Building Production Systems
Rational Production and Industrial Production
by
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Rationalization in Building Production
- Rationalization of formwork systems,
- Rationalization of concrete-related production items,
- Rationalization of reinforcement-related production items,
- Rationalization of equipment use,
- Rationalization of production process.

Formwork-related rationalization
- Various modular formwork systems that provide flexibility in design and speed up the construction process due to easier assemblage and removal process (e.g. climbing, traveling, tunnel, sliding and filigrane formworks),
- New materials for formworks that increase the precision and quality of load-bearing, partitioning and envelop system (e.g. plywood, steel sheet, aluminum),
- New materials that makes the formwork system more economic and endurable.

Concrete-related rationalization
- Additives (accelerating agents, retarders etc) and additional processes (curing) in concrete-related items,
- Higher precision, strength and speed by using concrete centers and ready-made concrete.

Reinforcement-related rationalization
- Higher strength for the precast components applied pre or post-tensioning process,
- New reinforcement solutions that is based on factory production (mesh reinforcement).

Equipment-related rationalization
- New equipments for concrete preparation, transportation and pouring (concrete centers, transmixers, pumps),
- New equipment for preparation of reinforcement (benches for preparation of mesh reinforcements and rod irons),
- New equipment for lifting components (cranes).

Process-related rationalization
- Shorter setting and releasing durations for the formworks,
- Removal of plaster-related production items and removal of scaffolding for plaster,
- Overlapping successive activities (fast-track process).

Why we use rationalized systems...?
- To minimize the duration of construction process,
- To maximize the speed of construction process,
- To optimize the use of the resource,
- Use of prefabricated components or elements (stairs, panel walls, slabs, etc.),
- Increased level of mechanization (construction process gets shorter),
- Decrease in use of handwork or use of labor (increase of precision and quality).

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Classification of formworks

A. Permanent formworks
B. Adjustable formworks
C. Moving formworks;
    C.1. Horizontally moving formworks
        C.1.1. Tunnel formworks
        C.1.2. Table formworks
    C.2. Vertically moving formworks
        C.2.1. Sliding formworks
        C.2.2. Climbing formworks.
        C.2.3. Inflating formworks

A. Permanent Formworks

Permanent formworks are formworks that remain where they are placed after the completion of superstructure. Their features:

- Smooth Surfaces,
- Standardization,
- No need to release the formworks.

B. Adjustable Formworks

Formworks for in-situ concrete work may be described as a mould or box into which wet concrete can be poured and compacted so that it will flow and finally set to the inner profile of the box or mould. It is important to remember that the inner profile must be opposite to that required for the finished concrete so if, example, a chamfer is required on the edge a triangle fillet must be inserted into the formwork.

C. Moving Formworks

They are large prefabricated formwork units designed to be moved horizontally on rollers or similar devices.

C.1. Horizontally Moving Formworks

They are formworks that move horizontally in erection and dismantling processes.

C.1.1. Tunnel Formworks

Tunnel Formwork is a Steel Formwork that is used during the placing of the concrete to form the floor and the wall at the same time. They can be in different shapes, sizes and modules.

C.1.2. Table Formworks

They are used for the production of slabs.

C.2. Vertically moving formworks

C.2.1. Sliding Formwork

They are:

- formwork that moves, usually continuously, during the placing of the concrete; also called "slip formwork".
- formworks that are made to move so that it leaves the formed concrete only after concrete is strong enough to retain its shape and support its own weight.
- formworks that are raised vertically as the concrete is placed.

C.2.2. Climbing Formwork

Formwork that is raised vertically for succeeding lifts of concrete in a given structure, usually supported on anchor bolts or rods embedded in the top of the previous lift. A hydraulic system lifts the whole formwork that contains one storey of building.

C.2.3. Inflating Formwork

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Concrete is sprayed over the inflating formwork, which has a sufficient inner pressure, layer by layer.

Formwork Materials

Formwork; Temporary structure or removable mold for the support of concrete while it is setting and gaining sufficient strength to be self-supporting.

- **Steel Formwork;** high initial cost, long usage: 400-500 times,
- **Plastic Formwork;** glass reinforced plastic, used to form the circular or curved surfaces,
- **Timber Formwork;** pressed and polished, low initial cost, short usage: 80-90 times.

The requirements for formwork make timber the most suitable material for general formwork.

1. **Softwood board** used to form panels for beam and column sides should be joined together by cross members over their backs at centers not exceeding twenty-four times the board's thickness.
2. **Plywood** is extensively used to construct formwork units since it is strong, light and supplied in sheets of 1.200m wide with standard lengths of 2.4, 2.7 and 3.0m. The quality selected should be an exterior grade and the thickness related to the anticipated pressure so that the minimum number is strengthening cleats on the back are required.
3. **Chipboard** can also be used as a formwork material but because of its lower strength will require more supports and stiffeners. The number of uses, which can be obtained from chipboard forms, is generally less than plywood, softwood boarding or steel.
4. **Steel forms** are generally based upon a manufacturer's patent system and within the constraints of that system are an excellent material. Steel is not so adaptable as timber but if treated with care will give thirty or forty uses, which are approximately, double that of similar timber forms.

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Basics of Industrial Production
- Division of work
- Repetition
- Specialization
- Standardization
- Mechanization
- Scientific Management

Factors affecting industrialization in BP

The product-related difficulties
- Since the variety of building functions and types standardization and unification is difficult.
- Due to the differences of spans, size of rooms and components originating from building function standardization is difficult.
- Since the relationship among the building and the land, the sub-structure should be produced on-site.
- Standardization and unification at component level is difficult due to some reasons like earthquake or climate.
- Transportation and assemblage is difficult since the weight of the building and its components.

The demand-related difficulties
- The duration of life-cycle of buildings is too long, so is the period of demand.
- The building demand has a postponable character since the instable economic conditions and high value of the product.
- The local character of the demand creates additional difficulties.

The product-related facilities
- Building can be divided into components and these components can be produced in accordance to the principles of industrialization. Mechanization is possible.
- The details and production process can be standardized and unified.
- It is possible to produce a product that is almost completed at factory.

The demand-related facilities
- The need and purchasing wishes for various types of buildings increases in emerging countries.
- Suitable payment conditions can easily convert these wishes to demand.
- Especially the need for residential buildings unavoidable and the stability of demand can be obtained.