Aam Aadmi Series - 5

HOUSE BUILDING DIGEST

(Construction Specifications-Superstructure)

bmtpc

Creating Enabling Environment for Affordable Housing for All

This is an attempt by BMTPC to provide useful but often ignored information about multifarious activities involved in house construction and other technical and non-technical matters associated with building materials and construction technologies. The series is being brought out with a specific rationale to reach out to common people of our nation and make them acquainted about building construction. Every individual has a dream of owning a house and through this series which is aptly named Aam Adami Series, we will slowly unravel myths and misconceptions about building construction. The language used here is lucid and simple to comprehend. The complicated technicalities are explained in a parlance which can be understood by one and all.

Superstructure

The elements of house construction include the foundation and superstructure. Having completed the foundation in a proper way, the next important element of construction is 'Superstructure' which has been dealt in this booklet.

Superstructure is the portion of the house constructed immediately above the substructure (Foundation and Plinth). It is the mainstay of the house as its proper construction enables comfortable and safe living. It basically consists of the walls, columns, beams, slabs, staircase and other such elements which may be required in the basic construction of a house.

Construction Types

There are a number of ways in which the superstructure can be built. In areas where average to good quality bricks are available, the walls of houses for two to three storeyed construction can be built out of bricks with the slabs, beams etc in reinforced concrete. Such construction is termed as load bearing construction. In areas where the quality of bricks is not dependable, it is advisable to build the house in Reinforced Cement Concrete (RCC) framed construction. However, there may be occasions where a combination of both the ways is required.

The type of superstructure is also dependant upon the nature/structure and Safe Bearing Capacity (SBC) of the soils, the number of storeys to be constructed, building plan, the available budget for construction etc. It is also dependant upon the choice of the owner, if it is structurally safe to build with any of the two types, i.e. with bricks or with RCC.

1. Brick Construction (Load Bearing Construction)

If the superstructure walls are primarily constructed with bricks it is called a 'Brick Load Bearing' construction. This is essentially because the entire load coming from the slabs, beams, walls etc is transmitted to the foundation through the brick walls. Where good quality bricks

Brick Load Bearing Construction

are available such load bearing construction will also prove to be economical.

Normally, the thickness of the walls should be kept as 23 cm (9") for upto two to three storeyed constructions. Good quality bricks are normally available in the Northern regions of the country from the State of Punjab to West Bengal. In the other regions the strength of the bricks is relatively less as the local soil available for their manufacture is not that good for brick making.

Brick Dimensions and Strength

Most of the bricks in the country are manufactured out of good soils and normally the size of the brick is 22.5 x 11.5 x 7.5 cm (9"x4½"x3") whereas brick of other sizes including 25x12.5x10 cm (10"x5"x4") are also manufactured. Good bricks, made out of soils, are bright red in colour and make a ringing sound when struck against each other. Good bricks should not absorb water more than 20% of their dry weight, when immersed in water for 24 hours.

The strength of a good brick can be 100 Kg/cm^2 or more. This strength can be got tested from the testing labs meant for the purpose. It is advisable to construct load bearing walls for upto two storeys only if the strength of the bricks is not good (say less than 70 Kg/cm^2). These values are indicative only for the information of the common man.

The owner must inspect the houses in the surrounding areas for assessing the thickness of the walls being adopted in construction, the number of storeys as well as the quality of bricks that have been used in construction. Normally, an experienced Architect/Engineer can interpret the quality of the brick to a reasonable extent.

Nowadays modular sized bricks having dimensions of 20x10x10 cm (8"x4"x4") are also being manufactured which are said to be economical in construction. These bricks can also be used for load bearing construction of superstructure.

Bricks can also be manufactured from other materials also like flyash, lime, concrete etc details of which will be given in a subsequent series of the digest.

Mortars for Brickwork

Brickwork in superstructure is laid with mortars. This mortar contains a binding material which is usually cement (although other cementing materials like lime etc can also be used). The other component is usually sand which can be coarse or fine in character, depending on the strength requirements of the brick masonry walls. Coarse sand provides higher strength in masonry than the finer sand.

The most common mix used for mortars consists of one part of cement and 6 parts of sand (1:6), however a mix of 1:4 or 1:3 can also be used if higher strengths are required. The proportions are however defined by the Architect/Engineer in the specifications of construction for the house.

Both cement and sand are mixed properly and required quantity of water is poured to get the mortar. The bricks are then laid in a particular pattern called 'Bond' with mortar of required thickness.

Bonds in Brickwork

The brick laying patterns or 'Bonds' as they are better known are dependant upon a number of factors including the local practices being followed. Usually a bond called the 'English Bond' is followed for construction in India. For the information of the house owner the pattern of laying of English Bond is given in Fig 1.

Care should however be taken that the superstructure walls are constructed in an exactly vertical manner, otherwise the structure will not be safe.

The bricks being used in the superstructure should be soaked in water before use. Further, the mortar should be spread on the bricks in a uniform manner so that a flat and even surface is obtained.

In order to obtain the required strength, the brick wall should be cured with water for at least seven days after construction. It is therefore advised that the date on which a particular wall is constructed should be painted on the wall itself.

The bonds should be laid in a manner that all the reinforcement bars required for the seismic strengthening measures are accommodated at the right places say at corners and junctions or at other such places as may be directed by the engineer. A close coordination of the owner is required with the engineer, architect and the contractor.

All openings for doors/windows, pipes, fittings etc should be appropriately provided in the superstructure walls.

Workmanship

Workmanship in simple terms would mean the ways and means being adopted by the mason and unskilled labour for construction of the superstructure walls of the house.The owner is expected to keep a close watch on the same.

The mason should have proper masonry kit for construction of the walls. This would include the water level, leveling tool, tools for keeping the wall in plumb besides other tools required for constructing the masonry.

Good workmanship would ensure that the wall corners and joints are meeting at 90^0 or at the required angles as may be required in the architectural plan. It would also ensure that the walls are truly plumb. Curing of masonry walls, which is to be done by waterman, would make them achieve the required structural strength.

In short good workmanship would make the house robust and strong.

2. RCC Framed Construction

Houses which have rooms of large spans say five meters or more, or where the quality of bricks is not good for adopting load bearing construction, RCC framed construction is usually adopted (Fig 2). Basically, RCC framed construction consists of a series of columns provided at corners and junctions or other such places in the house which are interconnected by beams to form a frame. For residential construction the columns and beam frames are put up in Reinforced Cement Concrete (RCC).

The frame, starting from the foundation, has to be designed by the structural engineer who would decide upon the mix of concrete to be used, the sizes of columns and beams as well as the reinforcement to be provided therein. For RCC framed construction the foundations are also to be provided in RCC.

RCC framed construction may be costlier than the load bearing brick wall construction, especially for residential houses of two or three storeys. It is accordingly recommended that RCC framed construction should be adopted only when it is absolutely necessary. Discussions on this issue should be had with the architect and the

RCC Framed Construction

structural engineer at the initial stages of planning and design of the architectural plan of the house.

The space between the frames is filled up with brick walls or other such material as may be required as per the architectural details.

Sizes of Beams and Columns

The sizes of beams and columns in the frame are largely dependant upon the load coming on each column and beam. A square or rectangular shape is adopted for them and a typical column size may be 30x30 cm (1'x1') and a typical beam size can be 22.5x30 cm (9"x12"). An ideal situation would be to have uniform sizes of columns and beams.

The RCC frame has to be structurally designed by a Civil/Structural Engineer and the owner should refrain from the advice/suggestions of non-professionals/thumb rules. Typically, the reinforcement bars provided in the columns and beams can be four in number having diameters of say 8mm or 10mm. The vertical bars are usually tied at about 22.5 cm to 30 cm (9" to 12") spacing by 6mm dia bars to get a proper cage. (The diameter of bars and spacing etc given are just indicative and in practice the structural design should be followed strictly).

The requirements of seismic strengthening should also be taken care of while structural designing of the frame.

Concrete Mix

The concrete mix adopted for encasing the reinforcement cage of beams and columns usually has the proportion of 1:1 $^{1}/_{2}$:3, i.e. 1 part of cement, 1 $^{1}/_{2}$ parts of coarse sand and 3 parts of stone aggregates having a maximum size of about 20 mm. For getting good quality mix all the three materials should be mixed in a concrete mixer and good quality water should be used for mixing.

The owner should see that the coarse sand and aggregates do not contain impurities like tree leaves, pieces of wood and the like.

Accordingly the coarse sand and aggregates should be washed clean by water before using them for construction. The Structural Engineer would be able to advice regarding the concrete mix to be adopted for construction.

Constructing the RCC Frame (Columns and Beams)

The construction for the frame commences from the foundation. RCC isolated/combined base of the footing or raft foundation is first constructed and shuttering is provided for the columns around the reinforcement cage put up initially. Concrete mix is then poured into the shuttering and vibrated properly.

The shuttering is usually removed after five to six days and the concrete surface is cured with water for about a week or so, depending upon the climatic conditions. During the summers the curing has to be done for a longer period. Similar process is to be adopted for construction of beams.

Columns

The columns can be constructed square, rectangular, circular etc as per design. The reinforcement cage (as per design) has to be properly placed vertically and tied (as directed by the structural engineer), giving proper cover. These bars should be provided with sufficient overlaps, when constructing higher floors.

Care has to be taken that the formwork (shuttering etc) is truly vertical, without any eccentricity. The shuttering has to be tied properly such that it does not split while pouring the concrete and its subsequent vibrations.

Concrete of the desired mix has to be poured gradually and properly vibrated to avoid any honeycombing. On removal of the shuttering the column has to be cured for about 7 to 10 days by putting gunny bags, which have to be kept moist.

Beams

Beams in the RCC frame are normally square or rectangular. The reinforcement for he beams has to be placed properly and tied with the columns at the intersections and junctions. The formwork for the beams (base & side shuttering and centering) has to be provided with great care, especially at the junctions and intersections of columns and beams.

Concrete of the desired mix has to be poured gradually and vibrated. The side shuttering of the beams can be removed within about 12 to 15 hours. However the bottom shuttering can be removed within 10 to 14 days as per directions. Curing has to be done as in case of columns.

The construction has to be done under the supervision of the Architect/Engineer or other such professional. Proper curing is one of the key factors in RCC constructions.

3. Floor Slabs

Floor slabs can be provide in a number of ways in a house. Traditionally, in the hilly regions of the country like J&K, Himachal Pradesh etc, wooden floors are provided; in the State of Rajasthan floors are provided in stone patties; Bamboo flooring is usually provided in the North Eastern States; in the States where good quality bricks are available, bricks are being adopted for providing the floor slabs by adopting different construction methods. The roof slabs are also being accordingly provided depending upon the availability of local materials.

RCC Floor/Roof Slabs

Reinforced Cement Concrete (RCC) floor/roof slab construction is the commonly adopted method especially in the urban areas of the country. Accordingly, the same is highlighted hereunder.

Slab Thickness

The slabs are spanned across the walls or the beams, as the case may be. For a span of about three to four meters the slab thickness is usually of the order of 11 cm to 12 cm, although the exact thickness has to be as per the design of the structural engineer.

Concrete Mix

The concrete mix to be used is usually 1:1 $^{1}/_{2}$:3 as has been explained under the head of columns and beams in RCC Framed Construction in the booklet.

Reinforcement

The reinforcement for slabs is normally of 8 or 10 mm dia size and is laid in both the directions. The size and spacing of the reinforcement bars has to be designed by the structural engineer. Slab being a crucial element of construction of the house, the advice of non-professionals should not be followed by the owner.

Construction of RCC Slab

The process of constructing the RCC slab commences by erecting the centering and shuttering. Wooden shuttering is usually provided for the purpose although steel shuttering is recommended for getting a good undersurface of the slab. Once the shuttering has been laid in a level, it has to be cleaned properly. A bitumen coat is then applied on the top such that the concrete, which has to be laid, does not stick to the surface of the shuttering.

The reinforcement bars are then laid as per design in both directions and tied properly with steel bars. Cover for reinforcement is provided by putting wooden or concrete blocks over the shuttering.

The concrete is then laid continuously to the required thickness and span and vibrated effectively such that no air gaps are left in the concrete.

The curing of top surface of concrete should commence within two or three days of its laying. Depending upon the climatic conditions, the curing should be done for 10 to 14 days. Alternatively, water pools can be made on the top of the slab by making squares in mud and filling them the same with water. The pools should be filled with water as soon as the same dries out. Curing can also be done by putting wet gunny bags on the concrete surface.

The side shuttering of the slab can be removed within 48 hours. However the bottom shuttering can be removed within 10 to 14 days. The undersurface of the concrete should be cleaned with steel brushes such that no impurities are left on the surface.

Although the slab should be constructed under the supervision of a professional, the owner should oversee that all the precautions are being taken during construction

4. Filling up the RCC Frame

The RCC frame so obtained should be filled up by brick walls or other such building material as would have been decided by the Architect under the 'Construction Specifications'. The external walls are usually having a thickness of one brick (22.5 cm) whereas the internal walls can be kept as half brick thick (11.5 cm). Proper openings for doors, windows, lintels and other fixtures to be provided have to be kept in the filler walls

5. Staircase

Another element of superstructure is the staircase which can be made in concrete, wood or steel etc. Some of the critical elements of staircases are as given herein (Fig 4).

Staircases are provided in a house to provide connectivity between two floors or levels. The effort in the design of the staircase is to facilitate an easy up and down movement of the individual without causing much stress, specially for the elderly. Accordingly, Its elements as indicated in the figure have to be properly proportioned.

Typical Flight of Stairs

Staircases can be constructed in a number of ways depending upon the location, purpose, availability of space and the like. (Fig 3). Some of the guiding criteria for the design of the staircase is given here.

The location of the stairs should be such that there is sufficient light and ventilation in the stairway. The slope of the stairway is normally kept between 25° and 40° and the width of the stair at lest 90 cm. From considerations of comfort and safety the rise and tread of the stair should be uniform and their ratio should be such that there is a comfortable climb up and down. However, the advise of the Architect should be closely followed in its design and construction.

The staircase design must meet technical requirements that ensure safe and functional construction that complies with the Building Codes and appropriate Standards.

6. In Conclusion

The planning and construction of superstructure of the house is a critical issue from considerations of safe and healthy living. The type of superstructure to be provided is dependent on the availability of the local materials and skilled manpower, existing construction practices etc.

It is advisable to have the advice of the Architect and the Structural Engineer before planning and construction of the house.

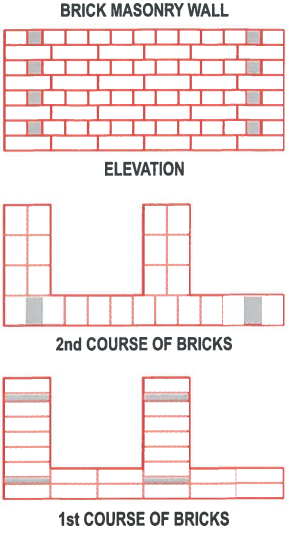

Fig. 1 : English Bond in Brick Work

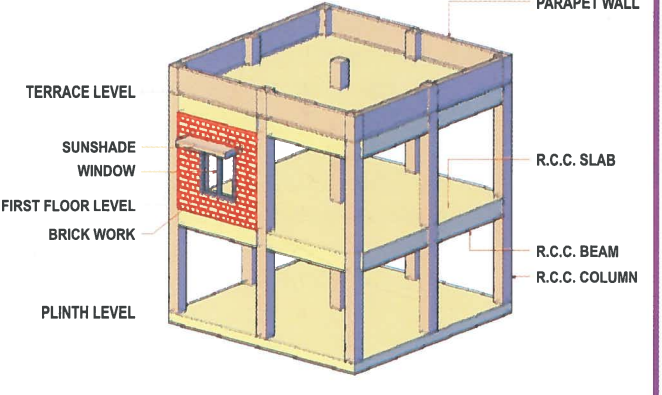

Fig. 2 : Typical R.C.C. Frame Structure

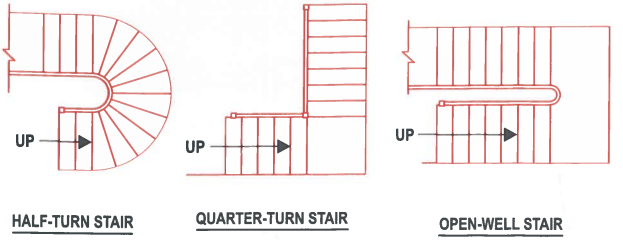

Fig. 3 : Types of Stairs

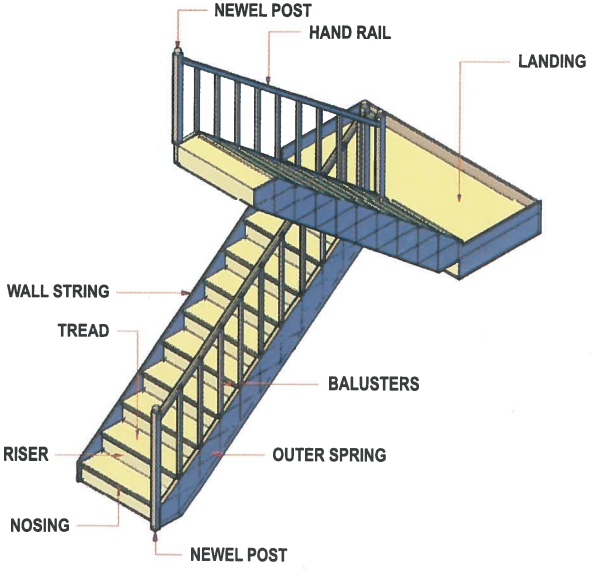

Fig. 4 : Typical Stair Detail

BMTPC

The Building Materials & Technology Promotion Council (BMTPC) was setup in 1990 as an inter ministerial organisation under the Ministry of Housing and Urban Poverty Alleviation to bridge the gap between the laboratory research and field level application.

VISION

BMTPC to be world class knowledge and demonstration hub for providing solutions to all with special focus on common man in the area of sustainable building materials, appropriate construction technologies & systems including disaster resistant construction.

MISSION

To work towards a comprehensive and integrated approach for promotion and transfer of potential, cost effective, environment-friendly, disaster resistant building materials and technologies including locally available building materials from lab to land for sustainable development of housing.

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