A Survey of Different Types of Materials, Technologies and Human Force Used in Construction of Multi-Storey Buildings

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Abstract

The construction of multi-storey buildings is not an easy task. It requires different types of materials, latest construction technologies, planners, designers, civil engineers, and skilled and unskilled labour force. In brief all the constituents can be divided into three parts i.e. Building portion; Internal Water supply and Sanitary Supply portion; and Internal Electrical Services. Building portion includes Plan, Design and Elevation; Land; Material; Labour; Shuttering; Tools & Plants; and Time element. Internal Water and Sanitary Services and Electrical Services require Fitting Materials and fitters and helpers. If all types of materials are of good quality and the human resource is well experienced and dedicated to their work; undoubtedly a multi-storey building will come out of outstanding quality and utilization of land will be in so efficient manner which will prove useful and convenient to the users of it.

Keywords : *Multi-Storey Buildings, Construction, Human Force.*
Classification-JEL : *D 13, J 24, R 21, R 32*

1. INTRODUCTION

Construction work is a combination of different types of materials and human force in the erection of buildings. It consists of several working operations performed by civil engineers, architects, contractors, and skilled and unskilled workers. Besides this, also the different types of materials and technologies are used in this process. These constituents of building construction can be divided into the following three parts i.e. (a) Building Portion, (b) Internal Water Supply and Sanitary Services, and (c) Internal Electrical Services.

2. CONSTITUENTS OF MULTI-STOREY BUILDING CONSTRUCTION

A detailed analysis of these parts is being given as below:

a) Building Portion

i) Plan, Design and Elevation: Plan, Design and Elevation planning is the prime constituent

of building construction whether it is single storey or double storey or multi-storey. This constituent makes the structure convenient to the users of it and serves the purpose for which it was constructed. This portion involves the services of architects. If the architects are well trained, efficient and experience holders, they will prove successful in drafting such a construction plan a building which will be according to requirements of the users, economical from the cost viewpoint, and well designed. An analysis of plan, design and elevation aspects is being given under separate heads:

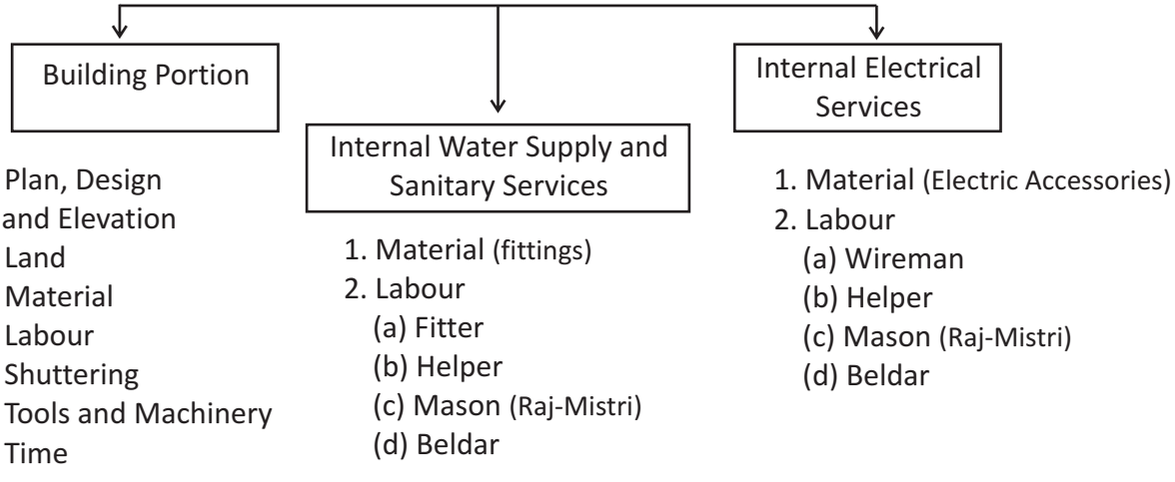
i **Plan:** Before starting construction work an effective erection plan is very much needed. It should be made according to the requirements for which the building is to be constructed. In fact, an appropriate construction plan proves successful in saving money, material, labour and time. It facilitates engineers and contractors to make the best possible utilization of land which is very costly in the present time.

i **Design:** Also the design of a building counts to a large extent. This work should be performed by efficient and experienced engineers. Proper designing of multi-storey building proves very useful to the users of it. It should be prepared in such a way so that there may be proper arrangements of light and air in the building and it may prove quite useful and comfortable. An effective designing also proves helpful in reducing the construction cost to some extent.

i **Elevation:** Elevation enhances the overall value and attraction of a building. In Government and industrial construction works elevation has a very little importance but in the case of private residential buildings, hotels, marriage halls, private offices of professionals and business houses elevation has an immense importance. In the present era special attention is given to the elevation of buildings as it has become the status symbol of rich and middle class families and big business houses. Thus also elevation is the most important constituent in the field of construction work especially in multi-story buildings.

ii) **Land:** Land is the base on which any construction work is done. In fact land is the god-gift which is limited as regards to its area that is why this source should be utilised very carefully. While planning to construct a building it should be considered for what purpose a building is to be constructed and in which

Chart 1
CONSTITUENTS OF MULTI-STOREY BUILDING CONSTRUCTION



locality or area the land is required for this purpose. When a new colony is to be constructed, there will be no problem to choose the land outside the present localities but in case constructing a house by an individual or opening an office or business house, the land will be required in busy area of the city which will be much costlier than that in the case of planning for a new colony in the outer of the city. Thus land occupies the prime importance among all the constituents of building construction; therefore, a deep thought is required while choosing land for an erection.

iii) **Material:** Construction work involves different types of materials viz bricks, cement, sand coarse-sand and concrete, stone patties, wall tiles and floor tiles, steel bars, wood etc. An analysis of such materials has been made under the separate heads:

ı **Bricks:** Bricks are the basic raw material which is used in about 90% of the building construction work in the area of study. Though in few buildings cement and concrete are used in place of bricks yet this technique is applied only in few cases and most of the construction of multi-storey buildings is completed using red bricks. The consumption of bricks depends upon its size, thickness of joints and position of the Frog. Though IS 2212 recommended the use of modular bricks due to change over of metric system yet it is often seen that major construction work is going on using traditional bricks only.

Investigations have revealed that in our country, there is a great variation in size of the traditional bricks. However, a study of the traditional bricks work in Meerut Region has shown that most common size of the brick is 9" × 4.375" × 2.75" or 22.9 × 11.1 × 7 cms and thickness of joints is .375" or 1 cm. and bricks are always laid with frog-up position.

ı **Mortar:** Mortar is that mixture or paste which is prepared with cement and sand. It is prepared of different strength for different purposes. Cement Mortar is used for plastering walls, preparing floors etc. It is prepared by mixing cement and sand in different ratios (1:3; 1:4; 1:5; 1;6; 1:7 and 1:8) for different purposes. Mortar containing the cement and sand ratio of 1:3 is generally used for flooring purposes, of 1:4 ratio is used to prepare walls of 4.5" in thickness, of 1:5 ratio for plastering lower part of walls i.e. up to 5 feet from floor level, of 1:6 ratio for plastering upper part of walls i.e. above 5 feet and of 1:7 and 1:8 ratio for constructing foundation of buildings.

ı **Concrete Mixture:** Concrete mixture is used in building construction work for lintel, slab and flooring purposes. Cement-concrete mixture is prepared with cement, coarse-sand and shingles by mixing them in different ratios according to the requirements of construction work. This mixture is prepared in the following ratios:

Table 1
Different Ratios of Cement Coarse-sand and Shingles Mixture with Their Strength Ranks

S.No.	Cement	Coarse-sand	Shingles	Strength Ranks
1	1	1	2	I
2	1	1.5	3	II
3	1	2	4	III
4	1	3	6	IV
5	1	4	8	V
6	1	5	10	VI
7	1	6	12	VII

In the construction of multi-storey buildings generally the cement concrete mixture is prepared in first three ratios while the mixtures of lower strengths are used in other construction works.

In the area of study generally cement

concrete mixture is used in most of the construction work. The main reason of this is the plentiful availability of cement, coarse-sand and shingles in this area.

ı **Plastering Material:** The consumption of mortar in plastering over brick walls depends up on the thickness of the plaster, unevenness or roughness of the surface and the dimensions of the raked joints. The thickness of plaster to be applied is always specified. Normally, 12 mm. thick plaster is applied on smooth surface of the brick wall and 15 to 20 mm. thick plaster on the uneven surface of the brick wall. Joints are raked to a depth of 10 to 12 mm. The consumption of mortar may be computed theoretically with the aid of thickness of plaster and the quantity required for filling up the raked joints. But the field observations have indicated that the actual quantity of mortar remains more to an extent of 3% on an average. It is mainly due to the breakage of edges of bricks during raking which cannot be taken into account in the theoretical calculations.

ı **Flooring Material:** Floors can be made of three types i.e. (Cement Concrete Floors, (b) Marble Chips Floors, and (c) Stone Patties/Tiles Floors. A detailed study of all these floors is being given below:

Cement Concrete Floors: Cement-Concrete floors are laid over a base of red concretes. The mix commonly used for the concrete finish is 1 Cement : 2 Coarse sand : 4 Shingles-20mm. by volume. The thickness of the concrete finish is usually kept of 2.5 cms. Extra cement is also required for finishing the top surface of the floor. In Modern time generally this type offloors are out of fashion and these are not made in private as well as in government buildings.

Marble-Chips Floors: Marble chips floors are laid down over base concrete in two layers viz under layer and top layer. The under layer normally consists of cement-concrete mixture in the ratio 1:2:4 (cement, coarse- sand and concrete respectively) and the top layer is of marble chips and binder mix. The minimum combined thickness of top layer and under layer is 40 mm. according to IS 2114. IS : 2114-1962 'Code of Practice for laying Insitu Tarrazzo (Marble Chips) floor finish. The thickness of top layer varies from 5-10 mm. and the proportion of chips to binder varies from 1.25 parts to 1.75 parts by volume, depending up on the grading of chips. The binder is composed of cement and marble powder in the ratio of 3:1 by weight. Also this type of floors is not in fashion in the present era in the area of the study.

Stone Patties/Tiles Floors: Also stone patties/Tiles floors are laid down over base of concrete in two layers viz under layer and top layer. The ratio of cement concrete mixture remains the same as in the case of marble chips floors. The top layer is laid down of stone patties/Tiles.

ı **Steel Bar, Sections and Angles:** Steel Bar is the basic raw material of lintel and beams of a building. It is consumed 80 kg. per 100 square feet in case of RBC lintel and 100 kg. per 100 square feet in case of RCC lintel. In manufacturing beams and RCC pillars it is normally consumed 292 kg. per m^3. Steel angels are normally used in making door frames and sections are used for manufacturing ventilators and windows. The consumption of angels having specification of 4 cm x 2 mm is generally 22.50 kg. per door frame having size of 3.5' x 6.5' (107 cm. x 198 cm.). As far as the consumption of sections is concerned, it depends on the strength of sections and size of windows and ventilators which may differ from building to building.

ı **Wood Material:** Wood is the most important constituent of building construction work. It is normally used in making doors, windows and ventilators. Generally the frames are made of saal wood and panels are made of sheesham, sagon, Dayer wood etc. In government buildings generally the ply-boards

are used for the same purpose. The quantity of wood to be used in building construction depends on the size and number of doors windows and ventilators in a building. On an average approximately 3.75 ft^3 wood is used in a door including frame, 4 ft^3 wood is used in a normal size window and .375 ft^3 wood is applied in a normal size ventilator.

Thus the main constituents of raw material used in building construction are Bricks, Mortar, Concrete mix, Flooring material, Plastering material, Steel bars, Sections, Angels and Wood.

iv) **Labour :** Labour is the only constituent which play an active role in building construction work. The function of labour starts from the very beginning of construction work and continues till the end of finishing work. Thus, labour is the most important constituent of building construction work. Total labour of building construction work can be divided into the following categories:

- **Mason:** Mason is the worker who erects building structure using bricks, cement, concrete, sand etc. These persons are called Raj-Mistri in local language.

- **Labour (Beldar):** Labour is the person who helps the mason in his work. Actually he is the helper of Raj-Mistri and provides ready material to him at his working site. He is called Beldar in local language.

- **Carpenter:** Carpenter is the skilled worker who performs wood-work in a building. Normally doors, windows, ventilators, wooden almirahs and furniture are manufactured by him.

- **Glazier:** Glazier is the worker who fit glasses in doors, windows etc. In other words, glazier is the skilled worker who does glass-work in a building.

- **Painter:** Also the painter is an important person who does the painting work in a building. He paints walls, doors, windows, ventilators, grilles, railings etc.

- **Blacksmith:** Blacksmith is the person who prepares grilles, railings, section windows, shutters etc. All the steel work is done by him.

Thus Mason, Beldar, Carpenter, Glazier, Painter and Blacksmith are the important working hands in building construction work and without their services no erection work is possible.

v) **Shuttering:** Shuttering is an important and inevitable constituent of building construction work. It is required at the time of laying slabs and lintels. In most of the cases the shuttering is hired from the dealers on the basis of covered area of the building. Following two types of shuttering are normally used in the area of the study:

- **Wooden Shuttering:** This type of shuttering includes Bamboos, wooden logs of different sizes, steel frames/ wooden patties, ladder, sandli, Chali, Barange, copra ropes etc. This type of shuttering is normally used in small building which are constructed by private owners.

- **Steel Shuttering:** Steel shuttering includes iron pipes of different sizes, iron plates, nut-bolts, steel ladder, and sandli made of iron angles. This type of shuttering is normally used in big buildings, multi-storey buildings and government construction works.

vi) **Tools and Machinery:** In building construction work also tools and machinery play their significant role. For the purpose of study these may be divided into the following heads:

- **Tools:** In building construction work different types of tools are used by masons and beldars. These tools are – Karni, Bisoli, Level, Soot, Fanta, Gutka, Majhola, Tasala, Spade, Hammer etc. All these tools are arranged partly by masons and partly by the owners or contractor.

- **Machinery:** In building construction work few machinery like mixture, grinder, stone cutter, vibrator, lifter etc. are also used. All these machinery are arranged either by contractor or by hiring from the market.

vii) **Time:** Time is the most important constituent of building construction work as it is concerned with money involvement and supervision expenses. If the construction work takes extra-ordinarily long time in its completion, the owner has to bear higher cost in the form of extra interest on capital, price hike of raw materials and extra supervision cost for the ingenuine period. Moreover, in government construction works contractors have to pay penalties if they remain failure to complete the construction work in pre-decided period. Hence, time element has its own importance in the building construction work either it is single storey building or double building or multi-storey building.

b) Internal Water Supply and Sanitary Services

Internal water supply and sanitary services is the second part of building construction work. It includes the following two constituents:

i) Material: For internal water supply and sanitary services different types of materials (components) are required. These are Water closet (WC), Wash Basin, Mirror, Urinals, Soaps Container, Sand Cast Iron (SCI) pipes (100 mm. and 50 mm.) pig led, Traps, Bends, Junctions, SW pipes 150 mm., Cement, Sand, Coarse aggregate, Spun yarn, GI pipes (15 mm., 20-25 mm., 32-50 mm.), Bibcock 15 mm., Stopcock 15 mm., Lead connector etc. The quantity to be used of all these materials (accessories) depends on the size of building and requirement of users.

ii) Labour: Four types of workers are engaged in water supply and sanitary services. These are Fitter Helper, Mason and Beldar. Fitter is the technical person who performs the work of fitting the different accessories related to water supply and sanitary in a building. A person who assists fitter in his work is called helper. Mason (Raj Mistri) is a person whose work starts after completion of fitter's work. Actually he does the repair and finishing work in walls, kitchen, toilets etc. Beldar (Majdoor) is the helper of mason who helps him in his work.

c) Internal Electrical Services

Internal electrical services include all the electric fitting work in a building. The constituents of this part of building construction may broadly be divided into the following two parts:

i) Material (Electric Accessories): For electric fitting various types of electric goods and other accessories are used. Normally these electric goods and accessories are 5 Amp. Tumbler switch (single pole), 15 Amp. Tumbler switch (single pole), 5 Amp. 3 pin socket, 15 Amp. 3 pin socket, 1.5 sq. Mm. PVC insulated alloy conductor single core cable, 2.5 sq. mm. and above PVC insulated aluminium conductor single core cable, HG Conduit 19 mm. dia. HG conduit 25 mm. and above, inspection bend 19 mm., Conduit inspection bend 25 mm. and above, socket for 19 mm. conduit, socket for 25 mm. and above conduit, saddles/staples, IC box 200 mm x 150 mm x 100 mm., IC box 75 mm x 75 mm x 60 mm phenotice laminated sheet, 2.24 sq mm bare aluminium wire, junction box 1 way, ceilingrose (2 plates), Iron screws 45 mm, 35 mm and 20 mm washers, Florescent light fitting, other light fittings, round wooden block, Ball and socket, check nut, Bush etc. All these fittings are required according to the size of building under construction and the specific requirements of the users.

ii) Labour: Four types of workers are required for electric fittings in a building. These are wireman, helper, mason and Beldar. Wireman is the technical person who fits electric switches, holders, meter board etc and does wiring work in the building. Besides, he completes all the wire connections work. He is fully skilled worker in electric field. There is also a semi-skilled worker with him who is called his helper. He assists him in his work. Mason and Beldar do repair work after the completion of wireman's work. •

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