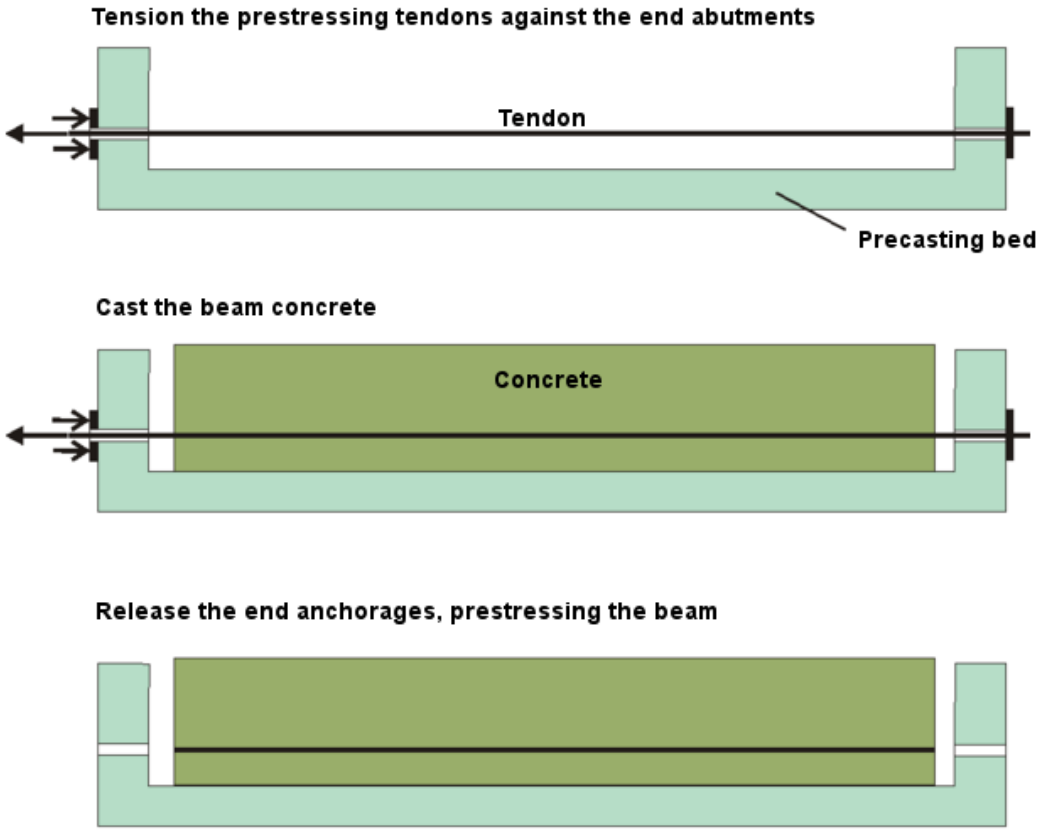
Pre-Stressed Concrete Constructions



Prestressed concrete is a concrete construction material which is placed under compression prior to it supporting any applied loads.
(i.e. it is "pre" stressed).

A more technical definition is ("Structural concrete in which internal stresses have been introduced to reduce potential tensile stresses in the concrete resulting from loads)."

This compression is produced by the tensioning of high strength "tendons" located within or adjacent to the concrete volume, and is done to improve the performance of the concrete in service. Tendons may consist of single wires, multi wire strands or threaded bars, and are most commonly made from high tensile steels, carbon fibre. The essence of prestressed concrete is that once the initial compression has been applied, the resulting material has the characteristics of high strength concrete when subject to any subsequent compression forces, and of ductile high strength steel when subject to tension forces.



Pre-tensioned concrete

Pre tensioned concrete is a variant of prestressed concrete where the tendons are tensioned prior to the concrete being cast. The concrete bonds to the tendons as it cures, following which the end anchoring of the tendons is released, and the tendon tension forces are transferred to the concrete as compression by static friction.

Post-tensioned concrete

Post tensioned concrete is a variant of prestressed concrete where the tendons are tensioned after the surrounding concrete structure has been cast.

(Post tensioning is a technique for reinforcing concrete. Post tensioning tendons, which are prestressing steel cables inside plastic ducts or sleeves, are positioned in the forms before the concrete is placed. Afterwards, once the concrete has gained strength but before the service loads are applied, the cables are pulled tight, or tensioned, and anchored against the outer edges of the concrete.)

Pre-Cast Concrete

Precast concrete is a construction product produced by casting concrete in a reusable mold or "form" which is then cured in a controlled environment, transported to the construction site and lifted into place. In contrast, standard concrete is poured into site specific forms and cured on site. Precast stone is distinguished from precast concrete using a fine aggregate in the mixture, so the final product approaches the appearance of naturally occurring rock or stone.

There are many different types of precast concrete forming systems for architectural applications, differing in size, function, and cost. Precast architectural panels are also used to clad all or part of a building facades or freestanding walls used for landscaping, soundproofing, and security walls, and some can be prestressed concrete structural elements. Storm water drainage, water and sewage pipes, and tunnels make use of precast concrete units.

Pre- Fabrication System

Prefabrication is the practice of assembling components of a structure in a factory or other manufacturing site, and transporting complete assemblies or subassemblies to the construction site where the structure is to be located. The term is used to distinguish this process from the more conventional construction practice of transporting the basic materials to the construction site where all assembly is carried out.

(Prefabrication is used in the manufacture of ships, aircraft and all kinds of vehicles and machines where sections previously assembled at the final point of manufacture are assembled elsewhere instead, before being delivered for final assembly.)

Offsite fabrication

OffSite fabrication is a process that incorporates prefabrication and preassembly. The process involves the design and manufacture of units or modules, usually remote from the work site, and the installation at the site to form the permanent works at the site. In its fullest sense, offsite fabrication requires a project strategy that will change the orientation of the project process from construction to manufacture to installation. Examples of offsite fabrication are wall panels for homes, wooden truss bridge spans, airport control stations.

Advantages

1. Moving partial assemblies from a factory often costs less than moving preproduction resources to each site
2. Deploying resources onsite can add costs; Prefabricating assemblies can save costs by reducing onsite work
3. Factory tools jigs, cranes, conveyors; etc can make production faster and more precise
4. Factory tools shake tables, hydraulic testers, etc can offer added quality assurance
5. Consistent indoor environments of factories eliminate most impacts of weather on production
6. Cranes and reusable factory supports can allow shapes and sequences without expensive onsite false work
7. Higher precision factory tools can aid more controlled movement of building heat & air, for lower energy consumption and healthier buildings
8. Factory production can facilitate more optimal materials usage, recycling, noise capture, dust capture, etc.
9. Machine mediated parts movement, and freedom from wind & rain can improve construction safety

Disadvantages

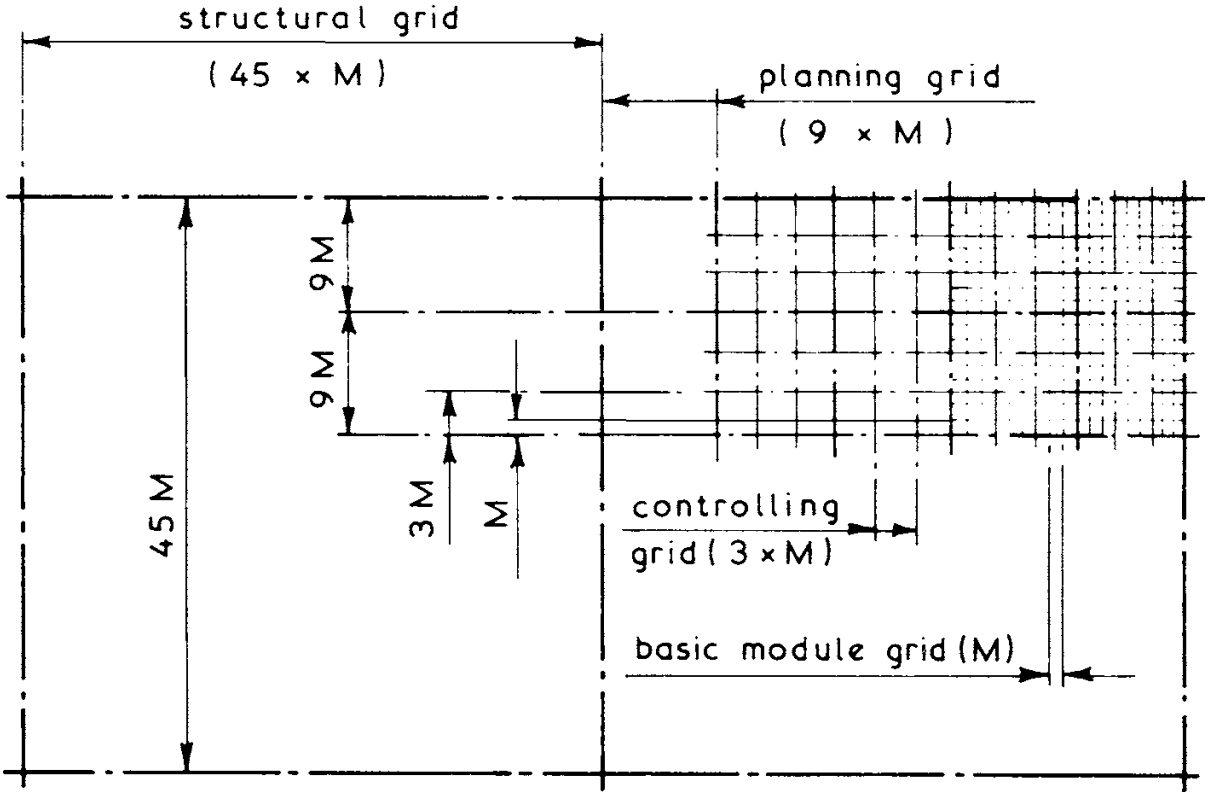
1. Transportation costs may be higher for voluminous prefabricated sections than for their constituent materials, which can often be packed more densely.
2. Large prefabricated sections may require heavy duty cranes and precision measurement and handling to place in position.

Modular Coordination

Modular Coordination ~ a module can be defined as a basic dimension which could for example form the basis of a planning grid in terms of multiples and submultiples of the standard module.

Typical Modular Coordinated Planning Grid ~

Let M = the standard module



Structural Grid ~ used to locate structural components such as beams and columns.
Planning Grid ~ based on any convenient modular multiple for regulating space requirements such as rooms.
Controlling Grid ~ based on any convenient modular multiple for location of internal walls, partitions etc.
Basic Module Grid ~ used for detail location of components and fittings.

All the above grids, being based on a basic module, are contained one within the other and are therefore interrelated. These grids can be used in both the horizontal and vertical planes thus forming a three dimensional grid system.

MODULAR COORDINATION: AN APPLICATION IN CONSTUCTION INDUSTRY

A modular building is a pre-engineered structure that is flexible enough to satisfy virtually any requirement tougher than standard drywall construction, expandable, can be relocated and completely re-usable. It has been found that Modular coordination is an outstanding choice having a minimum on-site modification and material wastage. Modular coordination differs from the traditional building methods, reducing the overall time of completion. Modular coordination facilitates sustainable benefits towards waste minimization and increases efficiency of productivity in the construction industry. The speed with which a building is completed its key advantage of modular coordination. With increasing industrialization to the building industry, steadily larger parts of buildings are made up of prefabricated components, delivered to the building site from the factories. Dimensional coordination of these component themselves and with the design are of paramount importance. The full benefit of the industrialization is impossible without standardization. No effective standardization is possible in the building industry, without dimensional coordination and modular coordination is a way to it.

Definition

Modular coordination is a concept of dimension and space, in which buildings components are dimensioned and positioned in a term of basic unit or module. The full benefit of industrialization can be achieved only by standardization. No effective standardization again is possible in a building trade without dimensional coordination. Dimensional coordination is possible if the coordinating dimensions of all parts, as well as the dimensions of the building to be erected are in multiples of one basic dimensional unit- The basic module. Such dimensional coordination is called modular coordination.

SIGMA COLLEGE OF ARCHITECTURE

Moododu, Anducode Post, Kanyakumari District
Approved by COA & Affiliated to Anna University

CONSTRUCTION TECHNOLOGY

ANNA UNIVERSITY, CHENNAI

AR6013 R - 2013

UNIT - 2

Ar. ARKIP SCODLIN D

2018

OBJECTIVES:

• To study the advancements in construction with concrete for large span structures.
• To familiarize the students with the manufacture, storage and transportation of concrete.
• To inform the various equipment used in the construction industry and the criteria for choice of equipment.
• To familiarize the students with an overview of construction management, planning and Scheduling

OUTCOMES:

At the end of the course, the student should be able to:

- Apply the concepts for large span structures.
- Concepts of construction management, planning and scheduling: apply them with examples.
- Materials storage and equipments for construction to be known before beginning of the work.

REQUIRED READINGS:

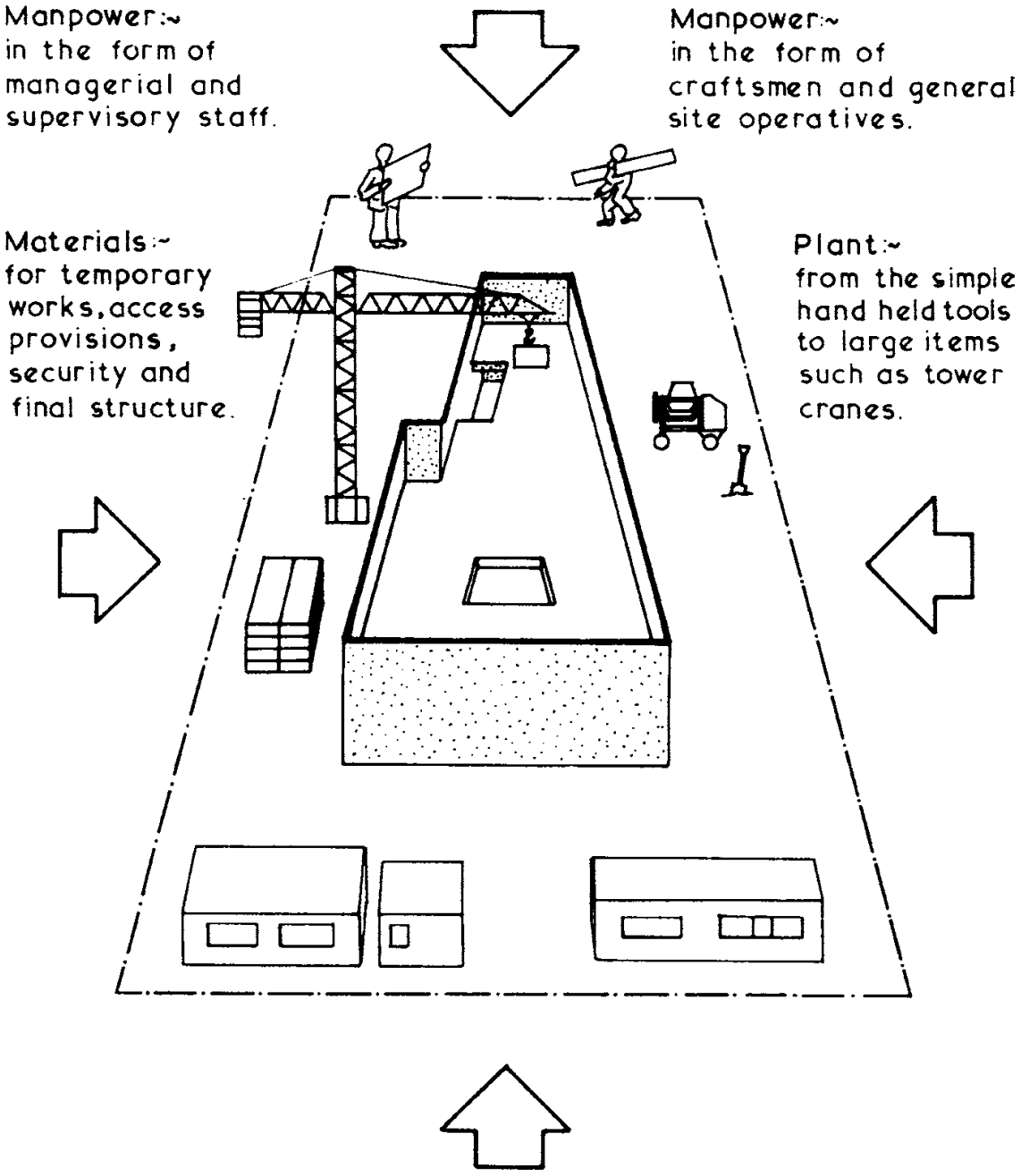
1. R. Chudley, Construction Technology, Pearson, 2005.
2. R. Barry, The Construction of Buildings, The English Language Book Society and Crosby Lockwood, Staples, London, 1976.
3. Construction Planning equipment and Methods by RL Peuriboy Tata McGraw Hill, 1979
4. Modern Construction and Management. Frank Harris John Wiley and Sons, 1983.

REFERENCES:

1. National Building Code of India, 2005 (NBC 2005)
2. Frank R. Dagostino, Materials of Construction, Details given Reston Publishing Company, nc. Virginia, 1976.
3. M. Mohsin, Project Planning and Control, Vikas Publishers, New Delhi, 1983
4. Concrete Technology – Theory and Practice, M.S. Shetty, Chand & Co, New Delhi, 2005.
5. Gurcharan Singh, “Building, Planning, Designing and Scheduling”, Standard Publications, 2009.

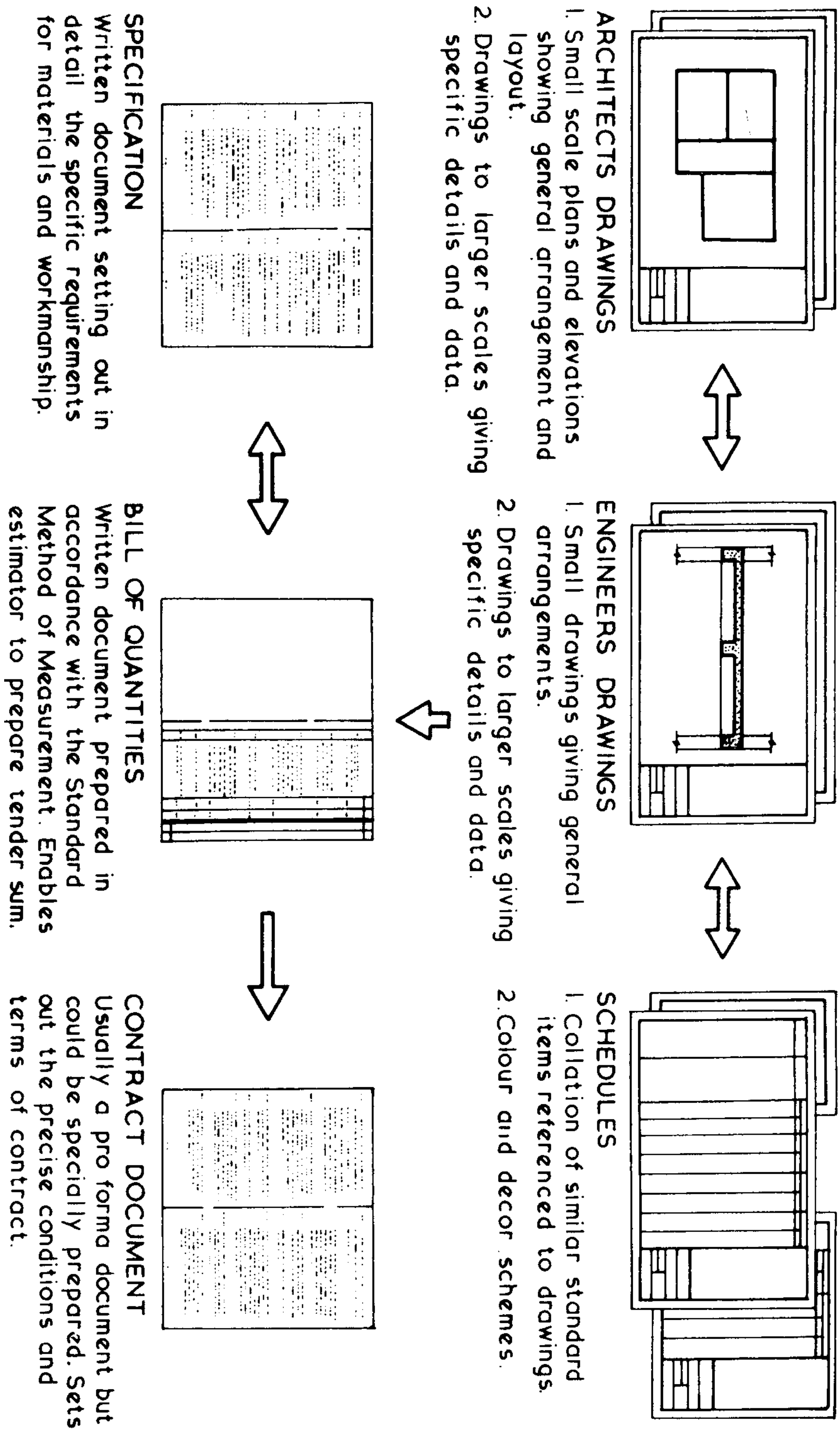
CONSTRUCTION PRACTICE

A Building or Construction Site can be considered as a temporary factory employing the necessary resources to successfully fulfil a contract.



Money :~
in the form of capital investment from the building owner to pay for the land, design team fees and a building contractor who uses his money to buy materials, buy or hire plant and hire labour to enable the project to be realised.

Construction Activities---The Documents



Construction

Construction is the process of constructing a building or infrastructure. Construction differs from manufacturing in that manufacturing typically involves mass production of similar items without a designated purchaser, while construction typically takes place on location for a known client. Construction as an industry comprises six to nine percent of the gross domestic product of developed countries. Construction starts with planning, design, and financing; and continues until the project is built and ready for use.

Large scale construction requires collaboration across multiple disciplines. An architect normally manages the job, and a construction manager, design engineer, construction engineer or project manager supervises it. 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 zoning requirements, the environmental impact of the job, the successful scheduling, budgeting, construction site safety, availability and transportation of building materials, logistics, inconvenience to the public caused by construction delays and bidding, etc. The largest construction projects are referred to as megaprojects.

Modern Construction Materials - Manufacture

India is witnessing construction of very interesting projects in all sectors of Infrastructure. High rise structures, under construction, include residential/commercial blocks up to a height of 320 m and RC chimneys for thermal power stations extending upwards up to 275m. Majority of the structures are in structural concrete. The functional demands of such high rise structures include the use of durable materials. High Strength Concrete, Self–compacting Concrete are gaining widespread acceptance.

Durable Concrete

Concrete Design and Construction Practices today are strength driven. Concrete grades up to M80 are now being used for highrise buildings in India. However, due to escalation in the repair and replacement costs, more attention is now being paid to durability issues. There are compelling reasons why the concrete construction practice during the next decades should be driven by durability in addition to strength.

High Performance Concrete

In the United States, in response to widespread cracking of concrete bridge decks, the construction process moved towards the use of High Performance Concrete (HPC) mixes. Four types of HPC were developed.

Very High Early Strength Concrete – 17.5 mPa in 6 hours
High Early Strength Concrete – 42.5 mPa in 24 hours
A Very High Strength – 86 mPa in 28 days
High Early Strength with Fiber Reinforcement

Self–compacting Concrete (SCC)

SCC was developed by the Japanese initially as a Quality Assurance measure, but now is being widely used for concrete structures worldwide. In India, one of the earliest uses of SCC was for some components of structures at Kaiga Atomic Power Project. Many components of the structures were very heavily reinforced and the field engineers found it difficult to place and compact normal concrete without honeycombs and weaker concrete. SCC was successfully used. SCC leaving the batching plant is in a semi-fluid state and is placed into the formwork without the use of vibrators. Due to its fluidity, SCC is able to find its way into the formwork and in between the reinforcement and gets self-compacted in the process. SCC is particularly useful for components of structures which are heavily reinforced. The fluidity is realized by modifying the normal mix components. In addition to cement, coarse and fine aggregates, water, special new generation polymer based admixtures are used to increase the fluidity of the concrete without increasing the water content.

Recycled Aggregates

With continuous development activity worldwide, the availability of coarse aggregates from natural sources or crushed rock is dwindling; at the same time, due to demolition of old structures, roads etc., a large amount of debris is generated

annually and their disposal poses problems for the individuals and the Governments. In many countries including the UK, any demolition agency is not permitted to dispose of the debris except at predetermined locations which may involve very long leads, expensive operations.

Extensive research has now established that the debris can be crushed, processed and recycled as coarse aggregate for fresh concrete.
Such recycling solves the above mentioned problems of disposal, and also more economical. Many national codes in the developed world permit the use of recycled aggregates in concrete, subject to safeguards.

Lightweight Aggregates
These are manufactured products and are extensively used in all types of structures involving longer spans where the dead-load forms a major component of the loads involved in the design. Such lightweight aggregates are manufactured products using expanded clay, sintered fly ash etc. Their contribution to strength depends on the type and quality of the lightweight aggregate, the size fraction used and the amount of aggregate used as well as the type and quality of binder in concrete. However, the addition of lightweight aggregating concrete reduces the modulus of elasticity.

High Performance Lightweight Concrete
By using high strength/high performance lightweight concrete in prestressed concrete bridge girders, spans of bridge girders can be extended by up to 20%. The implications of using lightweight aggregate on prestressing losses long-term creep and shrinkage deformation should be considered. Compressive strength of up to 75 mPa has been obtained. They also result in reduction in creep and shrinkage and consequently lower prestressed losses. The overall costs for a given load capacity are reduced. The reduction in the structure dead-load leads to a reduction in the foundation size.

Advanced Composite Reinforcement
In highly corrosive environments, the use of advanced composite fibber reinforced polymers (FRP) is attractive as a replacement for conventional steel reinforcements. While the FRP materials can be resistant to corrosion, there is lack of ductility. At the moment FRP reinforcement in India is quite expensive. The main market for FRP in India is for structural retrofit for increasing the load capacity, to remedy construction defects or repair damages.

Exterior Self–leveling Concrete Topping
This is a Portland cement based product for fast track resurfacing and smoothing of concrete. It produces a smooth flat hard surface and dries quickly without shrinking, cracking or spalling. Pourable or pump-able when mixed with water, it installs 6 to 20 mm thick in one application and up to 50 mm thick with the addition of aggregate. It is pourable or pump-able when mixed with water. It can be used on, above or below grade and it makes spalled or damaged concrete look like new. Once sealed it creates an excellent wearing surface.

Insulated Concrete Form (ICF)
ICF structural elements allow maximum clear spans. The ICF elements are used for large commercial buildings, residential buildings etc.

Hydrophobic Concrete Water proofing System
A typical patented product uses three materials to achieve a water-tight concrete structure, a super-plasticizer which reduces batching water requirements, thus limiting the volume of the capillary pour network in the concrete; a reactive hydrophobic pour blocking concrete admixture and product specific water stop protection at construction dams.

Cement Silos
The use of batching plants for producing concrete is gaining increasing acceptance. As large volumes of cement are used in a batching plant, the cement is generally stored in vertical steel silos. When cement is received in bulkers from the factory, the same is directly pneumatically pumped into the silos which have capacities ranging from 50 to 500 tonne depending upon the project requirements. If only bagged cement is available, they are emptied into the silos, usually with the help of screw conveyors. For modern applications, more than one silo will be required depending on the types of cement and mineral admixture used in the concrete mix.

List of Construction Materials

1.Cold rolled steel framing
- Steel framing systems
- Mezzanine floors
- Purlin and cladding rails
- Portable buildings
- Prefabricated buildings

2.Compressed earth block, mud brick, rammed earth

3.Concrete

4.Conveyor systems
- Elevator or "lift"
- Escalator

5.Composites

6.Thermal protection
- Building insulation

7.Moisture protection
- Building envelope
- Conformal coating
- Damp (structural)
- Housewrap

8.Doors

- Stile and rail, raised panel, wood clad
- Access, sliding glass doors, tambour
- Folding doors, garage door, storefront
- Door hardware

9.Electrical systems and equipment

- AC power plugs and sockets
- Circuit breaker
- Electrical connector
- Electrical wiring
- Switches

10.Surface finishing

- Plaster & gypsum board
- Cement render
- Ceramic tile, quarry tile, pavers, mosaic
- Dropped ceiling, coffered ceiling
- Flooring – wide plank, terrazzo, carpet
- Marble
- Wall covering, wallpaper, acoustic
- Paint, wood stain, faux finishing
- Staff – a type of artificial stone
- Stucco

11.Fire suppression equipment

12.Furnishings

13.Masonry, mortar (masonry), grout

- Adobe, brick and brickwork, glass brick, terra cotta
- Artificial stone
- Cinder block or concrete block
- Noxer block
- Stone dry stacked or mortar set
- Urbanite – brokenup
- Concrete

14.Metals

- Structural steel: Ibeam
- & column
- Rebar
- Wire rope and cables
- Metal joist, decking, framing, trusses
- Metal fabrications
- Stairway, ladder, railing, grating, Strut channel, roofing

- (including copper)
- Decorative metal

15. "Openings" include Doors & Windows
16. Plumbing fixtures and equipment
17. Building safety
18. Security systems
19. Telecommunications equipment
20. Plastics

Storage, transportation and erection of pre-cast component forms, moulds and scaffoldings in construction

Industry management issues, such as enterprise resource planning (ERP) and supply chain management (SCM), are discussed and implemented successfully in many manufacturing industries but construction.

The storage and transportation planning of a construction precast project is mainly discussed herein. Generally, whole process of a precast project can be divided into 5 stages: design, production, storage, transportation, and installation. Besides, at least 4 important roles: client, architect, subcontractor, and precast factory, are involved in these 5 stages.

From perspective of the precast factory, two stages are out of their control: design stage and installation stage.

In design stage, the architect confirms details of all precast components, such as shape, strength and material, with the client, and then makes components exact. The precast factory receives these component details and then produces components according to architect's designs as orders.

In installation stage, the subcontractor installs all completed components at where the places according to architect's design. The precast factory supplies components on time in the installation stage of most cases. It is obvious that the design stage and the installation stage involve two or more roles. Thus, production, storage, and transportation stage are more controllable than these two stages from precast factory's viewpoint.

Storage stage

Generally speaking, storage stage had been considered in the component producing planning but simplified as an inventory calculation. Daily inventory is a vehicle variable between component producing and the demand. Produced components are stored in factory as inventory and this inventory add up all produced components in factory in a period. In order to match the demand, the component inventory must equal to or exceed the demand of contract at the deadline of project. Thus, a component producing plan considers daily inventory is able to create, and it is still practical for factory business mainly considering production stage. Furthermore, the cost of inventory can be also calculated through the quantity of stored components,

and the inventory limits can be restrained if storage space is further concerned as constraints. Nevertheless, traditional precast factory can perform this kind of production planning formulation without considering how to store components.

No matter how a precast factory closed to a manufacturing one, the nature of product of precast factory, construction component, is very unique to other industries. A component that is unique to any other one is commonly concerned in most construction precast project. Thus, to identify each component is usually important in storage stage. Furthermore, there are several circumstances must be regarded in practical storage work: size of components; limitation in vertical loading of ground; safe distance between components and ways to store components. Briefly, the problem of component storage is a 2-dimensional or 3-dimensional spatial allocation with component identification.

Foreign site storage that components are stored in a space out of both factory and work site is another issue in practical factory business. When the space of the precast factory is insufficient to store all components, foreign site storage is a common alternative. Extra movements of components are needed to deliver components between different sites.

Site Storage

Site Storage ~ materials stored on site prior to being used or fixed may require protection for security reasons or against the adverse effects which can be caused by exposure to the elements.

Small and Valuable Items ~ these should be kept in a secure and lockable store. Similar items should be stored together in a rack or bin system and only issued against an authorised requisition.

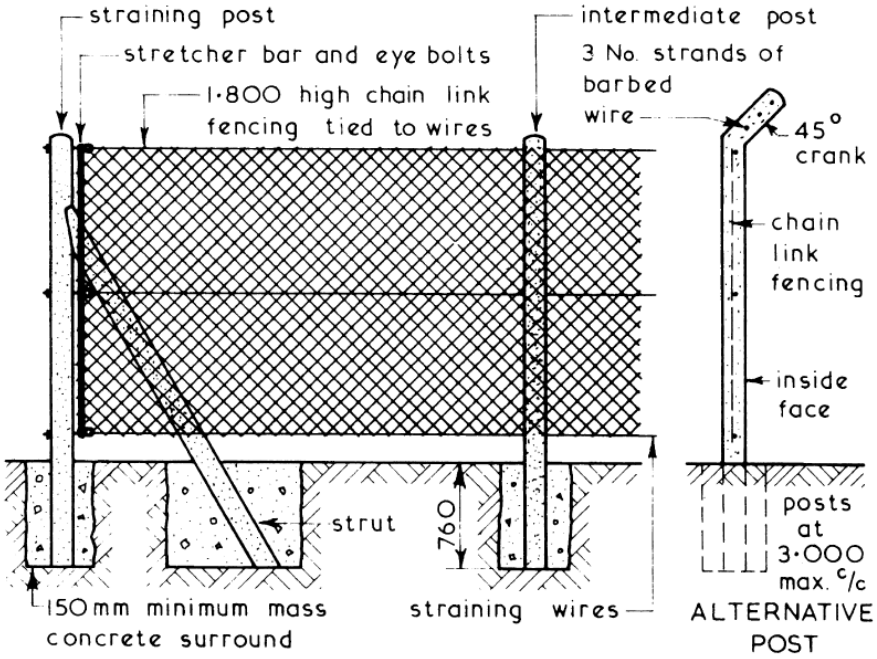
Large or Bulk Storage Items ~ for security protection these items can be stored within a lockable fenced compound. The form of fencing chosen may give visual security by being of an open nature but these are generally easier to climb than the close boarded type of fence which lacks the visual security property.

Typical Storage Compound Fencing

Close boarded fences can be constructed on the same methods used for hoardings

Alternative Fence Types ~ woven wire fence, strained wire fence, cleft chestnut pale fence, wooden palisade fence, wooden post and rail fence and metal fences

Typical Storage Compound Fencing



CHAIN LINK FENCING WITH PRECAST CONCRETE POSTS

Materials Storage

1. **Physical Properties** - size, shape, weight and mode of delivery will assist in determining the safe handling and stacking method(s) to be employed on site, which in turn will enable handling and storage costs to be estimated.

2. **Organisation** - this is the planning process of ensuring that all the materials required are delivered to site at the correct time, in sufficient quantity, of the right quality, the means of unloading is available and that adequate space for storage or stacking has been allocated.

3. **Protection** - building materials and components can be classified as durable or non-durable, the latter will usually require some form of weather protection to prevent deterioration whilst in store.

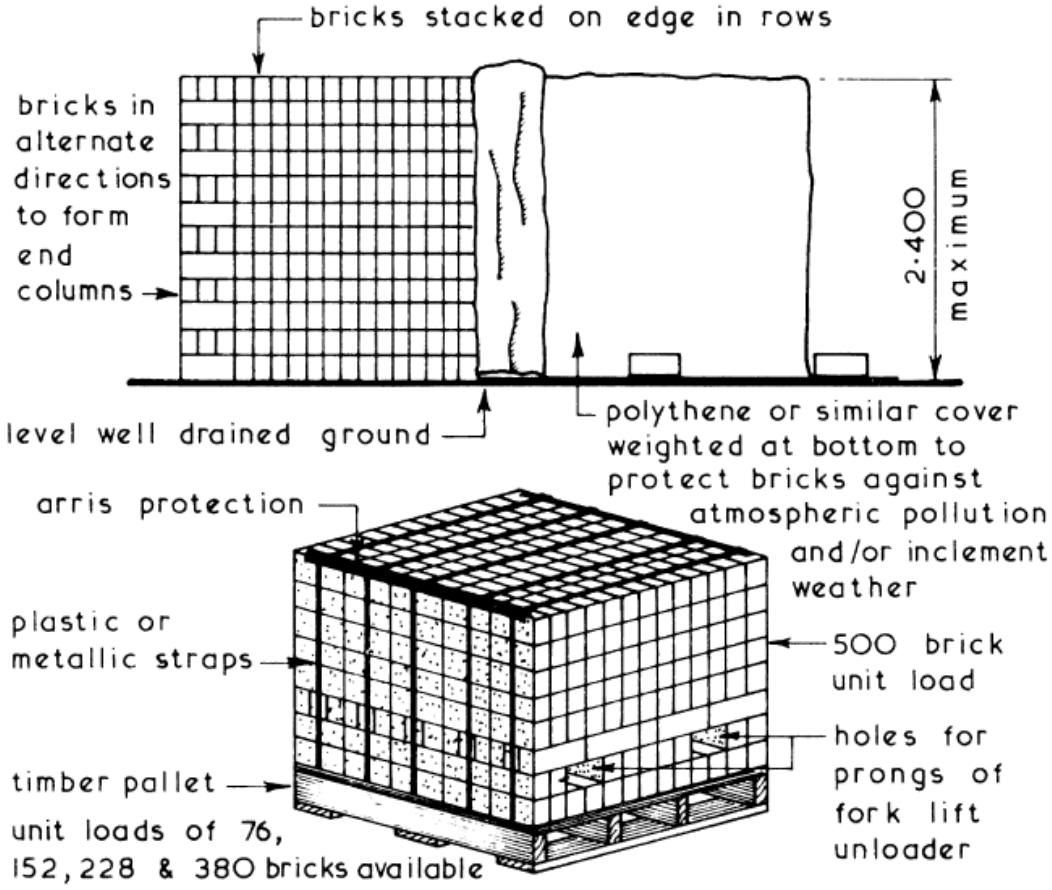
4. **Security** - many building materials have a high resale and/or usage value to persons other than those for whom they were ordered and unless site security is adequate material losses can become unacceptable.

5. **Costs** - to achieve an economic balance of how much expenditure can be allocated to site storage facilities the following should be taken into account:-

a. Storage areas, fencing, racks, bins, etc.
b. Protection requirements.
c. Handling, transporting and stacking requirements.
d. Salaries and wages of staff

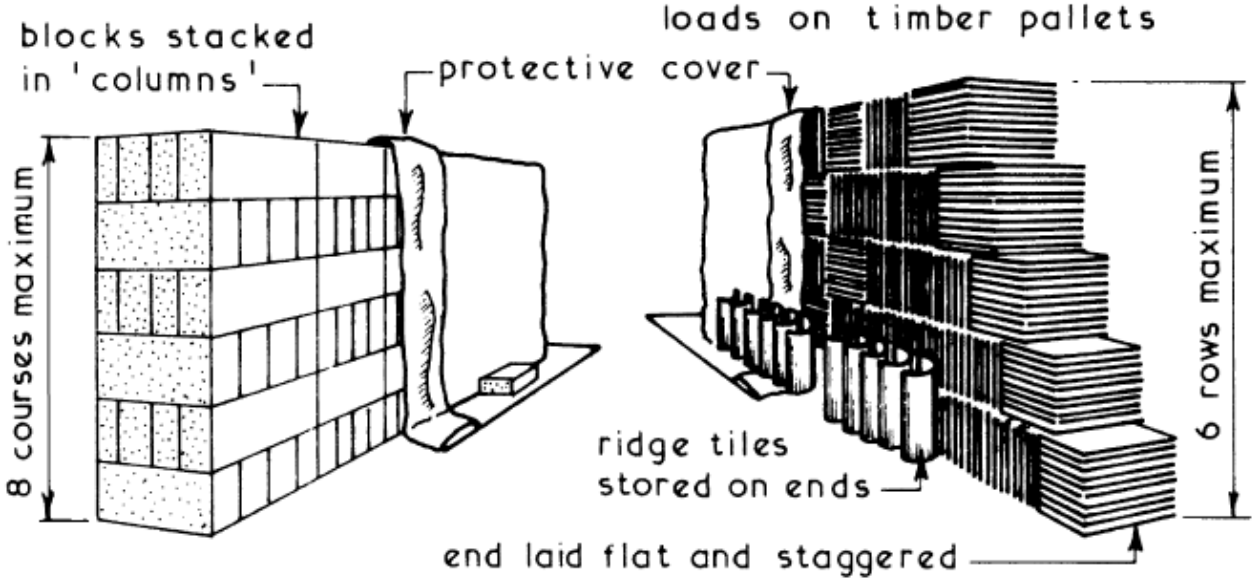
6. **Control** - checking quality and quantity of materials at delivery and during storage period, recording delivery and issue of materials and monitoring stock holdings.

Bricks ~ may be supplied loose or strapped in unit loads and stored on timber pallets

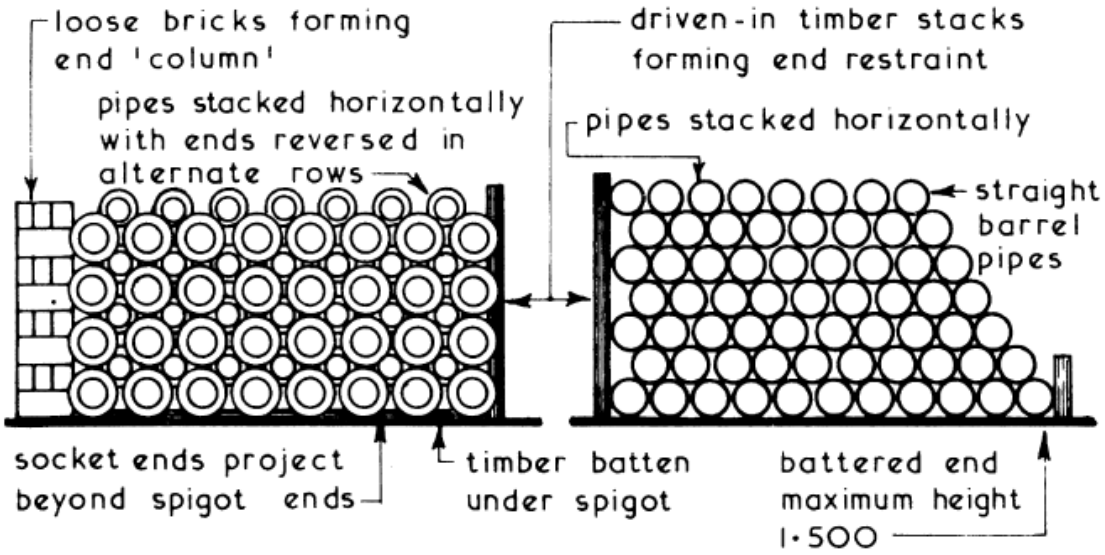


Blocks ~ may be supplied loose or in unit loads on timber pallets

Roofing Tiles ~ may be supplied loose, in plastic wrapped packs or in unit loads on timber pallets

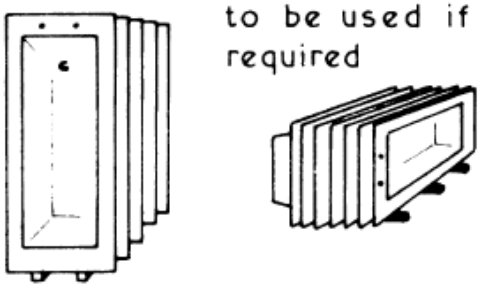


Drainage Pipes ~ supplied loose or strapped together on timber pallets



Gullies etc., should be stored upside down and supported to remain level

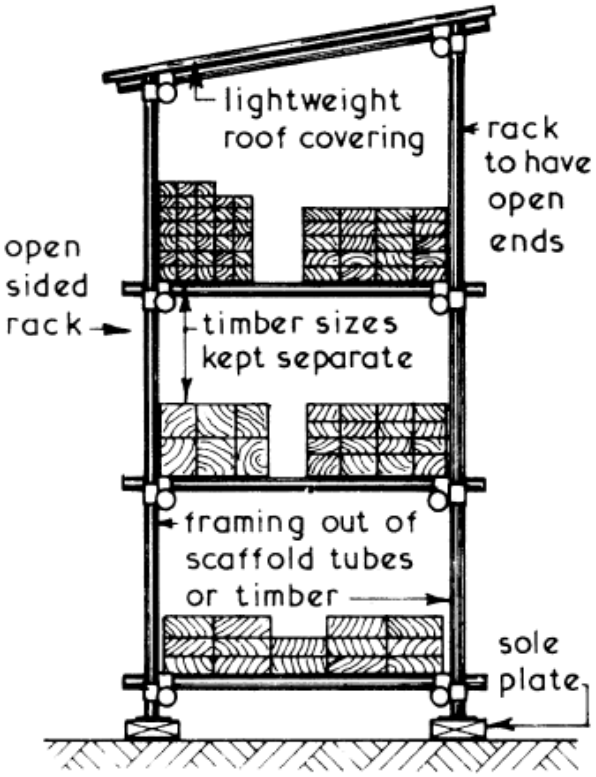
Baths ~ stacked or nested vertically or horizontally on timber battens



Basins ~ stored similar to baths but not more than four high if nested one on top of another

Corrugated and Similar Sheet Materials ~ stored flat on a level surface and covered with a protective polythene or similar sheet material

Timber and Joinery Items ~ should be stored horizontally and covered but with provison for free air flow



Transportation stage

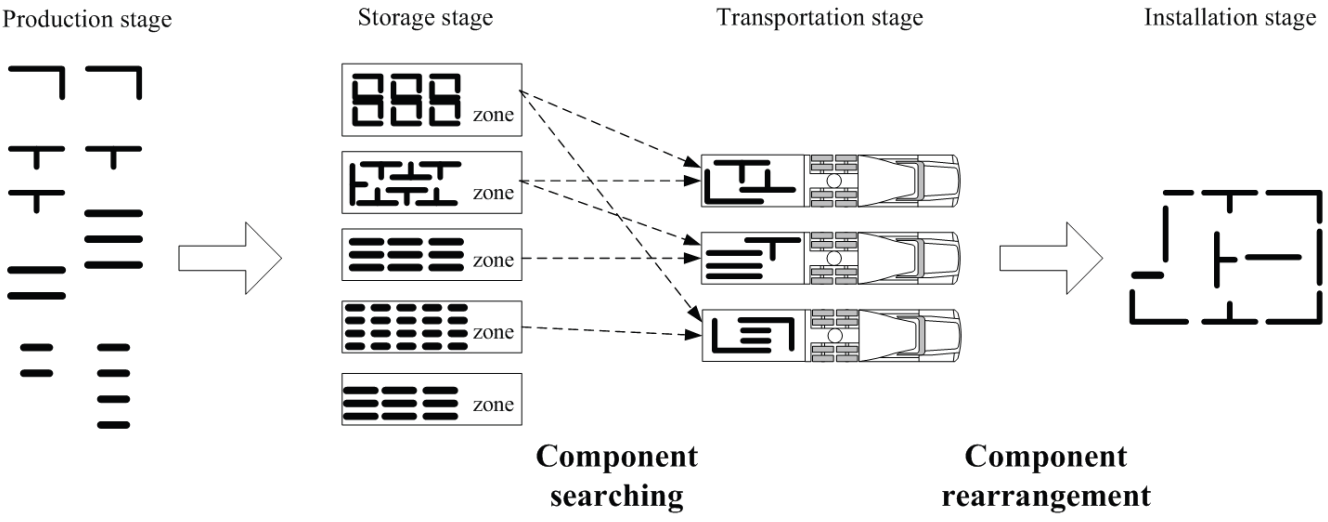
Transportation stage is ignored in previous precast management researches. Components always produced with few redundancies in a construction precast project, and all of them must be transported for installation to meet project requirement. Therefore, the cost of transportation can be treated as a fixed cost in most cases without detail delivery consideration because component delivery is necessary in a project. Thus, component transportation has been a parameter of fix cost which does not need to plan. However, the component transportation still plays an important role in factory business.

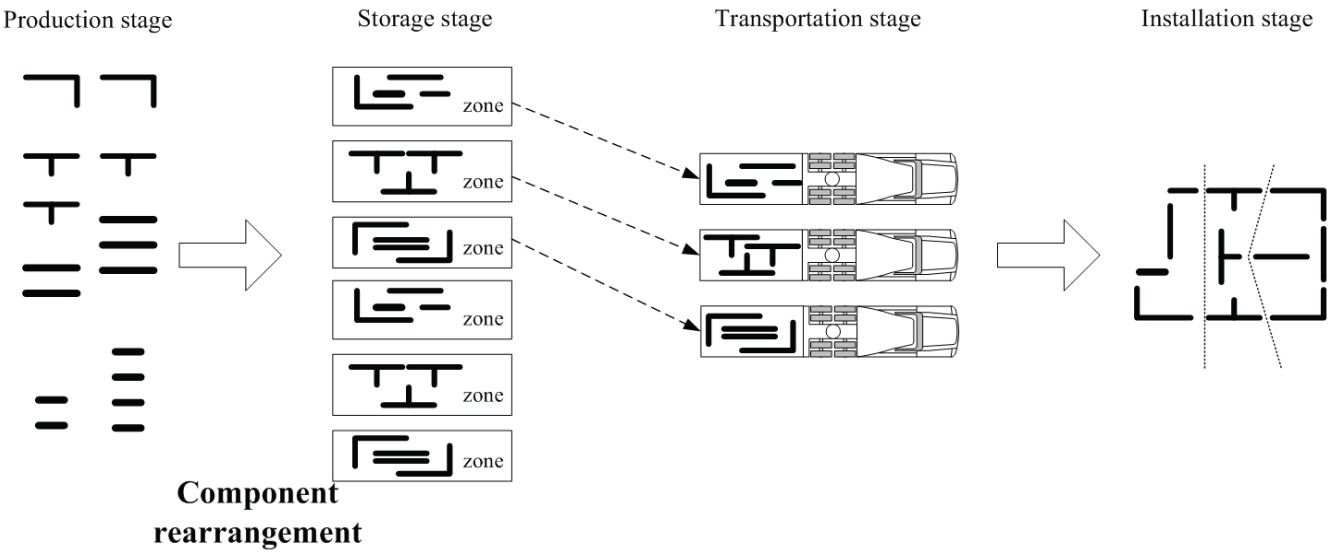
There are two kinds of transportation must be recognized in factory business: component movement within a site and component transportation between two sites for a long distance. Component movement within a site means that components are moved within the factory, a storage site, or the work site in short distance. Equipments such as cranes and trams can be utilized for this case. These equipments are owned or rented for daily business by precast factory. Hence, transportation cost in this case can be neglected from single precast project or transformed onto the cost for factory or site setting cost. The other, component transportation for a long distance is performed by trucks. In practice, trucks are mostly rented case by case when components transport in sites or turn over from any site to work site are sure.

Two important factors: weight of components and transported distance are commonly adopted for truck rental fee calculation. This long distance transportation is variable case by case. For example, components are delivered from the factory to a foreign site, the factory to the work site, and a foreign site to the work site.

Component zoning strategy

Taking to above issues as well as problems with component storage and transportation into consideration, a mechanism for precast factory planning which employed the concept of basic zoning with minimization of total cost is purposed.

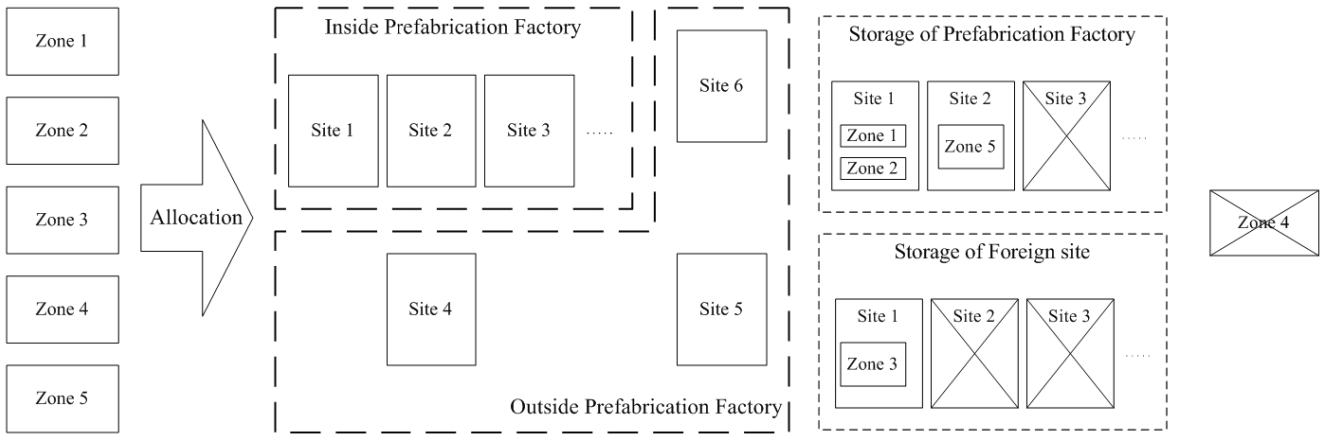




Zone selection and allocation

From perspective of component storage, zones are used as basic elements for checking the component storage and utility of each storage site. In order to form an optimized zoning strategy, procedure of picking up appropriate zones, in term of zone selection, is very important.

Two kinds of site that are site inside factory and foreign site are involved according foreign site inventory behaviour, extra site rental fee are considered if a foreign site is adopted during the period of a project. This rental fee contains land usage fee and necessary facility fee to operate storage business. Besides, truck rental fee can also be recognized by location of a foreign site and weight of component which are planned to store in this site.

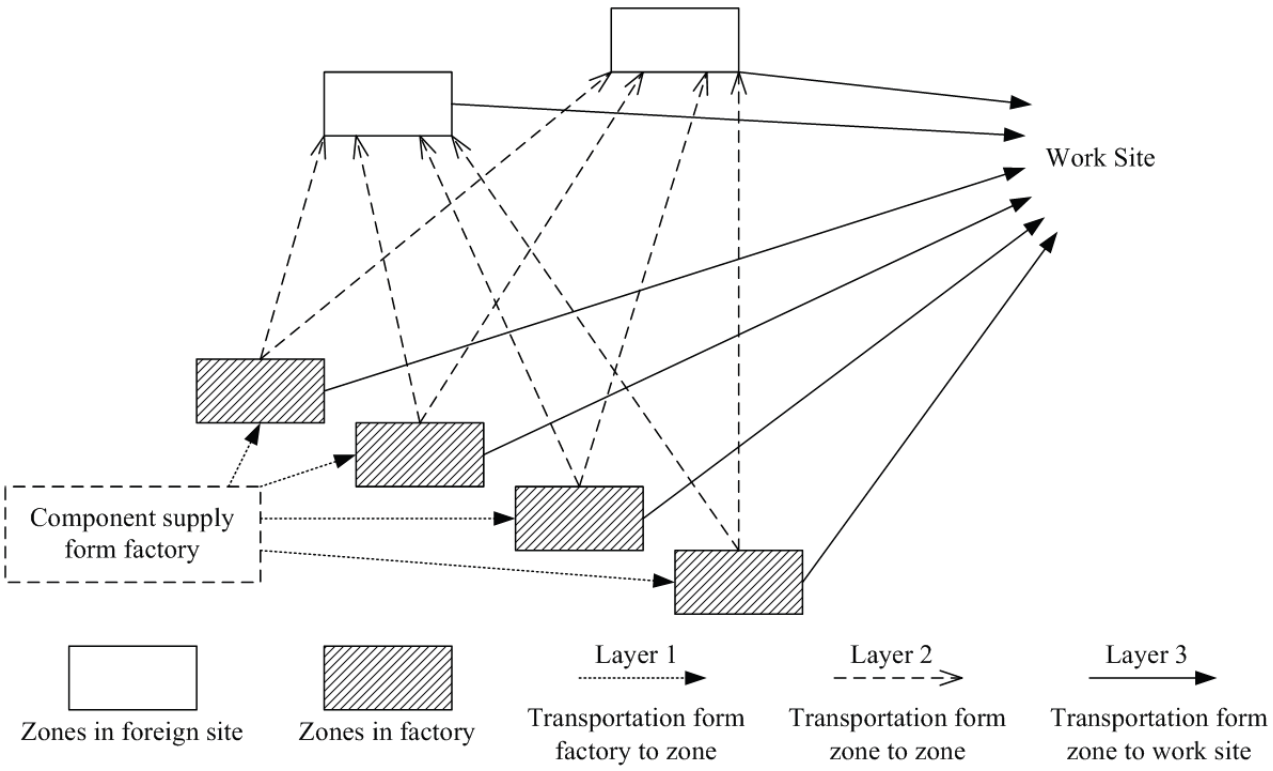


Transportation between sites

The whole transportation problem can be divided into 3 layers component movement according to zone allocation that mention above are:

1. Factory, in other word production stage, to sites inside factory;
2. Sites inside factory to foreign site;
3. Sites to work site, in other word installation stage.

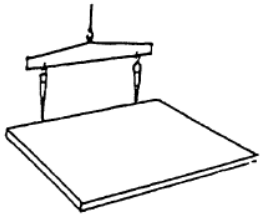
Two types of transportation, within a site and long distance transportation, can be identified into these 3 movements. The case of transportation within the same site occurs when components are moved from factory to sites inside factory, layer 1, obviously. No extra transportation cost will be charged because these movements are completed by equipments belonging to factory. The other, long distance movement occurs in layer 2 and 3 and the truck rental fee according to weight of components and distance between sites will be charged



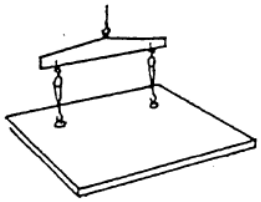
Transportation and Erection of Precast Concrete

PRECAST ELEMENT DESIGN

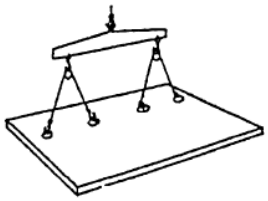
Lifting from Casting Beds-
The designer should take into account the size, shape and weight of the panel when designing the strong-back and the connection details. If the strong-back is to have lifting gear fixed to it, it must be designed for that purpose.



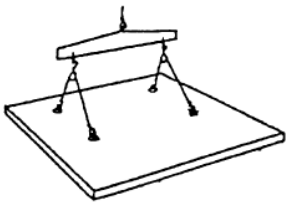
Edge lift



Single row (2 point)

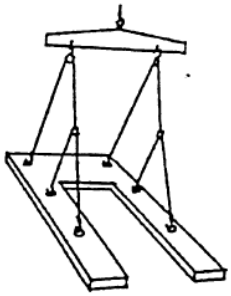


Single row (4 point)

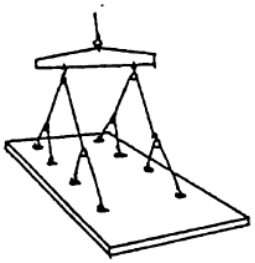


Double row

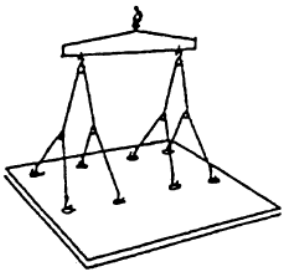
3 high equal load



3 high double load (top anchors)



4 high 2 wide

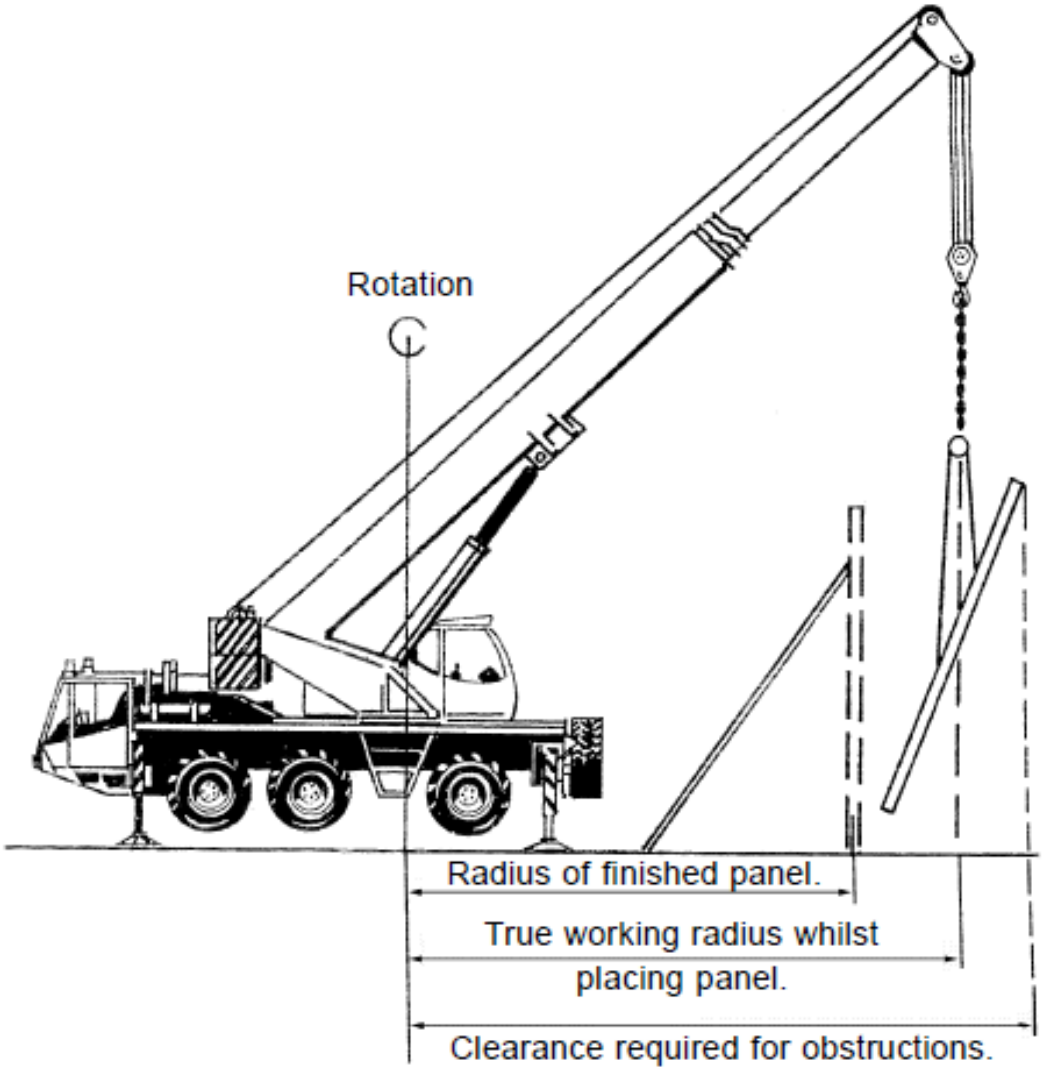


2 high 4 wide

Common rigging configurations

CRANES

The normal rated capacity of a crane refers to its load capacity at a minimum radius and often this bears little relation to its actual capacity at a working radius when lifting precast elements.



Note: The true working radius from the centre of rotation to the hook will depend on actual panel details.

Safety in erection and dismantling of constructions.

ERECTION AND DISMANTLING OF SCAFFOLDING/ FALSEWORK

False-work is any temporary structure used to support a permanent structure while it is not self-supporting, either in new construction or refurbishment. Any failure of false-work may lead to the collapse of the permanent structure. This could cause injury or death to those working on or near to it, as well as loss of time and money

Management

The law requires falsework to be erected and dismantled only under the supervision of a competent person. As early as possible, a person should be appointed for each site as a falsework co-ordinator, with responsibility for co-ordinating the various items and stages of use of the falsework.

Scaffold licenses

A licence from the local authority is required before a scaffold can be erected on a public highway. An additional licence is usually needed if you plan to install a protective fan. A licence may set down standards on such matters as lighting or painting the scaffold, or for a fan it may restrict the height at which it is set. For further advice you should contact your local highway authority.

Planning

All concerned should contribute towards the preparation of a design brief, which should serve as the starting point for subsequent decisions, design work, calculations and drawings. Initial planning should cover:

- What needs to be supported, and how it should be done; and

- How long the falsework will be in use.

Design
All falsework should be designed. This will vary from the use of simple standard solution tables and graphs, to site-specific design and supporting drawings. Designs should be checked. The designer of the temporary works and the person interpreting the standard solutions are commonly known as temporary works designers.

Statutory responsibilities
Contractors' responsibilities include:

●Preventing the falsework collapsing under load;
●Ensuring that those constructing and dismantling it can carry out their work safely, with particular regard to preventing falls from height; and
●Minimising risks to the health and safety of others who may be working on, or passing by, the construction activity. Risks could arise, for example, from falling materials, wind-blown plywood or scaffold boards, noise and dust.

Protection of the public
When scaffolding operations are in progress the public must be excluded from both the area of work and
a sufficient area around it. Steps to ensure this will include:

- Obtaining a temporary pavement or street closure whilst operations are carried out;
- Undertaking operations in "quiet" hours i.e. early morning, at night or at weekends;
- Incorporating fans, crash decks and "tunnels" as early as possible into a scaffold;
- Erecting barriers and signs and diverting the public away from operations;
- Storing scaffold clips and other loose material safely on the scaffold; and
- Not raising or lowering materials over members of the public or other site workers.

Stability of scaffolds
Each year there are a number of scaffold collapses across the country. To make sure your scaffold does not collapse you should ensure that:-

- The anchors specified to tie a scaffold to a structure are suitable for the base material and that they
- are installed correctly;
- Scaffold anchors or ties are installed as erection work progresses. Conversly, they should not be
- removed too early during dismantling operations;
- More ties will be needed on a sheeted or netted scaffold to ensure its stability;
- Scaffolds are not overloaded with equipment, especially tubes and fitting, during erection or dismantling operations.

Erecting the falsework

Before erection begins a risk assessment should be carried out and a safe system of work developed. A method statement which includes how all the hazards are to be managed should be prepared. This should be read and understood by those doing the work.

To ensure safety, falsework should be stable at all stages of erection and be regularly checked. Only 'Working Drawings' and not 'Preliminary Drawings' should be used. Erectors should know:

●Where to start;
●Whether the equipment supplied is the same as that ordered;
●At what stage checks or permits are required; and
●Whether checks and permits have already been carried out or issued.

Loading

Once complete, all falsework should be inspected and certified as ready for use (a written permit-to-load procedure is strongly recommended). The frequency of subsequent inspections will depend on the nature of the temporary works. They should be carried out frequently enough to enable any faults to be rectified promptly.

Training, supervision and monitoring

Effective training of scaffolders is possibly the most essential factor in preventing accidents on site. In addition, do not forget the importance of monitoring the scaffold contractor. Clients, principal contractors
and others in control should take reasonable steps to ensure that any work being carried out on their site or premises is undertaken safely. Simple steps to take include:

- Checking the training levels of scaffolders and who will supervise them on site; and
- Site monitoring of scaffolders to ensure they follow proper safety standards.

SIGMA COLLEGE OF ARCHITECTURE

Moododu, Anducode Post, Kanyakumari District
Approved by COA & Affiliated to Anna University

CONSTRUCTION TECHNOLOGY

ANNA UNIVERSITY, CHENNAI

AR6013 R - 2013

UNIT - 3

Ar. ARKIP SCODLIN D

2018

OBJECTIVES:

• To study the advancements in construction with concrete for large span structures.
• To familiarize the students with the manufacture, storage and transportation of concrete.
• To inform the various equipment used in the construction industry and the criteria for choice of equipment.
• To familiarize the students with an overview of construction management, planning and Scheduling

OUTCOMES:

At the end of the course, the student should be able to:

- Apply the concepts for large span structures.
- Concepts of construction management, planning and scheduling: apply them with examples.
- Materials storage and equipments for construction to be known before beginning of the work.

REQUIRED READINGS:

1. R. Chudley, Construction Technology, Pearson, 2005.
2. R. Barry, The Construction of Buildings, The English Language Book Society and Crosby Lockwood, Staples, London, 1976.
3. Construction Planning equipment and Methods by RL Peuriboy Tata McGraw Hill, 1979
4. Modern Construction and Management. Frank Harris John Wiley and Sons, 1983.

REFERENCES:

1. National Building Code of India, 2005 (NBC 2005)
2. Frank R. Dagostino, Materials of Construction, Details given Reston Publishing Company, nc. Virginia, 1976.
3. M. Mohsin, Project Planning and Control, Vikas Publishers, New Delhi, 1983
4. Concrete Technology – Theory and Practice, M.S. Shetty, Chand & Co, New Delhi, 2005.
5. Gurcharan Singh, “Building, Planning, Designing and Scheduling”, Standard Publications, 2009.

CONSTRUCTION METHODS AND EQUIPMENT

Construction methods

Construction methods are the ways in which materials are combined to construct the elements of a building. They can be classified according to the mass of the system into heavyweight and lightweight construction.

Heavyweight construction

Characteristics of heavyweight construction include:

- Excellent durability
- Low maintenance
- Good thermal mass
- Most suited to climates with a large diurnal (day/night) temperature range

Lightweight construction

Characteristics of lightweight construction include:

- Less durable than heavyweight construction
- Higher maintenance required than heavyweight construction
- Greater responsiveness to outdoor temperature changes – this can be beneficial by cooling
- More rapidly at night in warmer climates

Heavy **equipment** refers to heavy duty vehicles, specially designed for executing construction tasks, most frequently ones involving earthwork operations. They are also known as heavy machines, heavy trucks, construction equipment, engineering equipment, heavy vehicles, or heavy hydraulics. They usually comprise five equipment systems: implement traction, structure, power train, control and information.

Heavy equipment functions through the mechanical advantage of a simple machine, the ratio between input force applied and force exerted is multiplied. Some equipment uses hydraulic drives as a primary source of motion.

Structure

"This system connects components, transmits loads, provides attachment points for implements, and allows the machine to travel over uneven ground. The machine's frame, articulation, and steering for wheeled equipment are the major parts of this system."

A tractor is an engineering vehicle specifically designed to deliver a high tractive effort (or torque) at slow speeds, for the purposes of hauling a trailer or machinery used in agriculture or construction. Most commonly, the term is used to describe a farm vehicle that provides the power and traction to mechanize agricultural tasks, especially (and originally) tillage, but nowadays a great variety of tasks. Agricultural implements may be towed behind or mounted on the tractor, and the tractor may also provide a source of power if the implement is mechanised.

Safety

Agriculture in the United States is one of the most hazardous industries, only surpassed by mining and construction. No other farm machine is so identified with the hazards of production agriculture as the tractor. Tractor related injuries account for approximately 32% of the fatalities and 6% of the nonfatal injuries in agriculture. Over 50% is attributed to tractor overturns. The rollover protection structure and seat belt, when worn, are the most important safety devices to protect operators from death during tractor overturns.

Bulldozers

Bulldozers ~ these machines consist of a track or wheel mounted power unit with a mould blade at the front which is controlled by hydraulic rams. Many bulldozers have the capacity to adjust the mould blade to form an angle dozer and the capacity to tilt the mould blade about a central swivel point. Some bulldozers can also be fitted with rear attachments such as rollers and scarifiers.

The main functions of a bulldozer are:-

1. Shallow excavations up to 300 m deep either on level ground or side hill cutting.

2. Clearance of shrubs and small trees.

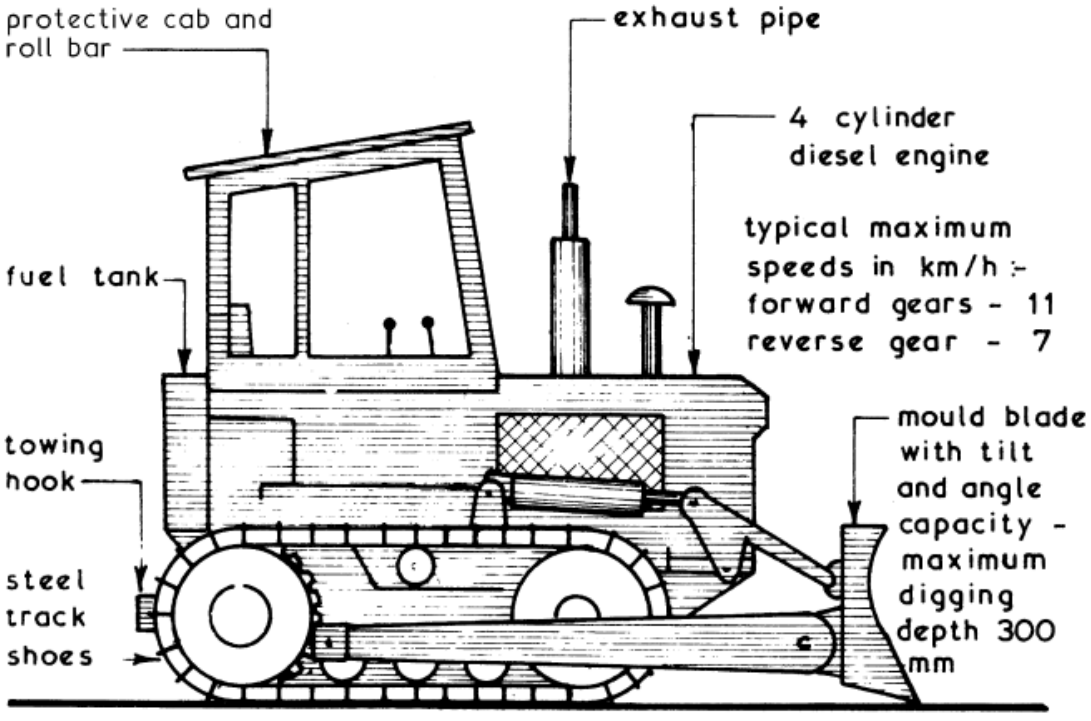
3. Clearance of trees by using raised mould blade as a pusher arm.

4. Acting as a towing tractor.

5. Acting as a pusher to scraper machines (see next page).

NB. Bulldozers push earth in front of the mould blade with some side spillage whereas angle dozers push and cast the spoil to one side of the mould blade.

Typical Bulldozer Details ~



Note: Protective cab/roll bar to be fitted before use.

A bulldozer is a crawler (continuous tracked tractor) equipped with a substantial metal plate (known as a blade) used to push large quantities of soil, sand, rubble, or other such material during construction or conversion work and typically equipped at the rear with a claw like device (known as a ripper) to loosen densely compacted materials.

Bulldozers can be found on a wide range of sites, mines and quarries, military bases, heavy industry factories, engineering projects and farms.

The term "bulldozer" correctly refers only to a tractor (usually tracked) fitted with a dozer blade.

Most often bulldozers are large and powerful tracked heavy equipment. The tracks give them excellent ground holding capability and mobility through very rough terrain. Wide tracks help distribute the bulldozer's weight over a large area (decreasing ground pressure), thus preventing it from sinking in sandy or muddy ground. Extra wide tracks are known as swamp tracks or LGP (low ground pressure) tracks. Bulldozers have transmission systems designed to take advantage of the track system and provide excellent tractive force.

Shovels

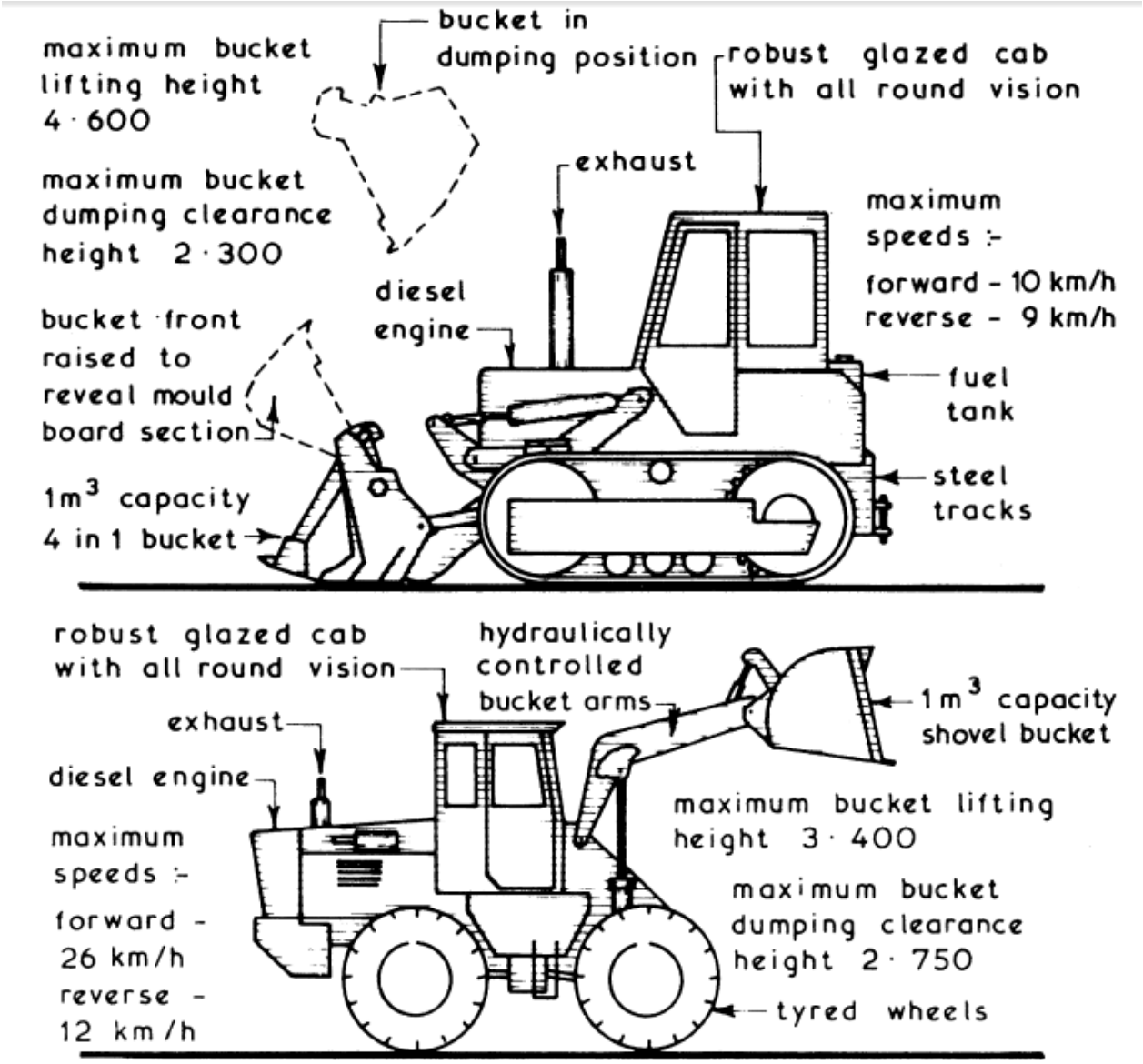
A shovel is a tool for digging, lifting, and moving bulk materials, such as soil, coal, gravel, snow, sand, or ore.

Most shovels are hand tools consisting of a broad blade fixed to a mediumlength handle. Shovel blades are usually made of sheet steel or hard plastics and are very strong. Shovel handles are usually made of wood (especially specific varieties such as ash or maple) or glass reinforced plastic (fibreglass).

Hand shovel blades made of sheet steel usually have a folded seam or hem at the back to make a socket for the handle. This fold also commonly provides extra rigidity to the blade. The handles are usually riveted in place. A T-piece is commonly fitted to the end of the handle to aid grip and control where the shovel is designed for moving soil and heavy materials. These designs can all be easily mass produced.

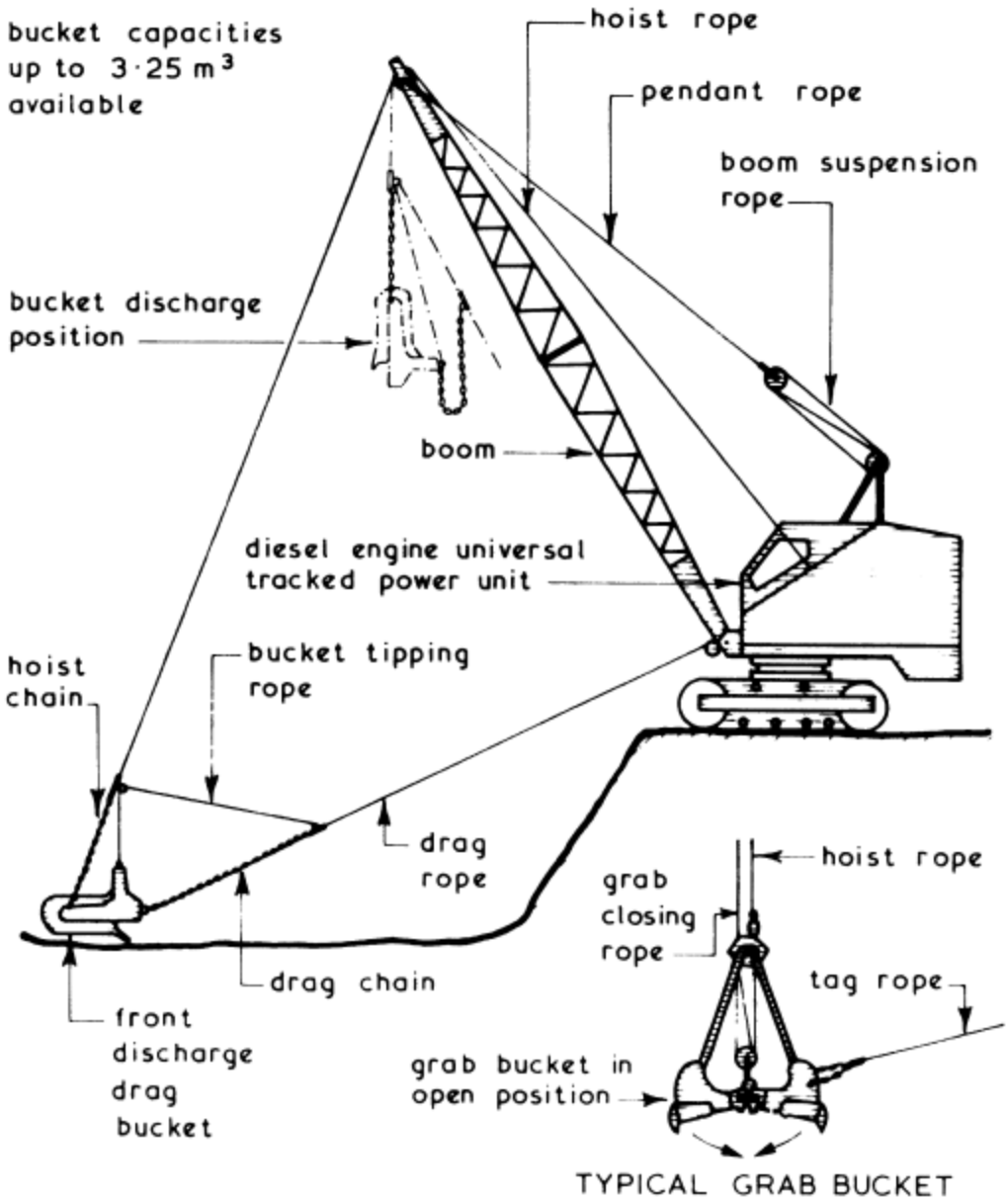
Tractor Shovels

Tractor Shovels ~ these machines are sometimes called loaders or loader shovels and primary function is to scoop up loose materials in the front mounted bucket, elevate the bucket and manoeuvre into a position to deposit the loose material into an attendant transport vehicle. Tractor shovels are driven towards the pile of loose material with the bucket lowered; the speed and power of the machine will enable the bucket to be filled. Both tracked and wheeled versions are available, the tracked format being more suitable for wet and uneven ground conditions than the wheeled tractor shovel which has greater speed and manoeuvring capabilities. To increase their versatility tractor shovels can be fitted with a 4 in 1 bucket enabling them to carry out bulldozing, excavating, clam lifting and loading activities.



Draglines

Draglines ~ these machines are based on the universal power unit with basic crane rigging to which is attached a drag bucket. The machine is primarily designed for bulk excavation in loose soils up to 3„000 below its own track level by swinging the bucket out to the excavation position and hauling or dragging it back towards the power unit. Dragline machines can also be fitted with a grab or clamshell bucket for excavating in very loose soils.



A dragline excavator is a piece of heavy equipment used in civil engineering and surface mining.

Draglines fall into two broad categories: those that are based on standard, lifting cranes, and the heavy units which have to be built onsite.

Most crawler cranes, with an added winch drum on the front, can act as a dragline. These units (like other cranes) are designed to be dismantled and transported over the road on flatbed trailers. Draglines used in civil engineering are almost always of this smaller, crane type. These are used for road, port construction, pond and canal dredging, and as pile driving rigs. These types are built by crane manufacturers such as LinkBelt and Hyster.

A dragline bucket system consists of a large bucket which is suspended from a boom (a large truss like structure) with wire ropes. The bucket is maneuvered by means of a number of ropes and chains. The hoist rope, powered by large diesel or electric motors, supports the bucket and hoist coupler assembly from the boom. The dragrope is used to draw the bucket assembly horizontally. By skillful maneuver of the hoist and the dragropes the bucket is controlled for various operations.

Cableways and belt conveyors

Cableways

Cable transport is a broad class of transport modes that have cables as the foundation for transporting things, people, or vehicles. The cable may be driven or passive; items may be moved by pulling, sliding, sailing, or by drives within the object being moved on cableways. The use of pulleys and balancing of loads going up and down are common elements of cable transport. They are also used in mountainous areas.

Common modes of cable transport are:

Aerial lifts, such as:

Aerial tramway, Chairlift, Funitel, Gondola lift, Ski lift, Zip line

Surface lifts, such as:

Cable car, Cable ferry, Funicular, Surface lift

Vertical lifts, such as: Elevator

Belt conveyors

A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—the conveyor belt—that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley.

There are two main industrial classes of belt conveyors; Those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural materials, such as grain, salt, coal, ore, sand, overburden and more.

Today there are different types of conveyor belts that have been created for conveying different kinds of material available in PVC and rubber materials.

Batching plants - Transit mixers

A concrete plant, also known as a batch plant or batching plant or a concrete batching plant, is equipment that combines various ingredients to form concrete. Some of these inputs include water, air, admixtures, sand, aggregate (rocks, gravel, etc.), fly ash, silica fume, slag, and cement. There are two main types of concrete plants: Dry mix plants and Wet mix plants, and also plants that contain both a transit mix side and a central mix side while utilizing common material storage points. A concrete plant can have a variety of parts and accessories, including: mixers (either tilt drum or horizontal or in some cases both), cement batchers, aggregate batchers, conveyors, radial stackers, aggregate bins, cement bins, heaters, chillers, cement silos, batch plant controls, and dust collectors.

Types

A **Dry mix Concrete Plants**, also known as Transit Mix Plants, weighs sand, gravel and cement in weigh batchers via digital or manual scales. All the ingredients then are discharged into a chute which discharges into a truck. Meanwhile, water is either being weighed or volumetrically metered and discharged through the same charging chute into the mixer truck.

A **Wet mix Concrete Plants**, combines some or all of the above ingredients (including water) at a central location into a Concrete Mixer that is, the concrete is mixed at a single point, and then simply agitated on the way to the jobsite to prevent setting (using agitors or ready mix trucks) or hauled to the jobsite in an open bodied dump truck.

Agitator trucks used for ready mix concrete pumps Guniting equipments

Concrete mixer

A concrete mixer (often mistakenly called a cement mixer) is a device that homogeneously combines cement, aggregate such as sand or gravel, and water to form concrete. A typical concrete mixer uses a revolving drum to mix the components. For smaller volume works portable concrete mixers are often used so that the concrete can be made at the construction site, giving the workers ample time to use the concrete before it hardens. An alternative to a machine is mixing concrete by hand. This is usually done in a wheelbarrow; however, several companies have recently begun to sell modified tarps for this purpose.

Trucks and trailers - Concrete mixing transport trucks

Special concrete transport trucks (in–transit mixers) are made to transport and mix concrete up to the construction site. They can be charged with dry materials and water, with the mixing occurring during transport. They can also be loaded from a "central mix" plant, with this process the material has already been mixed prior to loading. The concrete mixing transport truck maintains the material's liquid state through agitation, or turning of the drum, until delivery. The interior of the drum on a concrete mixing truck is fitted with a spiral blade. In one rotational direction, the concrete is pushed deeper into the drum. This is the direction the drum is rotated while the concrete is being transported to the building site. This is known as "charging" the mixer. When the drum rotates in the other direction, the Archimedes' screw type arrangement "discharges", or forces the concrete out of the drum. From there it may go onto chutes to guide the viscous concrete directly to the job site.

Concreting Plant

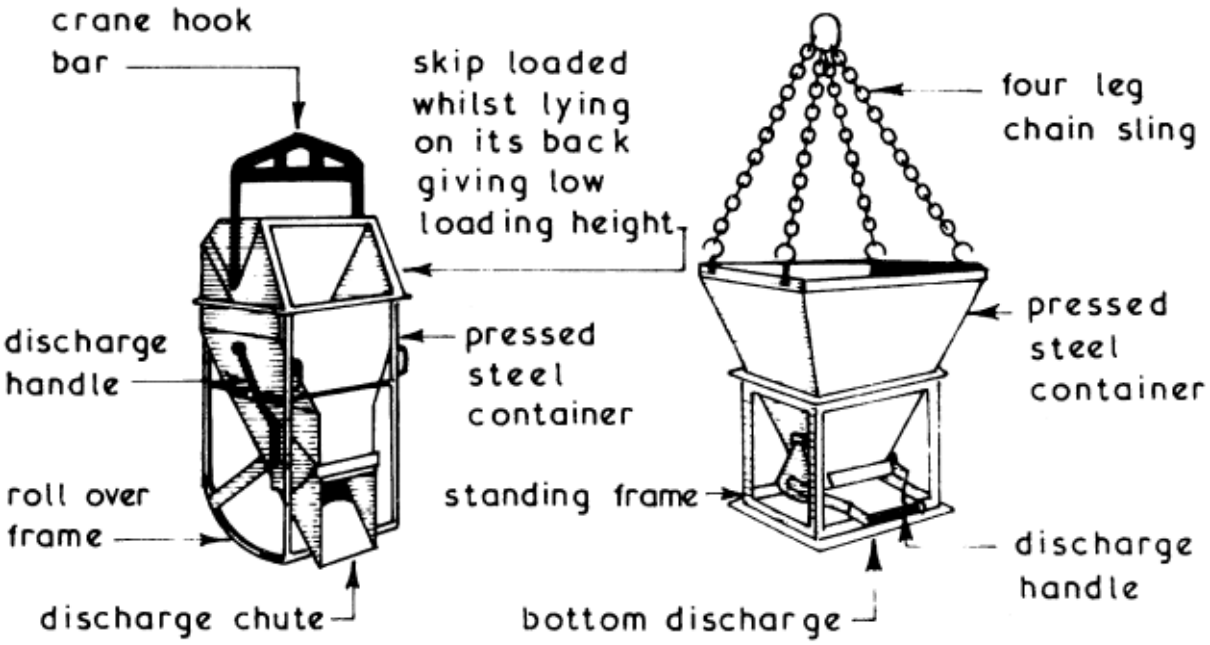
Concreting ~ this site activity consists of four basic procedures

1. **Material Supply and Storage** - this is the receiving on site of the basic materials namely cement, fine aggregate and coarse aggregate and storing them under satisfactory conditions.

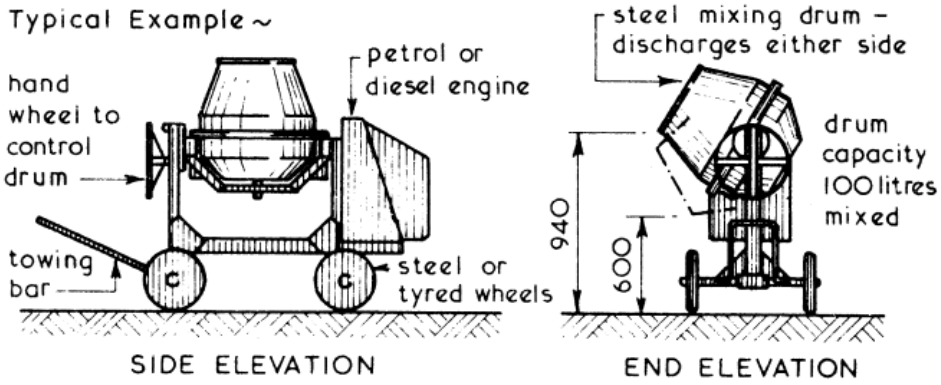
2. **Mixing** - carried out in small batches this requires only simple hand held tools whereas when demand for increased output is required mixers or ready mixed supplies could be used.

3. **Transporting** - this can range from a simple bucket to barrows and dumpers for small amounts. For larger loads, especially those required at high level, crane skips could be used.

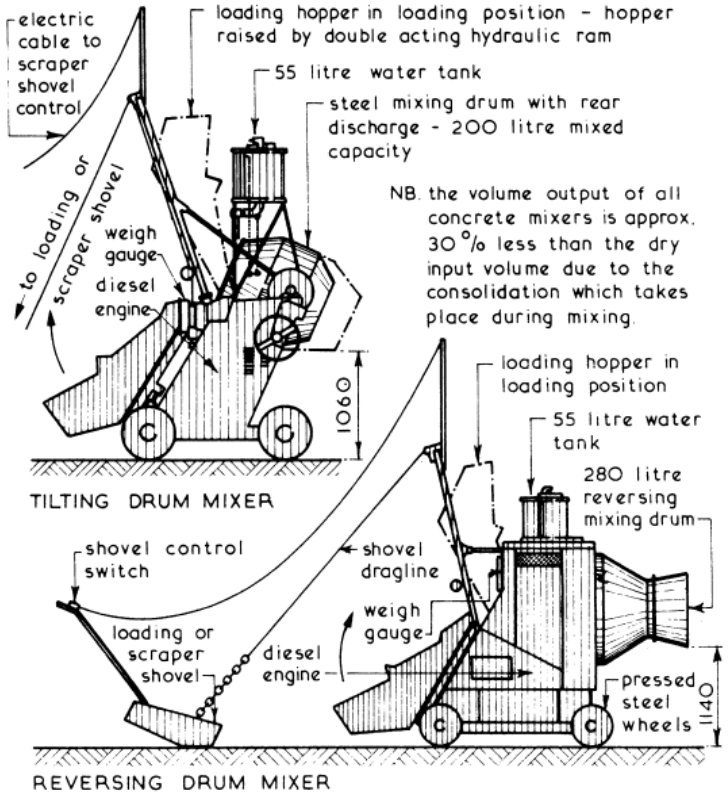
4. **Placing Concrete** - this activity involves placing the wet concrete in the excavation, formwork or mould; working the concrete between and around any reinforcement.



Small Batch Mixers ~ these mixers have outputs of up to 200 litres per batch with wheelbarrow transportation an hourly placing rate of 2 to 3 m3 can be achieved. Most small batch mixers are of the tilting drum type. Generally these mixers are hand loaded which makes the quality control of successive mixes difficult to regulate.

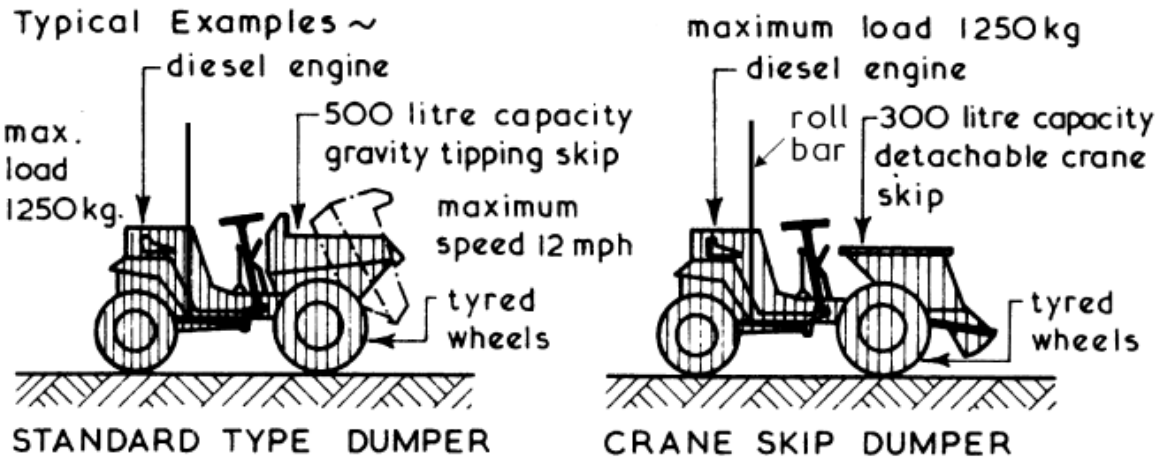


Medium Batch Mixers ~ outputs of these mixers range from 200 to 750 litres and can be obtained at the lower end of the range as a tilting drum mixer or over the complete range as a non-tilting drum mixer with either reversing drum or chute discharge. The latter usually having a lower discharge height. These mixers usually have integral weight batching loading hoppers, scraper shovels and water tanks thus giving better quality control than the small batch mixers. Generally they are unsuitable for wheelbarrow transportation because of their high output.

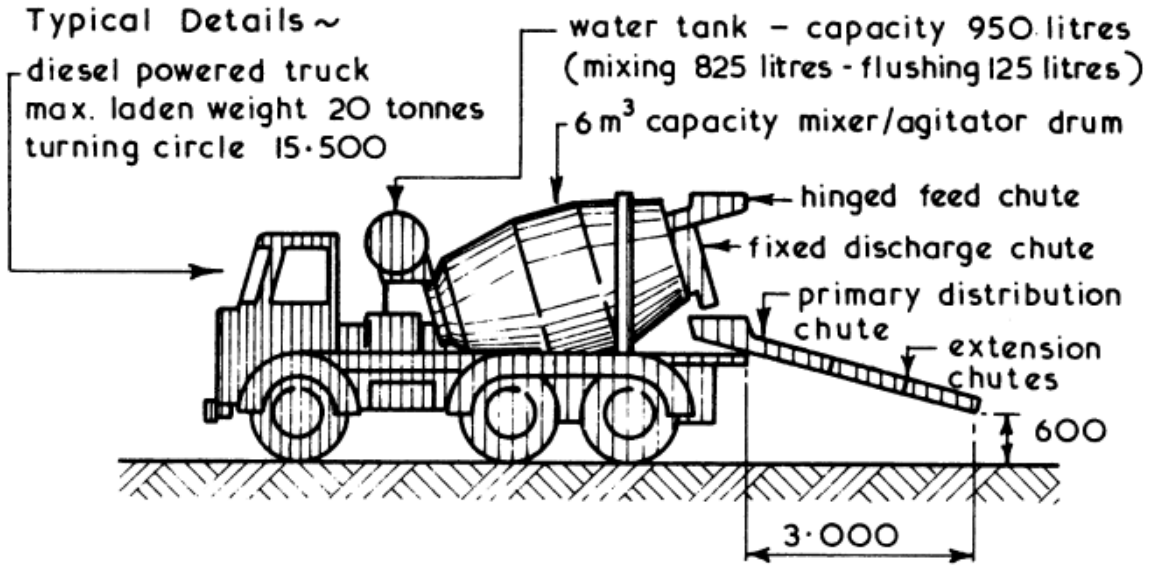


Transporting Concrete ~ the usual means of transporting mixed concrete produced in a small capacity mixer is by wheelbarrow. The run between the mixing and placing positions should be kept to a minimum and as smooth as possible by using planks or similar materials to prevent segregation of the mix within the wheelbarrow.

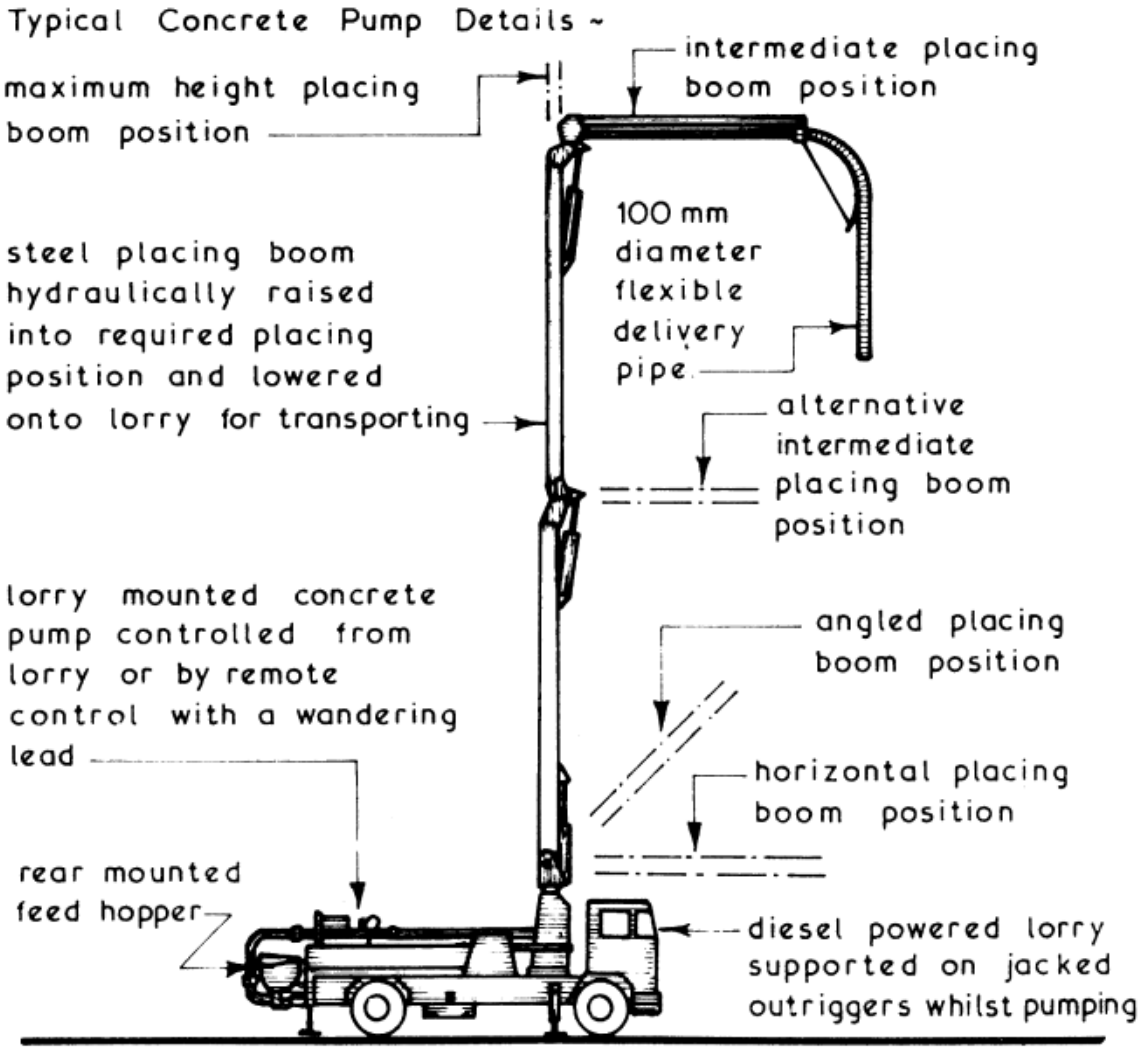
Dumpers ~ these can be used for transporting mixed concrete from mixers up to 600 litre capacity when fitted with an integral skip and for lower capacities when designed to take a crane skip.



Ready Mixed Concrete Trucks ~ these are used to transport mixed concrete from a mixing plant or depot to the site. Usual capacity range of ready mixed concrete trucks is 4 to 6 m3. Discharge can be direct into placing position via a chute or into some form of site transport such as a dumper, crane skip or concrete pump.



Concrete Pumps ~ these are used to transport large volumes of concrete in a short time period (up to 100 m3 per hour) in both the vertical and horizontal directions from the pump position to the point of placing. Concrete pumps can be trailer or lorry mounted and are usually of a twin cylinder hydraulically driven format with a small bore pipeline (100 mm diameter) with pumping ranges of up to 85„000 vertically and 200„000 horizontally depending on the pump model and the combination of vertical and horizontal distances. It generally requires about 45 minutes to set up a concrete pump on site including coating the bore of the pipeline with a cement grout prior to pumping the special concrete mix.



GUNITING EQUIPEMENT

Gunite is also known as shotcrete or pneumatically applied mortar.

Shotcrete is usually an all-inclusive term for both the wet-mix and dry-mix versions.

It can be used on vertical and overhead, as well as on horizontal surface and is particularly useful for restoring surfaces spelled due to corrosion of reinforcement.

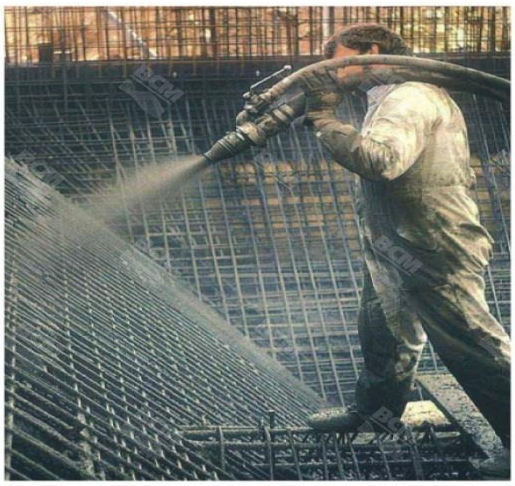
Gunite is a mixture of Portland cement, sand, and water, shot into the place by compressed air.

THE PROCEDURE OF GUNITING

The cement is mixed with slightly moist sand and then necessary water is added as the mixture comes out from the cement gun.

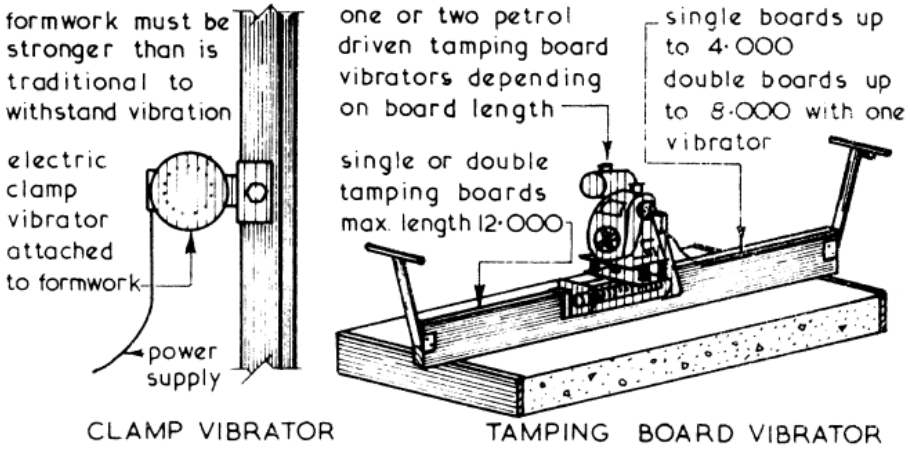
A regulating valve is provided to regulate the quantity of water.

The nozzle of gun is generally kept at a distance of about 750 mm to 850 mm from the surface to be treated and the velocity of nozzle varies from 120 to 160 m/sec.

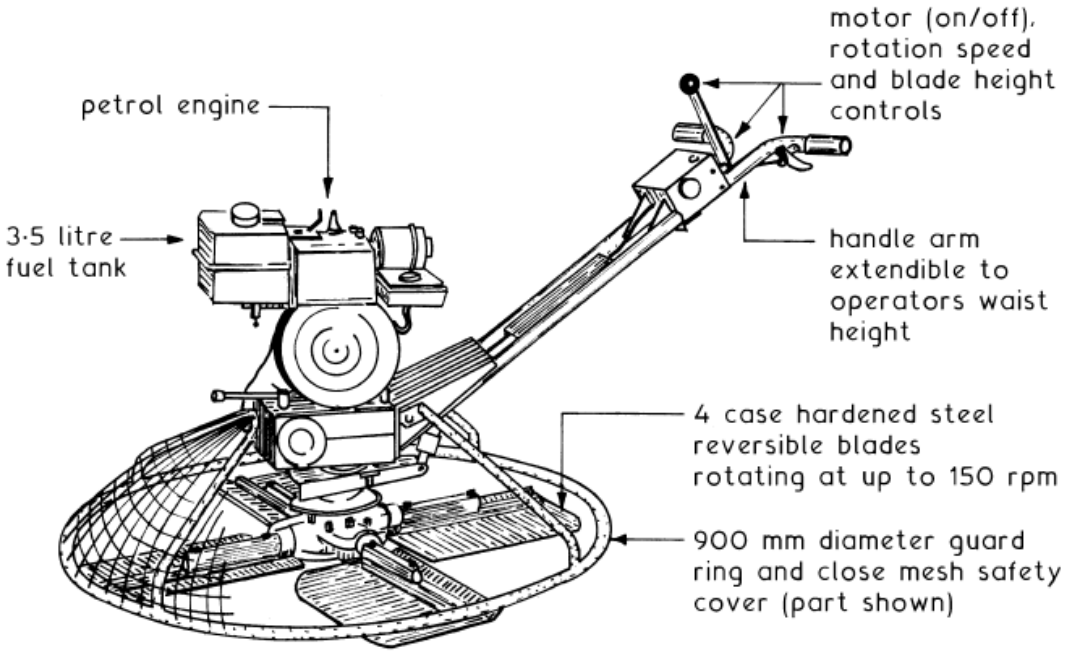


Placing Concrete ~ this activity is usually carried out by hand with the objectives of filling the mould, formwork or excavated area to the correct depth, working the concrete around any inserts or reinforcement and finally compacting the concrete to the required consolidation. The compaction of concrete can be carried out using simple tamping rods or boards or alternatively it can be carried out with the aid of plant such as vibrators.

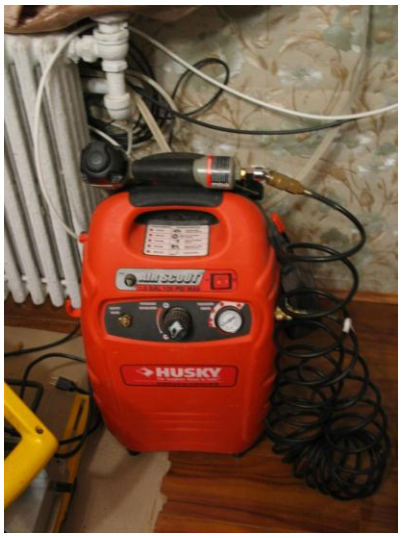
Poker Vibrators ~ these consist of a hollow steel tube casing in which is a rotating impellor which generates vibrations as its head comes into contact with the casing.



Power Float - a hand-operated electric motor or petrol engine, surmounted over a mechanical surface skimmer. Machines are provided with an interchangeable revolving disc and a set of blades. These are used in combination to produce a smooth, dense and level surface finish to in-situ concrete beds.



Air compressors



An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (compressed-air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use.

The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank.

Compressors can be classified according to the pressure delivered:

1. Low pressure air compressors (LPACs), which have a discharge pressure of 150 psi or less

2. Medium pressure compressors which have a discharge pressure of 151 psi to 1,000 psi

3. High pressure air compressors (HPACs), which have a discharge pressure above 1,000 psi

They can also be classified according to the design and principle of operation:

1. Rotary screw compressor

2. Turbo compressor

Welding equipment

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing fusion, which is distinct from lower temperature metal joining techniques such as brazing and soldering, which do not melt the base metal. In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that is usually stronger than the base material. Pressure may also be used in conjunction with heat, or by itself, to produce a weld.

Although less common, there are also solid state welding processes such as friction welding or shielded active gas welding in which metal does not melt.

Some of the best known welding methods include:

Oxy- fuel welding also known as oxyacetylene welding or oxy welding, uses fuel gases and oxygen to weld and cut metals.

Shielded metal arc welding (SMAW) – also known as "stick welding or electric welding", uses an electrode that has flux around it to protect the weld puddle. The electrode holder holds the electrode as it slowly melts away. Slag protects the weld puddle from atmospheric contamination.

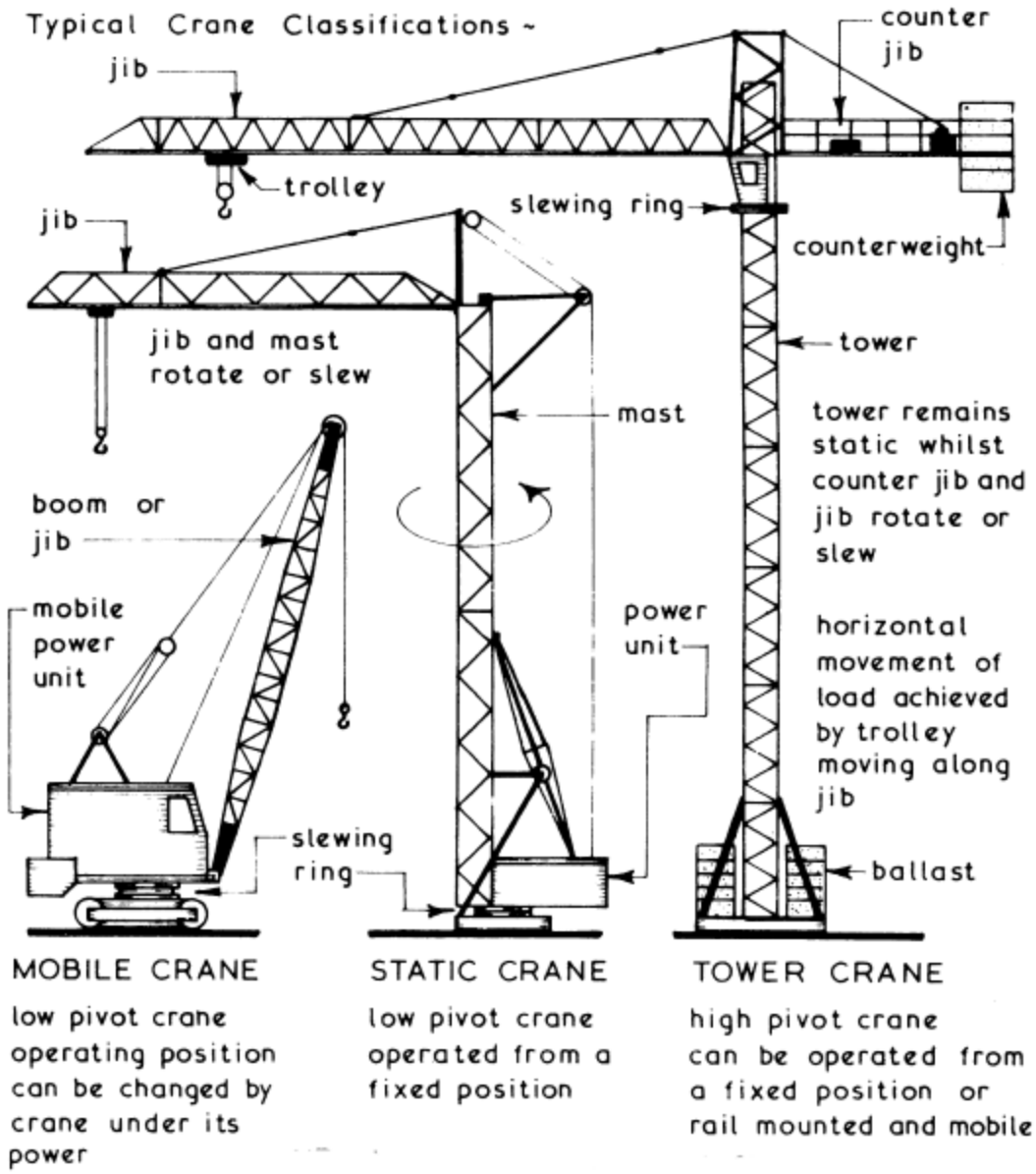
Gas tungsten arc welding (GTAW) – also known as TIG (tungsten, inert gas), uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas such as argon or helium.

Gas metal arc welding (GMAW) – commonly termed MIG (metal, inert gas), uses a wire feeding gun that feeds wire at an adjustable speed and flows an argon based shielding gas or a mix of argon and carbon dioxide (CO2) over the weld puddle to protect it from atmospheric contamination.

Cranes and other lifting devices, Choice of construction equipment for different types of works.

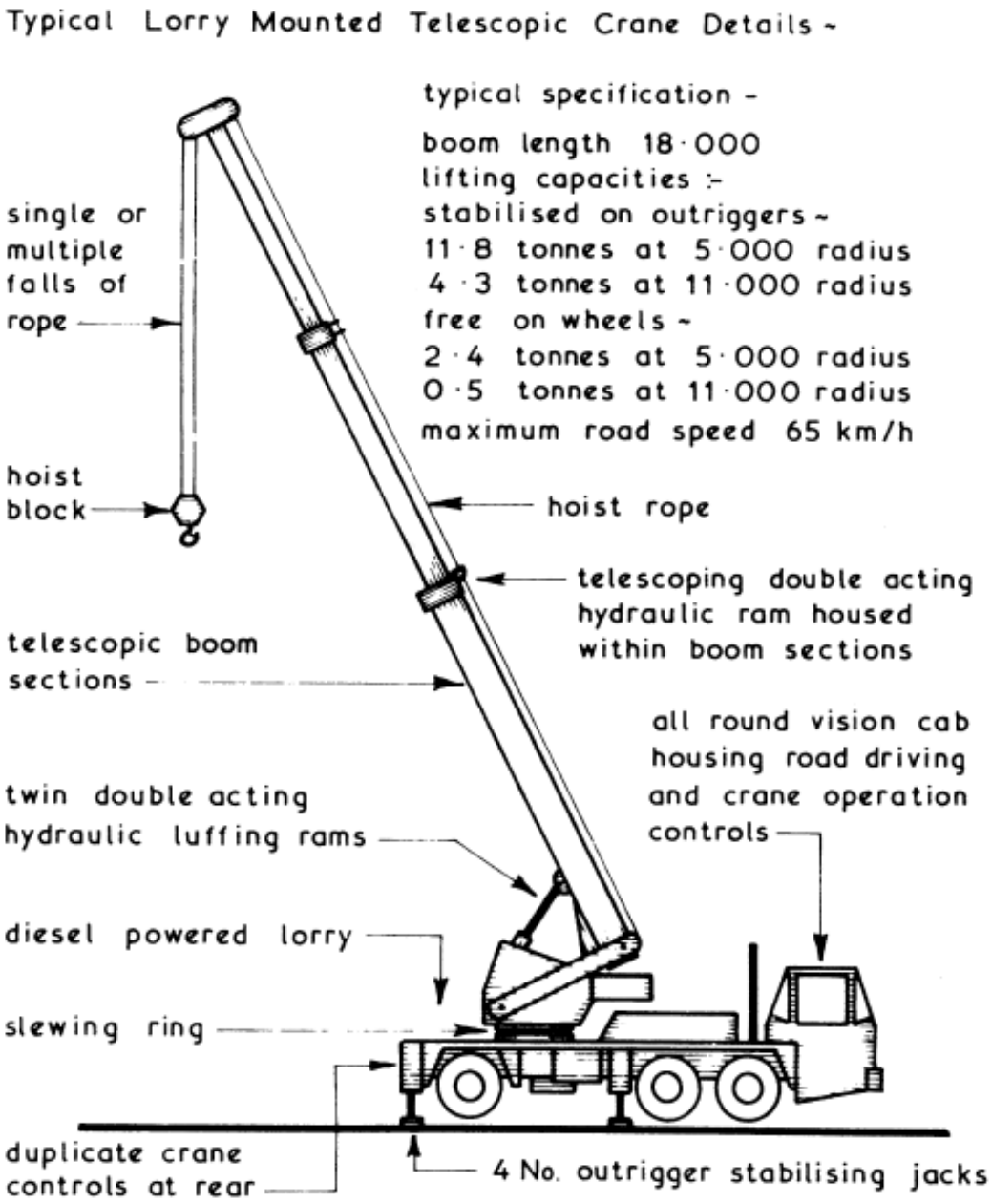
Cranes

Cranes ~ these are lifting devices designed to raise materials by means of rope operation and move the load horizontally within the limitations of any particular machine. The range of cranes available is very wide and therefore choice must be based on the loads to be lifted, height and horizontal distance to be covered, time period(s) of lifting operations, utilisation factors and degree of mobility required. Crane types can range from a simple rope and pulley or gin wheel to a complex tower crane but most can be placed within 1 of 3 groups, namely mobile, static and tower cranes.

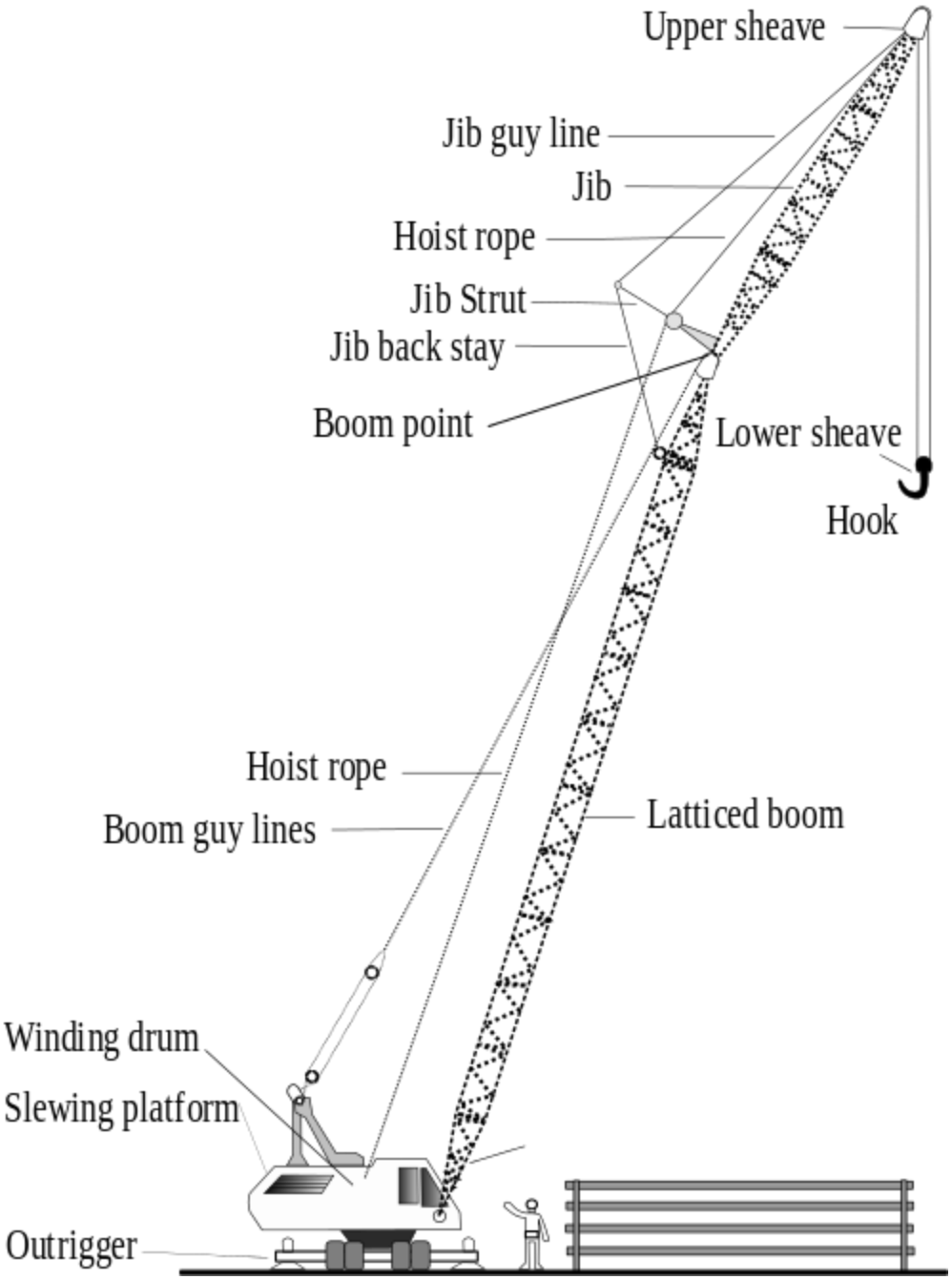


Lorry Mounted Cranes ~ these mobile cranes consist of a lattice or telescopic boom mounted on a specially adapted truck or lorry.

They have two operating positions: the lorry being driven from a conventional front cab and the crane being controlled from a different location. The lifting capacity of these cranes can be increased by using outrigger stabilising jacks and the approach distance to the face of building decreased by using a fly jib. Lorry mounted telescopic cranes require a firm surface from which to operate and because of their short site preparation time they are ideally suited for short hire periods.



A crane is a type of machine, generally equipped with a hoist rope, wire ropes or chains, and sheaves, that can be used both to lift and lower materials and to move them horizontally. It is mainly used for lifting heavy things and transporting them to other places. The device uses one or more simple machines to create mechanical advantage and thus move loads beyond the normal capability of a human. Cranes are commonly employed in the transport industry for the loading and unloading of freight, in the construction industry for the movement of materials, and in the manufacturing industry for the assembling of heavy equipment.



SIGMA COLLEGE OF ARCHITECTURE

Moododu, Anducode Post, Kanyakumari District
Approved by COA & Affiliated to Anna University

CONSTRUCTION TECHNOLOGY

ANNA UNIVERSITY, CHENNAI

AR6013 R - 2013

UNIT - 4

Ar. ARKIP SCODLIN D

2018

OBJECTIVES:

• To study the advancements in construction with concrete for large span structures.
• To familiarize the students with the manufacture, storage and transportation of concrete.
• To inform the various equipment used in the construction industry and the criteria for choice of equipment.
• To familiarize the students with an overview of construction management, planning and Scheduling

OUTCOMES:

At the end of the course, the student should be able to:

- Apply the concepts for large span structures.
- Concepts of construction management, planning and scheduling: apply them with examples.
- Materials storage and equipments for construction to be known before beginning of the work.

REQUIRED READINGS:

1. R. Chudley, Construction Technology, Pearson, 2005.
2. R. Barry, The Construction of Buildings, The English Language Book Society and Crosby Lockwood, Staples, London, 1976.
3. Construction Planning equipment and Methods by RL Peuriboy Tata McGraw Hill, 1979
4. Modern Construction and Management. Frank Harris John Wiley and Sons, 1983.

REFERENCES:

1. National Building Code of India, 2005 (NBC 2005)
2. Frank R. Dagostino, Materials of Construction, Details given Reston Publishing Company, nc. Virginia, 1976.
3. M. Mohsin, Project Planning and Control, Vikas Publishers, New Delhi, 1983
4. Concrete Technology – Theory and Practice, M.S. Shetty, Chand & Co, New Delhi, 2005.
5. Gurcharan Singh, “Building, Planning, Designing and Scheduling”, Standard Publications, 2009.

CONSTRUCTION TECHNOLOGY FOR HIGHRISE BUILDINGS

The key element technologies of skyscrapers are construction of mega mat foundation delivering architectural load into the ground, structural system optimization, high-rise building measurement technology, and construction equipment technology, etc.
For smooth construction, it is necessary to have experts who can manage technologies from material to maintenance, and apply them to the work. For example,

1) Material technology for high performance concrete and high-strength structural steel,
2) Construction technology for short construction cycle compared to scale,
3) Special equipment management skills such as tower crane, hoist and super high pressure pump etc.,
4) Structural technologies such as lateral load resisting system and column shortening analysis,
5) IT technologies such as PMIS, REIT, GPS system,
6) Design skills for complex use and special structure,
7) Highly advanced facilities and elevators,
8) Maintenance and Management for green energy technology.

Planning and scheduling for high rise building

Schedule

In project management, a schedule is a listing of a project's milestones, activities, and deliverables, usually with intended start and finish dates. Those items are often estimated by other information included in the project schedule of resource allocation, budget, task duration, and linkages of dependencies and scheduled events. A schedule is commonly used in the project planning and project portfolio management parts of project management. Elements on a schedule may be closely related to the work breakdown structure (WBS) terminal elements, the Statement of work, or a Contract Data Requirements List.

Planning and scheduling

In a traditional approach, a project can be completed in a sequence of steps. They are distinguished in five developed components.

- Beginning Phase
- Planning and Designing Phase
- Execution and Construction Phase
- Monitoring and Controlling Phase
- Completion Phase

It was common practice that most of the small scale construction organizations in India use Microsoft Excel by representing main categories of summaries of activities. Unique colors will be chosen for representing the process of activities, this lead to confusion and complexity in execution of structural activities. Sample representation of activities in Microsoft Excel is represented in

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2				2015								2016			
3		S. NO	Particulars	MAY	JUNE	JULY	AUGUST	SEP	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL
4		A	G+8												
5															
6		1	Initiation												
7															
8		2	Foundation												
9															
10		3	Plinth												
11															
12		4	Super Structure												
13															
14															

Figure 1 Sample representation of activities in Microsoft Excel

METHODOLOGY

Phase – 1:
• Site Supervision
• Observations at site
• Labour productivity

Phase – 2:
• Study of drawings
• Constructability checks

Phase – 3:
• Basic ideas in the improvement of construction plan
• Planning activities
• Work Breakdown Structure (WBS)
• Scheduling activities

PHASE – 1

Site Supervision

Site supervision includes the understanding of the site and working conditions at the project location. In this activity, one should get to know the various works that are being executed at the site, the degree of quality that is being followed, safety aspects, organization structure, rules, policies adopted etc.
Generally, inspection persons should create certain that every of the subsequent things is followed to:
a) That all workmanship and material are in unity with the specifications and the suitable good practice;
b) The quality control testing of material is at standard level of workmanship; and
c) That all works are to be in accordance with the equal, alignment, dimension, and cross sections as identified in construction drawings and specifications.

Observation at the site
Material required
Labour required
Tools, Plant and machinery required
Site conditions and surrounding environment
Estimating activity duration
Labour productivity

Table 1 Productivity observed on site conditions

S. No	Description of work	Rate/Man-hours	Comments
1	Formwork	5 Sq.m	Incorrect
2	Cement Plaster	2.31 Sq.m	Incorrect
3.	Concreting (Columns & Shear walls)	0.2 Cu.m	Correct
4	Concreting (Beams& Slab)	0.89 Cu.m	Correct
5	Gypsum plaster	2.24 Sq.m	Incorrect
6	Brickwork	0.7 Cu.m	Correct
7	Laying Reinforcement (Beams & slab)	1.48 Kgs	Correct
8	Laying of floor tiles	1.5 Sq.m	Correct
9	Bar bending (stirrups)	57.44 Kg	Incorrect

Table 2 Actual productivity at the site

S. No	Description of work	Rate/Man-hours
1	Formwork	2 - 6 Sq.m
2	Cement Plaster	5 - 10 Sq.m
3.	Concreting (Columns & Shear walls)	0.2 Cu.m
4	Concreting (Beams& Slab)	0.89 Cu.m
5	Gypsum plaster	10 - 12 Sq.m
6	Brickwork	24 Cu.m
7	Laying Reinforcement (Beams & slab)	10 - 15 Kgs
8	Laying of floor tiles	7 - 10 Sq.m
9	Bar bending (stirrups)	12 – 18 Kg

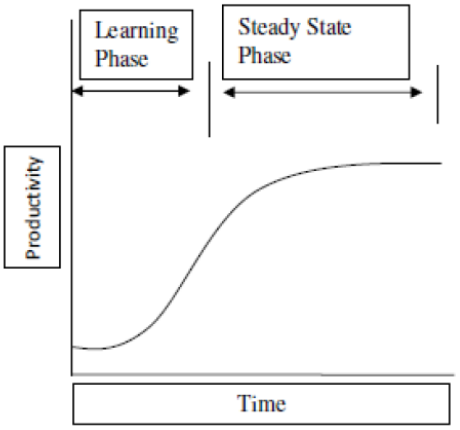


Figure 2 Illustration of Productivity Changes Due to Learning

PHASE – 2

Study of drawings

Study of drawings plays a significant role in the planning of activities. In this course of action, various drawings are identified like Superstructure architectural drawings, Structural drawings, Tile floor layout plan, Door & window schedule, Internal drawings, Reflected ceiling plan, MEP drawings etc. This study helps to recognize the various activities involved in delivering a project. In this course of study of drawings, firstly, all the activities are recognized and then the sequential order of the activities is deduced. This helps to identify the inter-dependency of the activities and its associated trade. This sequential inference of the activities helps in constructing a WBS which is to be adopted for the successful completion of the project.
By the study of drawings, not only the sequence of activities is known but also the various materials required, trades involved and special agencies (like water proofers) to be employed can be identified. Some of the details inferred from the study of drawings are

• Site grade elevation, finish floor level, and building location footprints coordinated with the other disciplines are identified.
• Geometrical information of various items used is known.
• The sequence of zoning can be deduced.
• Coordination of MEP drawings with civil drawings is known.

Constructability checks

Constructability is a project management procedure to analyze construction process from start to finish, during the pre-construction level. It is to spot the difficulties before a project is truly constructed to cut back or stop errors, cost overruns, and delays.

PHASE – 3

Planning of activities

• List out all the activities included in the project.
• Identify the total time required for project completion.
• Identify the individual time required for each activity.
• Make adjustments based on project deadlines.
• Estimation of resources.
• Allocate resources for all the activities.
• Next leveling of the resources should be done.
• Estimating cost and effort.
• Based on the plan generated squeezing/relaxing of the resources should be done.
• Identify milestones within the project element.
• Identify separate projects or sub- projects between the milestones.
• Identify the interfaces between projects or sub- projects.
• Identify the information requirement for each of these events, projects, sub etc.
• Identify the highest responsibility levels requiring the information.

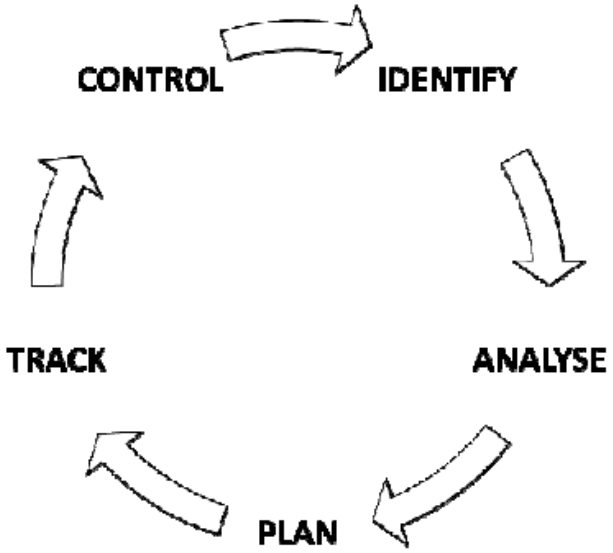


Figure 3 Risk Management Paradigm

WBS (Work Break-Down Structure)

WBS is defined as "deliverable-focused, hierarchical grouping of project elements that organizes and defines the total project scope".

Deliverables are tangible, measurable parts of a project which cannot be further broken- down Task is not a WBS element but a set of tasks produce a deliverable. Some of the last WBS elements could be tasks, but most probably it is not considered.

Table 3 Phases and criteria in WBS

Level	Description	Criteria
1	Sub-project phase	A self-determining, deliverable end product requiring processing of multi-tasking having large volume of work
2	Task phase	A recognizable and deliverable major work comprising one or more work packages
3	Work package phase	A sizeable, recognizable, measure, cost-able and manageable work item/package of activities
4	Activity phase	Recognizable lower level jobs, operations or process, which consumes time and resources
5	Operations phase	A lowest day-to-day tasks, or process which is part of an activity

In general, a Project is broken down into various sub-projects or breaking down the project into various levels of deliverables until it reaches single deliverable.

WBS can be broken down in many ways depending on the requirement of the project. Of such, creating a WBS based on trade (which has been followed traditionally over the past years) is shown in the Figure

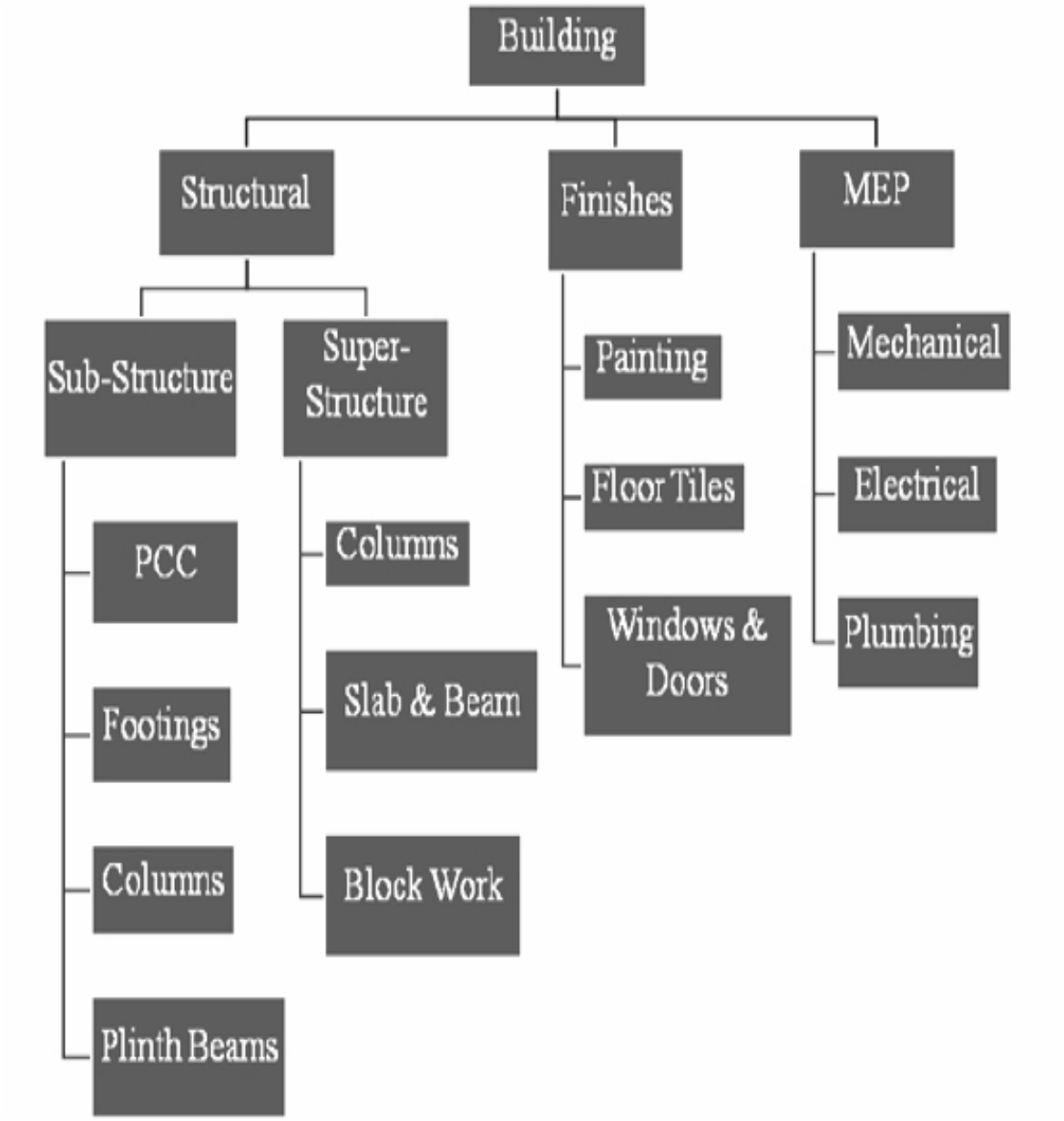


Figure 4 WBS of a building

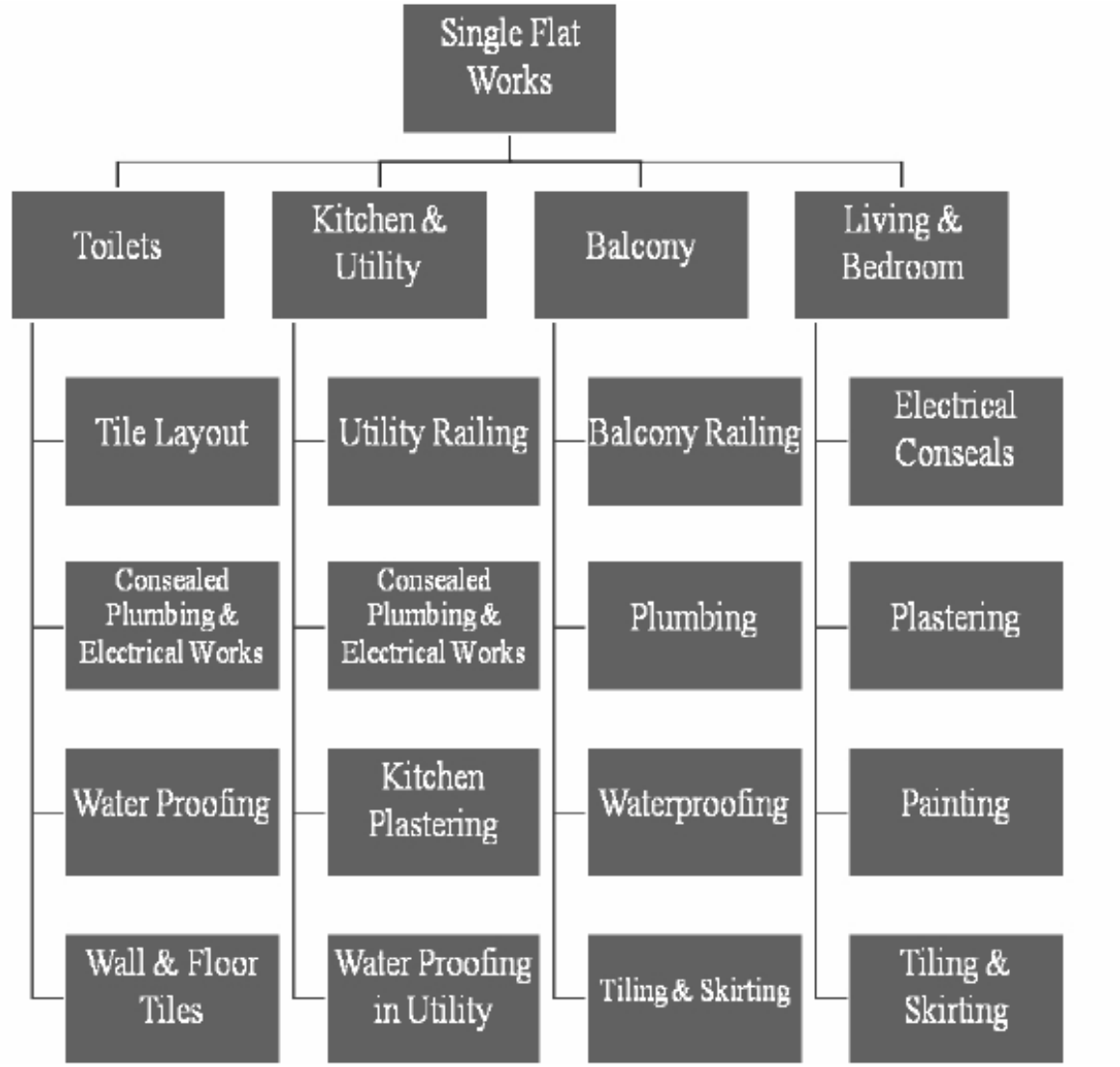


Figure 5 WBS of a single flat works

Scheduling of activities

The Schedule links the scope, work estimates, and deadline into a network of sequential tasks.

- Must Manage: Parallelism (tasks can be undertaken at the same time)
- Dependency (task has an effect on succeeding tasks)

Tools and techniques for Scheduling

- Critical Path Method (CPM).
- Work Breakdown Structure (WBS)
- Gantt Chart

Simulation

SIMULATION OF CONSTRUCTION PLANNING OR HIGH-RISE RC BUILDINGS

There are a variety of practical methods applicable to the process-planning phase of construction work. An increasing trend in developing construction work plans to consider the repetitive type of work, where the site work requires repetitive application of the same work process, particularly in such aspects as the need to suit the high-rise building construction or the mass construction of housing complexes.

With a simulation system for better planning and managing the work and processes of construction projects using a computer-aided support tool,

PROCESS SIMULATION SYSTEM

The system being introduced hereunder is a construction system simulation system by which the process to reduce time span needed for the any standard floor pattern work-cycle can be logically calculated electronically. It considers on-going quantitative changes in required materials and the accumulating learning effect. Also, it has a process-adjusting function that purposely incorporates overtime work. It can also evaluate the work plan through use of such data as balance loss and indices of working smoothness and leveling of labor fluctuation.

Simulation System Structure

The software used in our basic system is MS Excel for the spreadsheet program, combined with MS Project as the project management software. As shown in Fig, its nucleus is a database covering information about construction materials to be used, specific work items and required workforce. Visual Basic for Applications software is used in automating spreadsheet operation.

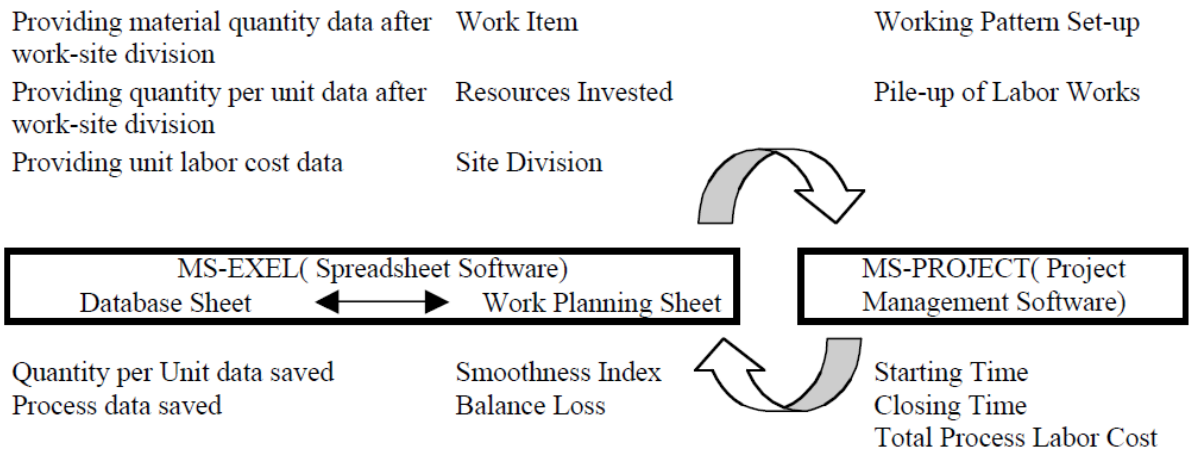


Fig. 1 The Structural Sketch of the Simulation System

Simulation Flow

STEP 1: Developing the Database
STEP 2: Work Plan
STEP 3: Preparing Work-process Chart for Each Floor
STEP 4: Work-process Adjustment
STEP 5: Work-process Planning
STEP 6: Work-process Evaluation
STEP 7: Analysis of the Final Results

SIMULATION APPLIED TO ACTUAL BUILDING CONSTRUCTION

Based on the actual data accumulated in the system, the construction process of the basic floor is simulated so as to validate and analyze the system itself in specifying

1) The effect of reducing the cycle term for each of the four Work Patterns;
2) process evaluation in terms of labor cost increase/decrease for overtime work;
3) process evaluation as reflected in Balance Loss and Smoothness Index;
4) evaluation of optimum planning of work-process.

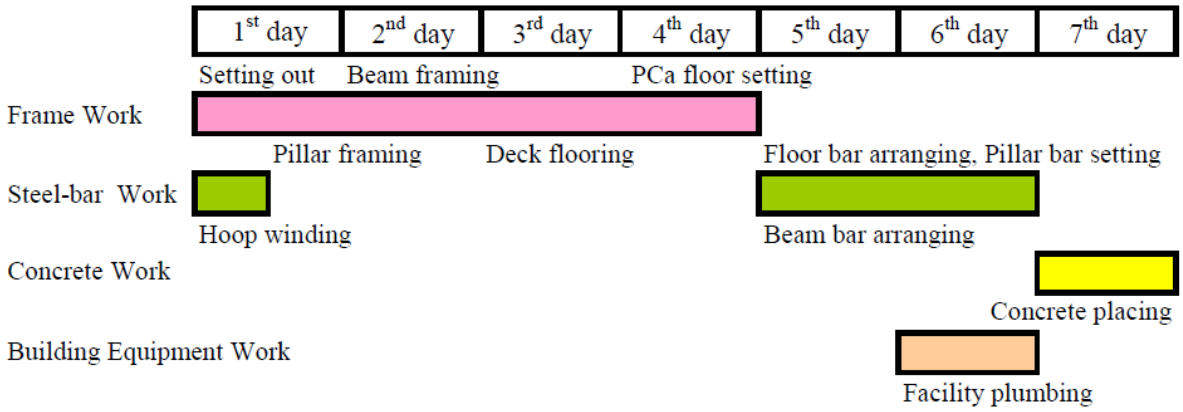


Fig. 3 Cycle Term Process

Table 3 Labor Work & Cost Data

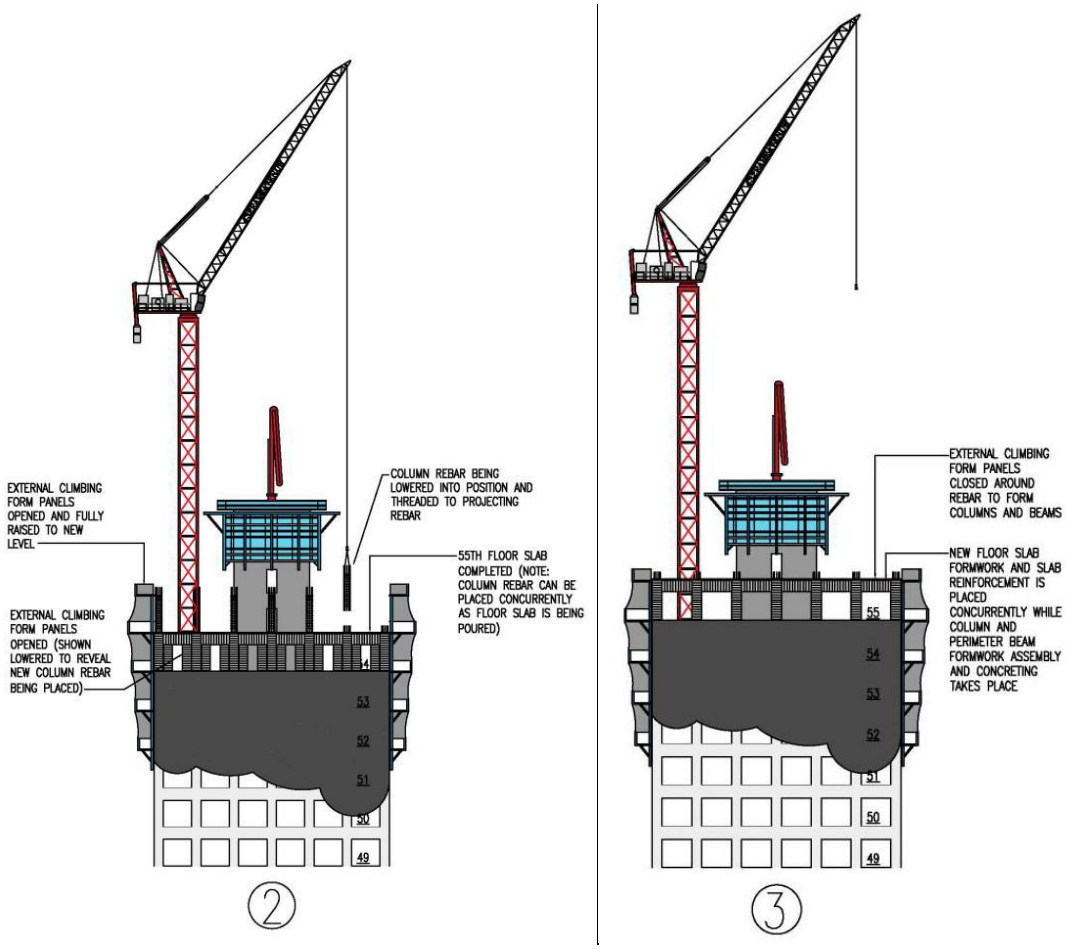
Type of Work	Learning Ratio (%)	Average Daily Attendance (Person)	Unit Labor Cost ••|´/person/day•	Unit Overtime Cost • ´/person/hour••
Framing Work	85	15	19,200	3,000
Steel Bar Work	85	12	18,900	2,900
Scaffold Work	95	8	18,400	2,800
Concrete Work	95	8	18,600	2,900

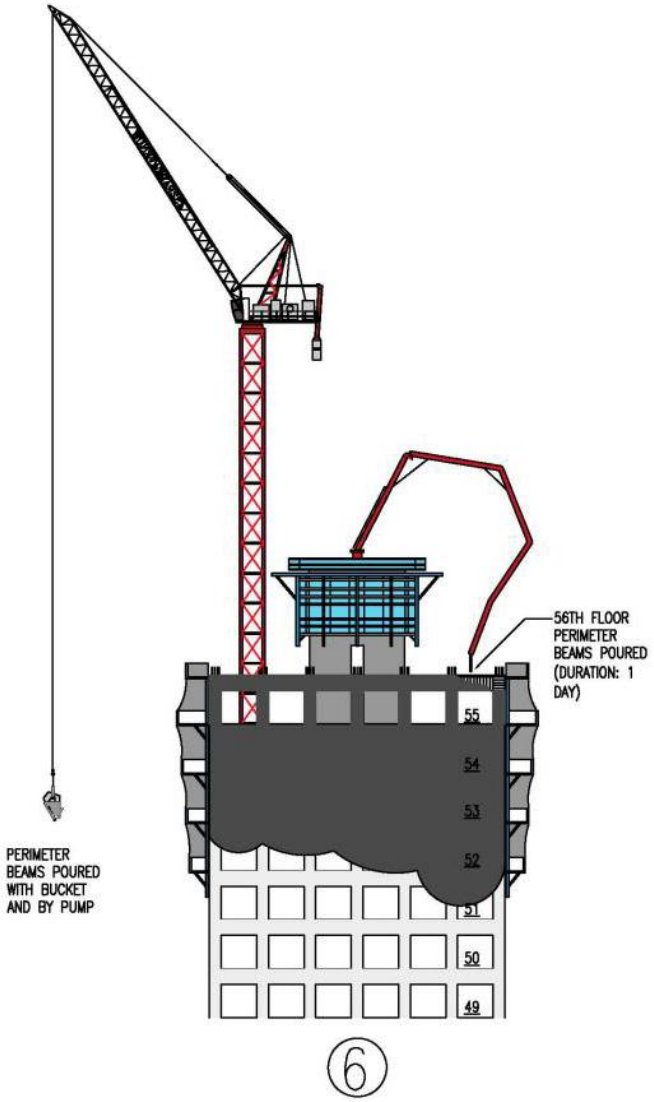
Typical Floor Construction Cycle

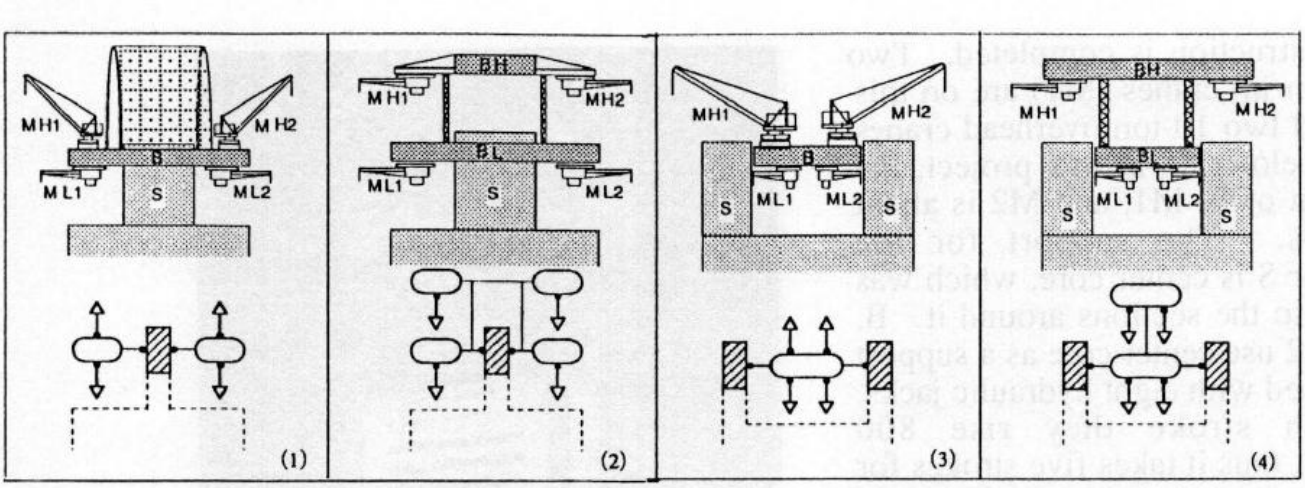
Totally Mechanized Construction System for High-Rise Buildings (T-UP System)

To totally mechanize construction work in building production, particularly through the introduction of robots, construction methods that can be carried out by machines must be developed. In developing new construction methods, the characteristics of construction machinery must be carefully considered, and new machines and materials must be developed. Mechanized construction is most effective in the construction of building superstructures built of large and heavy materials.

To maximize the efficiency of mechanized construction, a continuous cycle of transportation and assembly with each type of member must be used to build superstructures. Through repetitions of this cycle, it should be possible to build superstructures quickly and without interruption.







S : Support for Base B : Base for Manipulator M : Manipulator

Figure 2. Variations of the T-UP System

Details of the Application of the T-UP SYSTEM

With T-Up System, the top floor is constructed on the ground and used as the support for the manipulator base. As the superstructure is assembled, this support is raised with machines such as overhead cranes and jib cranes. The overhead cranes are installed below the support and the jib cranes are installed above it. The key concept of the T-UP System is to use the superstructure as a production apparatus to the fullest possible extent.. To realize this, the top floor (hat truss) is used as a production platform. The platform weighs about 2,000 tons and can be raised automatically by remote control from the central control room; it can kept within 5 mm difference of level as it is raised. By controlling the platform in this way, the superstructure construction cycle can quickly advance.

High-Speed Construction

The biggest advantage of the T-UP System is the shortening of the construction period, a one floor per three days construction cycle has been established, which means that the hat truss climbs every three days.

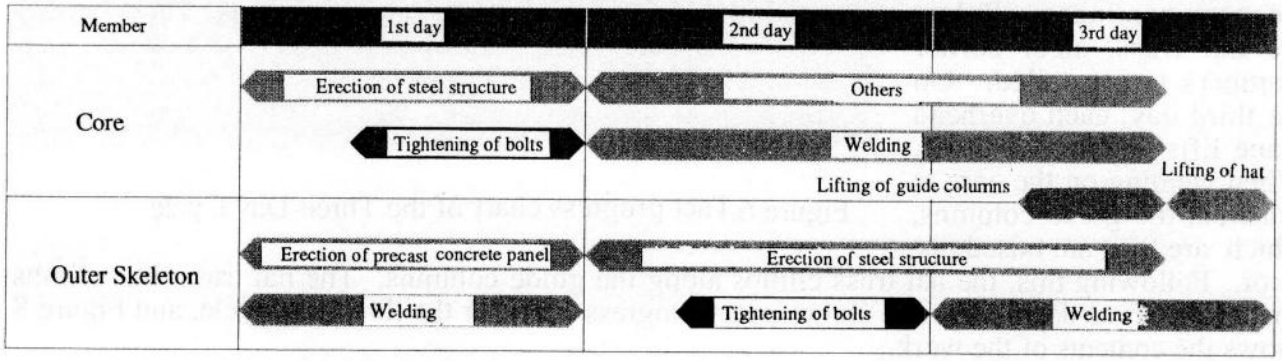


Figure 7. Progress Chart of the Three-Day Cycle

Appropriate working schedule.

High-rise buildings are commonly built in densely populated countries or urban areas. A balanced floor construction cycle is critical for construction of the frame structures. The objectives in scheduling the floor cycle are to ensure smooth flows of resources and to optimise the use of formwork and other materials. The floor area is usually divided into zones to allow the labour force and formwork materials moving between zones. The preparation of the floor construction cycle would therefore be a resources allocation exercise. However, the process is complex and difficult when it is done manually. Floats are created deliberately in the schedule to ensure the balance in resources and to provide buffers. Simulation that can demonstrate the real world operations is an effective tool in handling this scheduling problem.

TYPICAL FLOOR CONSTRUCTION CYCLE

In the construction of a high-rise building, one of the planning objectives is to ensure the early completion of the structural frames to generate floor areas for the execution of finishing works, building services installation and internal fitting out. The completion of the structural frames is therefore critical in the overall programme.

For a building of 42-storeys high, it may consist of 40 typical floors resting on two podium floors. It is not surprised to have construction programme aiming at a 2-day or 4-day cycle for the typical floors. It would be a time-cost trade off problem in determining the duration for a project in project-wise considerations or in selecting construction methods for major construction activities. Planning engineers have to balance the resources inputs and the duration for activities in order to ensure a smooth flow of work sequences in meeting the project duration.

The simulation results generated show that the duration for the floor cycle could be shortened by 25% to 37%. The shortening is achieved by reducing the idling time of the resources. In deciding the duration of the floor cycle, planning engineers have to consider the project budget because additional overtime costs for labour would be incurred. The simulation results could provide useful information for planners to decide upon their strategies in scheduling a typical floor construction cycle at different stages of the project.

ARCHITECTURE SCHEDULE - (COA India)

1. Taking Client's instructions and preparation of design brief.
2. Site evaluation, analysis and impact of existing and / or proposed development on its immediate environs.
3. Design and site development.
4. Structural design.
5. Sanitary, plumbing, drainage, water supply and sewerage design.
6. Electrical, electronic, communication systems and design.
7. Heating, ventilation and air conditioning design (HVAC) and other mechanical systems.
8. Elevators, escalators, etc.
9. Fire detection, Fire protection and Security systems etc.
10. Periodic inspection and evaluation of Construction works.

ALLIED FIELDS

1. Landscape Architecture
2. Interior Architecture
3. Architectural Conservation
4. Retrofitting of Buildings
5. Graphic Design and Signage

ARCHITECT SCHEDULE OF SERVICES

CONCEPT DESIGN	[STAGE 1]
PRELIMINARY DESIGN AND DRAWINGS	[STAGE 2]
DRAWINGS FOR CLIENT'S/ STATUTORY APPROVALS	[STAGE 3]
WORKING DRAWINGS AND TENDER DOCUMENTS	[STAGE 4]
APPOINTMENT OF CONTRACTORS	[STAGE 5]
CONSTRUCTION	[STAGE 6]
COMPLETION	[STAGE 7]

SIGMA COLLEGE OF ARCHITECTURE

Moododu, Anducode Post, Kanyakumari District
Approved by COA & Affiliated to Anna University

CONSTRUCTION TECHNOLOGY

ANNA UNIVERSITY, CHENNAI

AR6013 R - 2013

UNIT - 5

Ar. ARKIP SCODLIN D

2018

OBJECTIVES:

• To study the advancements in construction with concrete for large span structures.
• To familiarize the students with the manufacture, storage and transportation of concrete.
• To inform the various equipment used in the construction industry and the criteria for choice of equipment.
• To familiarize the students with an overview of construction management, planning and Scheduling

OUTCOMES:

At the end of the course, the student should be able to:

- Apply the concepts for large span structures.
- Concepts of construction management, planning and scheduling: apply them with examples.
- Materials storage and equipments for construction to be known before beginning of the work.

REQUIRED READINGS:

1. R. Chudley, Construction Technology, Pearson, 2005.
2. R. Barry, The Construction of Buildings, The English Language Book Society and Crosby Lockwood, Staples, London, 1976.
3. Construction Planning equipment and Methods by RL Peuriboy Tata McGraw Hill, 1979
4. Modern Construction and Management. Frank Harris John Wiley and Sons, 1983.

REFERENCES:

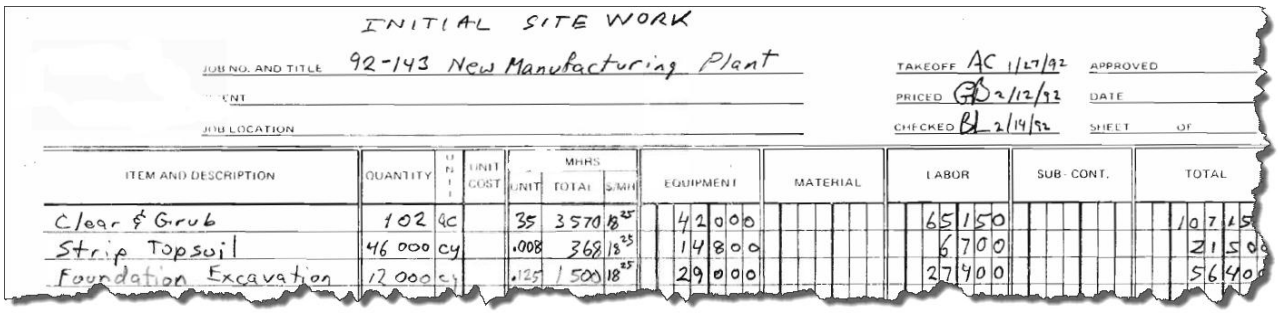
1. National Building Code of India, 2005 (NBC 2005)
2. Frank R. Dagostino, Materials of Construction, Details given Reston Publishing Company, nc. Virginia, 1976.
3. M. Mohsin, Project Planning and Control, Vikas Publishers, New Delhi, 1983
4. Concrete Technology – Theory and Practice, M.S. Shetty, Chand & Co, New Delhi, 2005.
5. Gurcharan Singh, “Building, Planning, Designing and Scheduling”, Standard Publications, 2009.

CONSTRUCTION MANAGEMENT

Construction Project Management (CM) is a professional service that uses specialized, project management techniques to oversee the planning, design, and construction of a project, from its beginning to its end. The purpose of CM is to control a project's time, cost and quality. CM is compatible with all project delivery systems, including design-bid-build, design-build, CM At-Risk and Public Private Partnerships. Every construction project features some amount of CM. However, professional construction managers, or CMs, are typically reserved for lengthy, large scale, high budget undertakings (commercial real estate, transportation infrastructure, industrial facilities, military infrastructure, etc...), called capital projects. No matter the setting, a CM's responsibility is to the owner, and to a successful project.

Overview of construction management topics including- estimating

Cost estimators used columnar sheets of paper to organize the take off and the estimate itself into rows of items and columns containing the description, quantity and the pricing components. Some of these were similar to accounting ledger paper. They became known as green sheets or spreadsheets.



INITIAL SITE WORK

JOB NO. AND TITLE 92-143 New Manufacturing Plant — TAKEOFF AC 1/27/92 — APPROVED

ENT — PRICED GD 2/12/92 — DATE

JOB LOCATION — CHECKED BL 2/14/92 — SHEET OF

ITEM AND DESCRIPTION	QUANTITY	UNIT	UNIT COST	MHRS UNIT	MHRS TOTAL	MHRS $/MH	EQUIPMENT	MATERIAL	LABOR	SUB-CONT.	TOTAL
Clear & Grub	102	ac		35	3570	18.55	42000		65150		107150
Strip Topsoil	46 000	cy		.008	368	18.55	14800		6700		21500
Foundation Excavation	12 000	cy		.125	1500	18.55	29000		27400		56400

Many construction cost estimators continue to rely primarily upon manual methods, hard copy documents, and/or electronic spreadsheets such as Microsoft Excel. While spreadsheets are relatively easy to master and provide a means to create and report a construction cost estimate and or cost models, their benefit comes largely from their ability to partially relieve estimators of mundane calculations. Accuracy, however, is not necessarily improved and productivity is not maximized.

Construction cost estimating software is computer software designed for contractors to estimate construction costs for a specific project. An cost estimator will typically use estimating software to estimate their bid price for a project, which will ultimately become part of a resulting construction contract. Some architects, engineers, construction managers, and others may also use cost estimating software to prepare cost estimates for purposes other than bidding.

Work Item	Vendor	Labor	Equipment	Materials	Subcontr.	Subtotal	Markup %	Markup	Total
Permits/Fees	City of Los Angeles				$1,500.00	$1,500.00		$0.00	$1,500.00
Excavation		$6,000.00	$8,000.00	$500.00		$14,500.00	15.00%	$2,175.00	$16,675.00
Utilities		$3,500.00	$2,500.00	$2,750.00	$1,000.00	$9,750.00	15.00%	$1,462.50	$11,212.50
Water Well						$0.00		$0.00	$0.00
Septic Tank						$0.00		$0.00	$0.00
Foundation	Connie's Concrete				$3,500.00	$3,500.00	5.00%	$175.00	$3,675.00
Concrete Flatwork	Connie's Concrete				$1,900.00	$1,900.00	5.00%	$95.00	$1,995.00
Framing		$3,500.00	$1,500.00	$9,000.00		$14,000.00	15.00%	$2,100.00	$16,100.00
Roofing	Robert's Roofing				$3,500.00	$3,500.00	5.00%	$175.00	$3,675.00
Windows/Ext.Doors	Wally's Windows				$8,000.00	$8,000.00	5.00%	$400.00	$8,400.00
Garage Door	Gary's Garage Doors				$2,250.00	$2,250.00	5.00%	$112.50	$2,362.50
Siding						$0.00		$0.00	$0.00
Electrical	Ernie's Electric				$18,500.00	$18,500.00	5.00%	$925.00	$19,425.00
Plumbing	Mac's Mechanical				$16,500.00	$16,500.00	5.00%	$825.00	$17,325.00
HVAC	Mac's Mechanical				$23,000.00	$23,000.00	5.00%	$1,150.00	$24,150.00
Insulation		$3,500.00		$1,000.00		$4,500.00		$0.00	$4,500.00
Masonry	Mason's Masonry				$14,500.00	$14,500.00	5.00%	$725.00	$15,225.00
Drywall	Doug's Drywall				$12,500.00	$12,500.00	5.00%	$625.00	$13,125.00
Interior Trim	Doug's Drywall				$9,000.00	$9,000.00	5.00%	$450.00	$9,450.00
Painting	Paul's Painting				$13,500.00	$13,500.00	5.00%	$675.00	$14,175.00
Floor Coverings	Carl's Carpets				$16,500.00	$16,500.00	5.00%	$825.00	$17,325.00
Cabinets	Ken's Kabinets				$22,500.00	$22,500.00	5.00%	$1,125.00	$23,625.00
Appliances	Abby's Appliances	$2,500.00		$11,500.00		$14,000.00	15.00%	$2,100.00	$16,100.00
Landscaping	Sonny's Sodding				$2,750.00	$2,750.00	5.00%	$137.50	$2,887.50
Overhead Costs		$10,000.00				$10,000.00	20.00%	$2,000.00	$12,000.00
Other						$0.00		$0.00	$0.00
						$0.00		$0.00	$0.00
						$0.00		$0.00	$0.00
						$0.00		$0.00	$0.00
						$0.00		$0.00	$0.00
						$0.00		$0.00	$0.00
TOTALS						**$236,650.00**	**7.71%**	**$18,257.50**	**$254,907.50**

1. List all the various parts of the job.
2. List all the hours that it will take someone to complete each portion.
3. List all the materials that will be used on each part of the job.
4. List each sub-contractor that you will need.
5. List all the other items you will have to purchase or rent to get the job completed, such as permits, rentals, port-a-potties, etc.
6. Go back through your lists and put a cost on each item.
7. Last, have a knowledgeable second party double-check your lists and your math (this step is the one few estimators bother to do).

cost control

Cost control is the practice of identifying and reducing business expenses to increase profits, and it starts with the budgeting process. A business owner compares actual results to the budget expectations, and if actual costs are higher than planned, management takes action. As an example, a company can obtain bids from other vendors that provide the same product or service, which can lower costs.

The purpose of the cost plan is to allocate the budget to the main elements of the project to provide a basis for cost control. However, the difference is that the budget is the limit of expenditure defined for the project, whereas the cost plan is the definition of what the money will be spent on and when. The cost plan should cover all stages of the project and will be the essential reference against which the project costs are managed.

The construction industry and the environment in which it operates have changed significantly

•New and varied ways of buying design and construction
•Fragmentation of the industry with increased in specialist trade contracting
•Demise of direct employment
•Growth of labour-only and fixed term contracts
•Fee competition for consultancy services
•Introduction of partnering
•More conflict and less trust
•Clients wanting more value for money

Cost Control and Management

Business cycles hit peaks and lows with consultants and contractors having to cope with increasing pressure for: Faster construction Higher quality Lower costs

Clients want:

Certainty of price
Projects constructed and delivered within budget
Completion on time
The best quality possible for the price
Value for money
No surprises

Contractors and Consultants want:

A reasonable return for the risks they take
Payment on time
Clients who do not keep changing their minds
Satisfied clients
Positive feedback, enhanced reputation and glowing references
Repeat commissions and business

Cost monitoring and Control

•Make employers and designers aware of the cost consequences of their desires and/or proposals
•Provide advice to designers to enable them to arrive at practical and balanced designs within cost limits
•Ensure employers are provided with value for money
•Keep expenditure within cost limits approved by the employer
•Provide robust cost information upon which the employer can make informed decisions - cost predictability

quality control

Quality control is the part of quality management that ensures products and service comply with requirements. It is a work method that facilitates the measurement of the quality characteristics of a unit, compares them with the established standards, and analyses the differences between the results obtained and the desired results in order to make decisions which will correct any differences.

Technical specifications define the type of controls that must be carried out to ensure the construction works are carried out correctly. They include not only products materials, but also the execution and completion of the works.

One way of controlling quality is based on the inspection or verification of finished products. The aim is to filter the products before they reach the client, so that products that do not comply with requirements are discarded or repaired. This reception control is usually carried out by people who were not involved in the production activities, which means that costs can be high, and preventative activities and improvement plans may not be effective. It is a final control, located between producer and client, and although it has the advantage of being impartial, it has a large number of drawbacks, such as slow information flows, and that the inspectors are not familiar with the circumstances of production and are not responsible for the production quality.

Quality assurance in accordance with ISO 9001

ISO 9001 is the world's most widely recognized Quality Management System (QMS). It belongs to the ISO 9000 family of quality management system standards (along with ISO 9004), and helps organizations to meet the expectations and needs of their customers, amongst other benefits.

Quality assurance is a set of planned and systematic actions to ensure that products and services comply with specified requirements. It not only involves checking the final quality of products to avoid defects, as is the case in quality control, but also checking product quality in a planned way in all the production stages. It is the development of work and product design procedures to prevent errors from occurring in the first place, based on planning backed up by quality manuals and tools.

The ISO 9000 standards consists of four basic interdependent standards supported by guides, technical reports and technical specifications:

ISO 9000: Quality management.
ISO 9001: Quality management systems Requirements.
ISO 9004: Managing for the sustained success of an organization A quality management approach.
ISO 19011: Guidelines on internal and external audits of quality management systems.

When a quality system is applied to a product as complex and unique as construction, a specific quality plan must be drafted by applying the company's global system to the specific project. The plan must be drafted by the contractor before the start of the construction works and will be reviewed throughout its execution. The quality plan is applicable to the materials, work units and services that have been specifically chosen by the construction company in order to comply with the quality requirements stipulated in the contract. The quality plan is drafted for the construction works when a preventive strategy is needed to guarantee the construction quality, even though there might also be a quality manual, in compliance with the ISO 9001 standard requirements.

Safety

Construction work is a hazardous land-based job. Some construction site jobs include: building houses, roads, tree forts, workplaces and repair and maintain infrastructures. This work includes many hazardous task and conditions such as working with height, excavation, noise, dust, power tools and equipment. The most common fatalities are caused by the fatal four: falls, struck by object, electrocutions and caught-in/between. Construction work has been increasing in developing and undeveloped countries over the past few years. With an increase in this type of work occupational fatalities have increased. Occupational fatalities are individuals that pass way while on the job or performing work related tasks. Within the field of construction it is important to have safe construction sites.

Hazards to construction workers

Various workplace safety signs commonly used at construction sites and industrial work environments. The leading safety hazards on construction sites include: falls, caught between objects, electrocutions, and struck by objects. All four of those hazards have caused injuries and deaths throughout the world of construction sites. Failures in hazard identification are often due to limited or improper training and supervision of the construction site workers. Examples of areas were there are limited training includes: tasks in design for safety, safety inspection, and monitoring safety. Failure in any of these areas can result in an increased risk in exposing workers to harm in the construction environment.

Motor vehicle crashes are another major safety hazard on construction sites. It is important to be cautious while operation motor vehicles or equipment on the site. Motor vehicles should have a service brake system, emergency brake system, and a parking brake system. All vehicles must be equipped with an audible warning system if the operator chooses to use it. Vehicles must have windows and doors, power windshield wipers, and have a clear view of site from the rear window. All employees should be properly trained before using motor vehicles and the equipment.

Employees on construction sites also need to be aware of dangers on the ground. The hazards of cables running across roadways were often seen, until cable ramp equipment was invented to protect hoses and other equipment which had to be laid out. Other hazards found on construction site includes: asbestos, solvents, noise, and manual handling activities.

Education and safety

Construction workers need to be properly trained and educated on the task or job before working, which will assist in preventing injuries and deaths. There are many methods on training construction workers. One method is coaching construction site foremen to include safety in their daily verbal exchanges with workers to reduce work-related accidents. It is important that the workers use the same speaking language to assure for the best communication. In recent years, apart from traditional face to face safety knowledge sharing, the popularity of mobile apps make knowledge sharing through apps possible

Each construction site should have a construction site manager. A construction site manager's is an occupational health and safety specialist who designs and implements safety regulations to minimize injuries and accidents on construction sites. He or she also is in charge of conducting daily safety audits and inspections to ensure compliance with government regulations.

Preventing accidents and improving safety

Site preparation will aid in preventing injury and death on construction sites. Site preparation includes removing all the debris existing on the site, leveling the ground, filling holes, cutting off tree roots, and marking gas, water, and electric pipelines. This process improves the safety on the construction site. Another prevention methods on the construction site is to provide scaffold that is rigid and sufficient to carry its own weight plus four times the maximum intended load without settling or displacement.

Ways to prevent injuries and improve safety include:

1. Management safety
2. Integrate safety as a part of the job
3. Create accountability at all levels
4. Take safety into account during the project planning process
5. Make sure the contractors are pre-qualified for safety
6. Make sure the workers are properly trained in appropriate areas
7. Have a fall protection system
8. Prevent and address substance abuse to employees
9. Make safety a part of everyday conversation
10. Review accidents and near misses, as well as regular inspections

Personal protective equipment

Hard hats and steel-toe boots are perhaps the most common personal protective equipment worn by construction workers around the world. A risk assessment may deem that other protective equipment is appropriate, such as gloves, goggles, or high-visibility clothing.

Hazards to non-workers

Many construction sites cannot completely exclude non-workers. Road construction sites must often allow traffic to pass through. This places non-workers at some degree of risk.

PERSONAL PROTECTIVE EQUIPMENT

1.Hard hats will be worn on job sites at all times.

2.Eye protection will be worn when there are potentials of hazards from flying objects or particles, chemicals, arcing, glare, or dust.

3.Leather work boots shall be worn to protect from falling objects, chemicals, or stepping on sharp objects. Safety toe footwear may be necessary in some instances. Athletic or canvas-type shoes shall not be worn.

4.Protective gloves or clothing shall be worn when required to protect against a hazard.

5.Harnesses and lanyards shall be utilized for fall protection as required.

SAFETY DISCIPLINE

1.Wear appropriate clothing and use sun block to prevent sunburn.

2.Watch where you are walking. Do not run. Keep your mind on your work at all times.

3.The use of illegal drugs or alcohol or being under the influence during working hours shall be cause for termination. Inform your supervisor if taking strong prescription drugs that warn against driving or using machinery.

4.Do not distract the attention of fellow workers or engage in horseplay. Do not engage in any act which would endanger another employee.

5.Keep your working area free from rubbish and debris. A clean job is the start of a safe job.

6.Do not use a compressor to blow dust or dirt from your clothes, hair, or hands.

7.Report any fear of walking at heights to your supervisor.

8.Know where fire extinguishers are located and how to use them.

9.Lift correctly - with legs, not the back. If the load is too heavy GET HELP. Do stretching exercises prior to work activities. Approximately twenty percent of all construction related injuries result from lifting materials.

10.Keep back at least 10’ from all power lines, further if high voltage.

11.Nobody but the operator shall be allowed to ride on equipment unless the equipment is designed to carry a passenger.

12.Do not use power tools and equipment until you have been properly instructed in the safe work methods and become authorized to use them.

13.Do not remove, displace, damage, or destroy any safety device or safeguard on equipment or machinery.

14.Barricade danger areas. Guard rails or perimeter cables may be required. Do not enter an area which has been barricaded.

15.If you must work around power shovels, trucks, rough-terrain fork-lifts, dozers, or other heavy equipment, make sure operators can always see you.

16.Never oil, lubricate, or fuel equipment while it is running or in motion.

17.Before servicing, repairing, or adjusting any powered tool or piece of equipment, disconnect it, lock out the source of power, and tag it out.

18.Excavations over five feet deep must be shored or sloped as required. Keep out of trenches or cuts that are not properly shored or sloped. Excavated material or other debris shall not be stored nearer than two feet from the edge of the excavation. Excavations less than 5 feet will require cave in protection where conditions indicate possible side failure.

19.Practice the following safety procedures when using ladders:
•Use the "four to one" rule when using a ladder. One foot of base for every four feet of height.
•Portable ladders in use shall be equipped with safety feet unless the ladders are tied, blocked or otherwise secured. Step ladders shall not be used as a straight ladder.
•Ladders must extend three feet above landing on roof for proper use.
•Defective ladders must be properly tagged and removed from service.
•Keep ladder bases free of debris, hoses, wires, materials, etc.

20.Build scaffolds according to manufacturers' recommendations

EMERGENCY PROCEDURES

In case of an emergency on site the following procedures will be instituted at each site:

1.Method of communication will be determined at each site: telephone, radio, etc.

2.Post the following emergency telephone numbers:

•Police
•Fire
•Medical Response Team

3.Post the job site address near the communication station.

4.Post names of first aid responders on site.

5.Designate a person to direct emergency crews to site of emergency.
6.Instruct each employee of known harmful plants, reptiles, animals, insects, or other environmental hazards present, including:

•The potential hazards.
•How to avoid injury.
•Applicable first aid procedures to be used in the event of injury

SAFETY AND HEALTH TRAINING

1.New Employee Orientation: New employees will receive training on the company safety and health management system, safe work practices and expectations, and specific safety and health training for the tasks that they will perform.

2.After inspecting a job site, (Name/Title) will identify and evaluate all potential hazards for potential of serious injuries and probability of an accident. Actions will be taken to minimize the hazards and protect the workers.

3.The Safety Coordinator or other designated site person will appraise the skill and knowledge level of exposed workers, and provide any needed training.

4.Where safety and health training is needed, appropriate training will be provided.

5.Records will be maintained for all training sessions with descriptions of topics covered and names of workers trained.

6.Toolbox Talks: Toolbox talks will be conducted regularly (weekly/daily).

Productivity

Factors affecting productivity

- Design or capacity
- Varying site conditions such as soil, drainage, and so on
- Weather conditions such as climate and temperature
- Season changes
- Manpower and labor conditions, such as union versus open shop, and skilled versus unskilled labor
- Experience factors such as learning curve and legacy data from previous projects
- Intangible factors such as morale, fatigue, and attitude, which leads to absenteeism, turnover, and crew size inefficiency
- Site access
- Unplanned errors and omissions, work stoppages, delays, and so on
- Source and location of power and utilities
- Governmental or regulatory requirements
- Material source, supply, and codes
- Different project team and supervision
- Proximity to transport and logistics

Factors Affecting Labor Productivity

1. **Overtime**
Scheduling of extended work days or weeks exceeding a standard eight-hour work day or 40- hour work week lowers work output and efficiency through physical fatigue and poor mental attitude.

2. **Morale and Attitude**
Spirit of workers based on willingness, confidence, discipline, and cheerfulness to perform work or tasks can be lowered due to a variety of issues, including increased conflicts, disputes, excessive hazards, overtime, over-inspection, multiple contract changes, disruption of work rhythm, poor site conditions, absenteeism, unkempt workspace, and so on.

3. **Fatigue**
Fatigue can be caused by prolonged or unusual physical exertion.

4. **Stacking of Trades**
This occurs when operations take place within physically limited space with other contractors, resulting in congestion of personnel, inability to use or locate tools conveniently, increased loss of tools, additional safety hazards, increase visitors, and prevention of crew size optimum.

5. **Joint Occupancy**
This occurs when work is scheduled utilizing the same facility or work area that must be shared or occupied by more than one craft, and not anticipated in the original bid or plan.

6. **Beneficial Occupancy**
This is a result of working over, around, or in close proximity to other crafts, owner's personnel, or production equipment, which may cause noise limitations, dust, or other hazardous risk. This may also prevent or cause access restrictions.

7. **Concurrent Operations**
This is the effect of adding operations to any sequence of operations that has already been planned, without a gradual and controlled implementation of additional operations.

8. **Absenteeism and Turnover**
There is a great deal of time and money lost associated with high turnover and absenteeism on projects. Construction projects in certain areas with low manpower and high demand for labor will usually be more impacted than others. Extreme weather conditions (such as extreme heat or cold) will also increase absenteeism and turnover. Replacement workers are usually not familiar with the work or area, and require experienced workers to stop work and show them what to do.
The impact can be up to four days of lost work for each worker.

9. **Mobilize/Demobilize**
This relates to moving resources on and moving off to projects as a result from changes or delays, causing work disruptions. Productivity may drop during these periods as time is lost when crews move from one area or work assignment to another.

10. **Errors and Omissions**
Increases in errors and omissions impact on labor productivity because changes are then usually performed on a crash basis, out of sequence, cause dilution of supervision, or any other negative impacts.

11. **Start/Stop**
This results from a work stoppage or suspension of work, which may cause a break in the schedule, usually triggering a start/stop of work activity. Stop-starts can have an impact on productivity and cost of a project. Work scheduled or reassigned during holidays such as Thanksgiving, Christmas, New Year's, and so on are often impacted with stop-starts. Workers tend to discuss the time off and lose previous momentum with a drop in productivity before they get back in routine.

12. **Reassignment of Manpower**
When workers are reassigned, they experience unexpected or excessive changes, losses caused by move-on or move-off, reorientation, and other issues that result in a loss of productivity.

13. **Late Crew Build-up**
This is caused when the planned project manpower loading is altered and causes manpower loading to build up slower than planned due to availability, shortage of resources, or competition from resources. Impacts can be in excess of 10 percent.

14. **Crew Size Inefficiency**
This is when the optimal crew size is altered by adding or deleting crew members. When workers are added or deleted from a crew, it breaks up the original team effort and rhythm of the crew and results in loss of productivity.

15. **Site Access**
This is a result of interferences to the convenient or planned access to work areas. This can be due to blocked stairways, roads, walkways, insufficient man-lifts, or congested work sites.

Value engineering

Value engineering (VE) is a systematic method to improve the "value" of goods or products and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. It is a primary tenet of value engineering that basic functions be preserved and not be reduced as a consequence of pursuing value improvements.

Value engineering is used to solve problems and identify and eliminate unwanted costs, while improving function and quality. The aim is to increase the value of products, satisfying the product's performance requirements at the lowest possible cost. In construction this involves considering the availability of materials, construction methods, transportation issues, site limitations or restrictions, planning and organisation, costs, profits and so on. Benefits that can be delivered include a reduction in life cycle costs, improvement in quality, reduction of environmental impacts,and so on.

Value engineering should start at project inception where the benefits can be greatest, however the contractor may also have a significant contribution to make as long as the changes required to the contract do not affect the timescales, completion dates or incur additional costs that outweigh the savings on offer.

Value engineering involves:

- Identifying the main elements of a product, service or project.
- Analysing the functions of those elements.
- Developing alternative solutions for delivering those functions.
- Assessing the alternative solutions.
- Allocating costs to the alternative solutions.
- Developing in more detail the alternatives with the highest likelihood of success.

Claims, and legal issues

Construction projects are becoming more and more complex due to new standards, advanced technologies, and owner-desired additions and changes. While the successful completion of projects has been thought to depend mainly on cooperation between the contractor, consultant, and owner, problems and disputes have always erupted due to conflicting opinions as to the various aspects of design and construction.

Legal issues

Theoretically, any legal issue that can arise under a contract (in general) can arise in relation to a construction contract also. These include issues relating to formation of the contract, legal validity of the contract, performance of the contract, effect of force majeure, assignment of the contract, damages and so on. However, in the case of construction contracts, some of these issues, arising as they do against the background of a contract of some magnitude or complexity, present a few peculiar features, requiring special attention.

Documents and their incorporation of documents

A works contract usually involves numerous documents, namely:
(a) the main agreement,
(b) the general conditions,
(c) the specifications,
(d) the bills of quantities,
(e) the drawings,
(f) the schedule of rates,
(g) the form of tender, and
(h) the bond.

Claims under the contract

Contracts entered into in connection with buildings and other construction projects are drawn elaborately on standard forms, seeking to provide for various contingencies. Nevertheless, legal disputes about payment of the contractors' claims there under do arise from time to time, occupying a considerable time of arbitrators and courts. Some legal principles have been evolved as to the quantification as well as the validity of such claims. These deserve discussion in view of the practical importance of the subject.

Types of claims

Claims by a building contractor (or other contractors engaged in construction work) are principally of two types

(a) claims under the contract, and
(b) claims for payment for work which is done outside the contract, for which, the contractor seeks payment as a matter of justice.

The first category is contractual. The contractor claims payment on the basis of the contract. Such claims usually involve questions of assessing the work (seeing that it is according to contract) and questions of interpretation of contractual terms.

Socio-Political Pressures

Socio-Political pressures have more impact on construction than in the past.
Political pressures and community involvement affect public and to some extent, private sector work. Pressures emanate from adjacent property owners and the public at-large, including existing businesses, institutions, and residences adjacent to the constructed facility. Civic organizations and community groups have more input into design and construction of public works projects, and greater impact on private work through the land use and planning process. The community has greater input through citizen advisory boards that are engaged during project initiation, design, and construction. Today's CM has substantially greater accountability to the public than previous generations. Increasing the number of stakeholders further complicates an already complex process.

Question Paper Code: 91982

B-Arch DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Ninth Semester

AR 2078/AR 1011— CONSTRUCTION TECHNOLOGY

(Regulation 2009)

Time: Three Hours Maximum : 100 marks

Answer ALL questions

PART A — (10 x 2 = 20 marks)

1. Explain the need of National Building Code of India.
2. Explain the basic requirements of mezzanine floor as per NBC- in India.
3. Discuss the advantage of precast over cast in situ construction.
4. Write short notes on "Commissioning.
5. What are the criteria for choice of technology in construction.
6. What do you mean by 'scaffolding'?
7. Define the terms * forms" and "form work".
8. What are the general considerations for selection of equipment.
9. Explain the duties and responsibilities of construction manager.
10. Differentiate between "estimation* and "scheduling".

PART B — (5 x 16 = 80 marks)

11.(a) Outline the objectives and important content of NBC 2005 of India.

Or

(b) Outline the Minimum requirements of parts of Residential buildings as per NBC 2005 of India.

12.(a) Write short notes on Pre-stressed concrete with its types, concept, and application in construction industry.

Or

(b) Outline the important components of prefabricate systems and write short notes on the various precast components with its application in residential construction.

13.(a) What are the safety measures to be followed during the erection process of scaffolding for buildings?

Or

(b) What are the safety measures to be followed during the erection and dismantling process of form work?

14.(a) Explain in detail of "Equipment planning" on major construction projects.

Or

(b) Write detailed notes on the following: **(4 x 4 = 16)**

(i) Ready mix concrete.

(ji) Earth movers.

(iii) Bulldozers.

(iv) Lifting devices.

15.(a) Explain the main components of Construction management.

Or

(b) Explain in detail the role and responsibilities of a project manager in the construction industry.

Question Paper Code: 31889

B-Arch DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Ninth Semester

AR 2078/AR 1011— CONSTRUCTION TECHNOLOGY

(Regulation 2009)

Time: Three Hours Maximum : 100 marks

Answer ALL questions

PART A — (10 x 2 = 20 marks)

1. Name any four types of buildings according to their uses.
2. Write the importance of site study.
3. Define modular coordination.
4. Define framed structures with examples.
5. Write the purpose of scaffolding.
6. Write short notes on fly ash blocks.
7. Chart out any four important construction equipments.
8. Write a note on RMC.
9. What is the purpose of estimation.
10. What are the objectives of planning.

PART B — (5 x 16 = 80 marks)

11. (a) Discuss in detail the general classification of construction works

Or

(b) Enumerate the parts of buildings and explain their functions and requirements.

12. (a) Explain the principles and types of pre stressed concrete construction Mention its applications. .

0r

(b) Write short notes on 'lift slab construction and waffle wall construction

13. (a) Under what situation pre cast components are preferred. Mention their types.

Or

(b) List out .the precautions taken while erecting and dismantling the building components.

14. (a) Classify the equipments for construction on ' functional basis with subgroups.

Or

(b) What are the different types of cranes used in construction industry. Explain briefly their applications and operations.

15. (a) Describe the working of truck mixers and concrete pumps,

Or

(k) Write importance of scheduling and its types.