



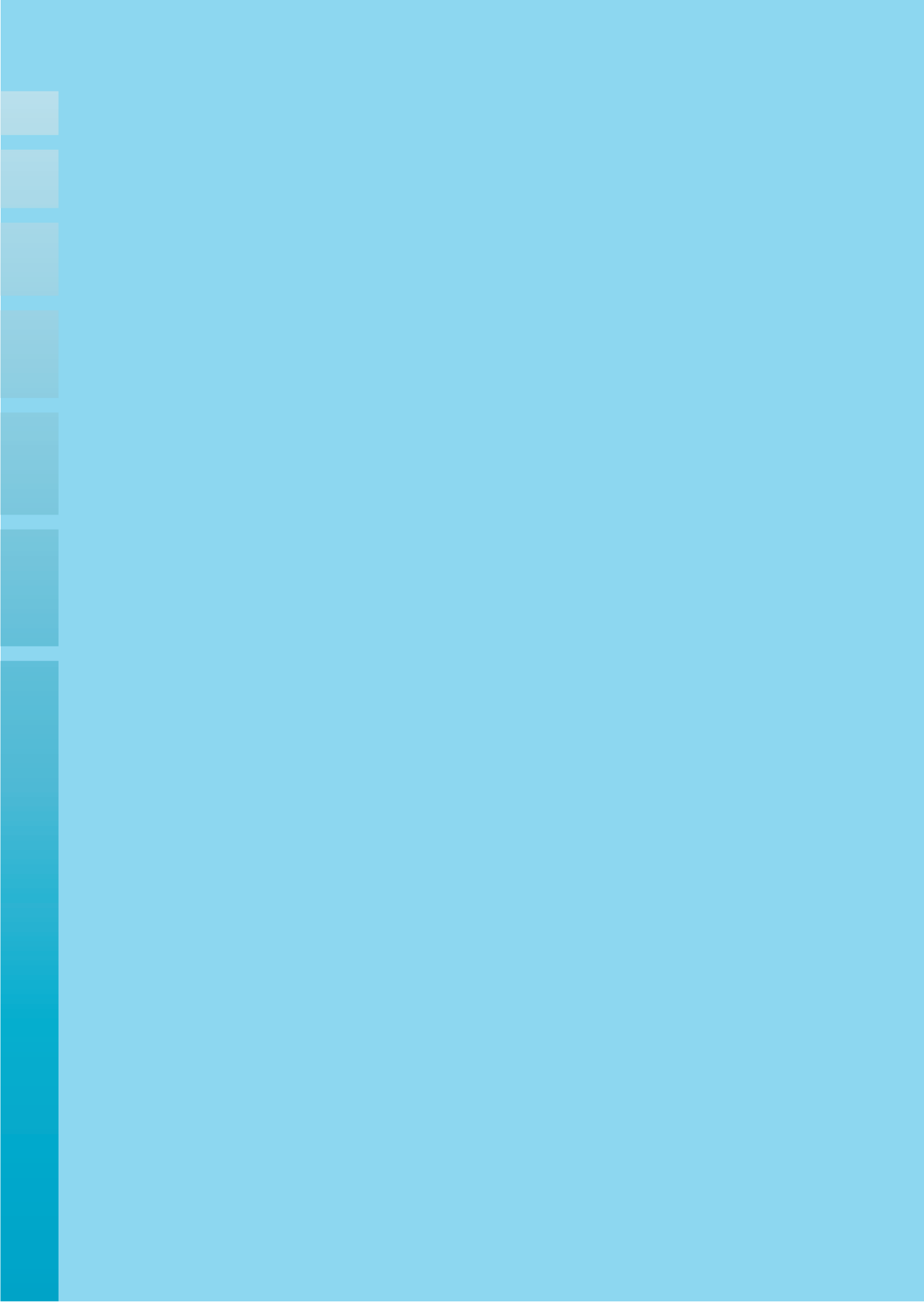
Block-by-Block

How to build the perfect home



**Perfect Ghar Ke Liye
Perfect Rebar**

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1

Planning

Good planning makes life simpler when you build your home. The first step is to allocate funds for plot purchase and house construction separately from your total budget.

The following are some important factors to be considered while selecting the plot location:

- Distance from work place, railway station, bus stand and airport
- Availability of public amenities like road, water, electricity, drainage, etc.
- Availability of hospital, parks, recreational centres, etc.

Keep in mind, the following things while purchasing a plot

- The land is not prone to frequent flooding
- The soil is not soft and is not liquefiable. (This could be a problem particularly in the river bed and coastal areas)
- There are no known earthquake faults in close proximity to your plot
- The plot should not be under any acquisition / litigation proceedings
- The plot is designated for residential use
- Check for plot survey number and ensure that the land title deed is clear
- Obtain a No Objection Certificate for the plot from the registrar's office
- Take advice from experts about relaxation on stamp duty during land purchase



1.1 Hiring Services of Professionals

Once you finalise the land you can meet professionals like Architects / Engineers / Contractors, etc. for the design and drawing of your house. He should be registered with the Municipal Authority and fully conversant with the Development Control Regulations and Building By-laws. He will provide you with the plan, elevation, side and rear views of your proposed house along with steel reinforcement details. From your hired professionals you will need to get the following (if applicable):

- Certificate of Undertaking from Architect
- Certificate of Undertaking from Structural/ Civil Engineer
- Certificate of Undertaking from Construction Supervisor
- Certificate of Undertaking for Hazard Safety Requirements (to be signed jointly by the Owner and the Structural Engineer)
- Structural Design Basis Report from the Structural / Civil Engineer
- Soil Investigation Certificate from the Geo-technical / Soil Engineer
- Certified copies of Building Plans
- No Objection Certificate from various authorities

Generally fees charged by the Architects / Engineers are a small percentage of the total construction cost. But a good professional can compensate this expense by designing your house in an economical way.

If you are engaging a contractor then specify the terms and conditions in writing to him. You must specify the construction schedule, payment terms, quality of work, quality of materials like cement, sand, steel, finishing & fittings, flooring, painting, electricals, sanitary items, doors & windows, etc. in the contract specification.



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1.2 Budgeting and Estimation

Estimates will depend on the actual design and drawing of your home and market rate of materials and labour. However, an approximate estimate can be done before that.

Cost estimation can be done broadly on two heads – land cost and construction cost.

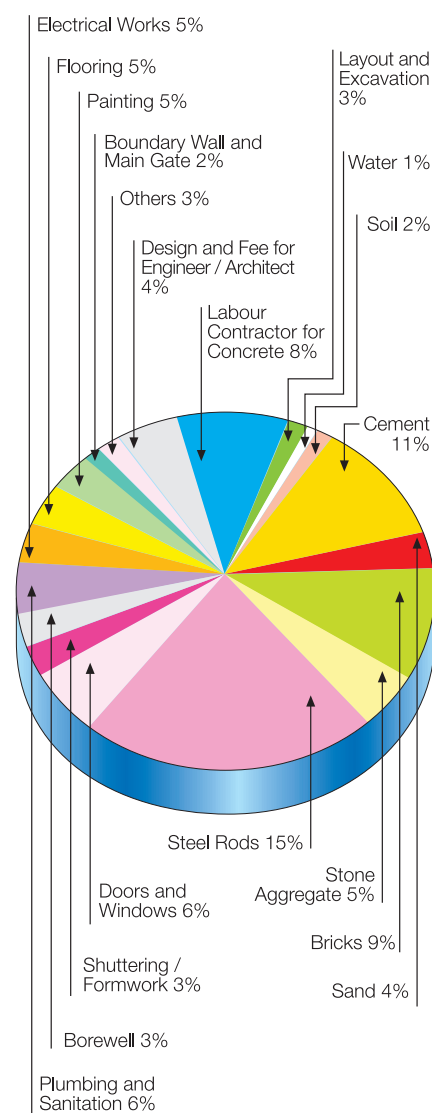
Land cost includes actual cost of land and the land registration cost. For example, if you buy a plot of 1200 square feet at the rate of say Rs. 300 per square feet, the cost of land becomes $1200 \times 300 = \text{Rs. } 3.6 \text{ Lac}$, excluding the land registration cost which varies from state to state.

Construction cost depends on the quality of construction and the finish one wants to have. Finishing can be a high class finish, a medium class finish or an economy class finish. This includes quality of flooring, electrical works, sanitary & fittings, paints, timber, doors & windows etc. Just to illustrate - a high class finish construction can cost you as much as 50%-100% higher than an economy class finish. So simply put, finishing cost depends on the amount one wants to spend on the house construction.

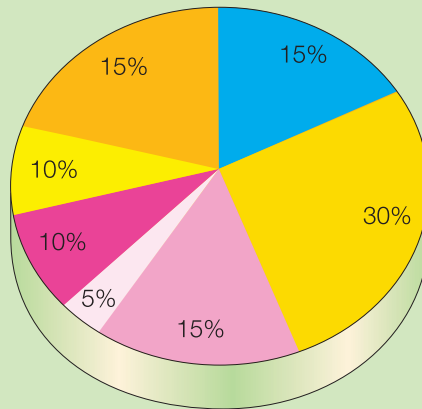
While you can always make a rough estimate of the cost using your judgment, but it is always advisable to take professional consultation on budgeting of the construction project.

Construction costs can be divided into material cost, labour cost and other expenses in the ratio of 60:30:10 respectively. For instance, if you incur Rs 10 lakh in construction cost then you should incur Rs 6 lakh on material, Rs 3 lakh on labour and Rs 1 lakh on other expenditure. You can also estimate the item wise cost of construction as per the pie chart below.

Item-wise cost break up of construction



Stage-wise break up of construction cost as given below can help you plan your financial outflows during construction



- Excavation, Concrete for Foundation and Plinth
- Superstructure Concrete & Brickwork
- Roof Slab
- Flooring
- Plastering & Painting
- Doors, Windows & Woodwork
- Water Supply, Sanitary Fittings, Electrification & Others

Note: Above estimates are tentative and may vary from place to place

*1.3 Planning Material Requirements

1.3.1 Reinforced Cement Concrete (RCC) Work

Material requirement for 1 cubic metre of RCC is given in the table below.

Concrete Mix	Water and Cement Ratio	Water (Litre Per Bag of Cement)	Cement (Bags)	Sand Stone (Cubic Metre)	Aggregates (Cubic Metre)	Steel Rebars (Kg)
M 25 (1:1:2 approx.)	0.35	17.5	11.2	0.40	0.80	80 - 120
M 20 (1:1.5:3 approx.)	0.42	21.0	8.0	0.42	0.83	75 - 115
M 15 (1:2:4 approx.)	0.55	27.5	6.2	0.43	0.87	70 - 110

Note: Indian Code IS 456:2000 has recommended that minimum grade of concrete for PCC and RCC is M 20 (1:1.5:3 approx.).

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1.3.2 Brickwork

Material requirement for 1 cubic metre of brickwork for various mortar mixes are given in the table below.

Mortar	Cement (Bags)	Sand (Cubic Metre)	No. of Bricks
1:3	2.6	0.267	500
1:4	1.9	0.275	500
1:6	1.4	0.299	500



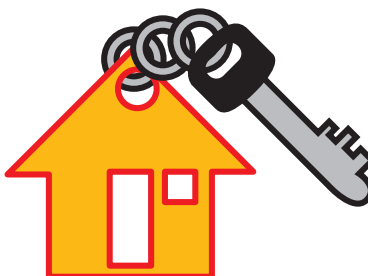
1.3.3 Plaster Work

Material requirement for 100 square metre of plaster of 12 mm (1/2 inch) thick is given in the table below.

Mortar	Cement (Bags)	Sand (Cubic Metre)
1:2	21	1.4
1:3	15	1.5
1:4	12	1.6
1:6	9	1.8

*Note: Add about 5% more material for wastage in all estimates.

1.4 Home Loan



From above estimates you can derive the cost of construction and look for a home loan if required. Do not forget to examine the repayment terms and interest rates of the bank / financial institution from where you wish to avail the loan. Look for hidden costs, if any, and carefully examine all the terms and conditions of the loan offer.

2 Construction Material

2.1 Cement

Cement is a very important construction material. It was invented by a mason named Joseph Aspdin in England in 1824. Cement when mixed with water and other material like sand, aggregates (gitti), etc. binds them together. It is used in concrete, brickwork and plaster work. Generally the following two categories of cement are used for normal house construction.

1. Ordinary Portland Cement (OPC)	2. Blended or Composite Cement
• 33 grade • 43 grade • 53 grade	• Flyash Based Portland Pozzolana Cement • Portland Blast Furnace Slag Cement

Grades 33, 43 and 53 represent minimum compressive strength of cement sand mortar cubes after 28 days. For example the minimum compressive strength of 43 grade OPC would be 43 N/mm² or 430 kg/cm² after 28 days. Always use good quality cement for your house.

2.1.1 Characteristics of Good Cement

Cement should feel smooth when touched or rubbed between fingers. If it feels rough, it indicates adulteration with sand. When hand is inserted in a cement bag it should feel cool and not warm. If a small quantity of cement is thrown into a bucket of water it should sink and not float on the surface. Cement should be free from hard lumps. If a thick paste of cement and water is made on a piece of thick glass and kept under water for 24 hours, it should set and crack. This is sign of cement having good strength. Initial setting time of normal cement should be about 30 minutes.

2.1.2 Safe Storage of Cement

Cement should always be kept free from moisture and water. A cement storage shed should have a finished floor raised atleast 150 mm from ground level, and should have airtight doors and windows. At site, cement should be kept on a raised platform, covered under tarpaulin. As cement deteriorates with time, the First-In-First-Out (FIFO) method should be adopted in its use. Also, cement should be used within 2-3 months from the date of manufacture.

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2.2 Sand or Fine Aggregates

Sand is classified as fine sand (used for plastering), coarse sand (used for masonry work) and gravelly sand (used for concrete). Good sand should be chemically inert, well graded, clean and coarse. It should contain sharp, angular and durable grains. It should be free of any salt and organic matter.

Following tests can be carried out to ascertain the properties of sand:

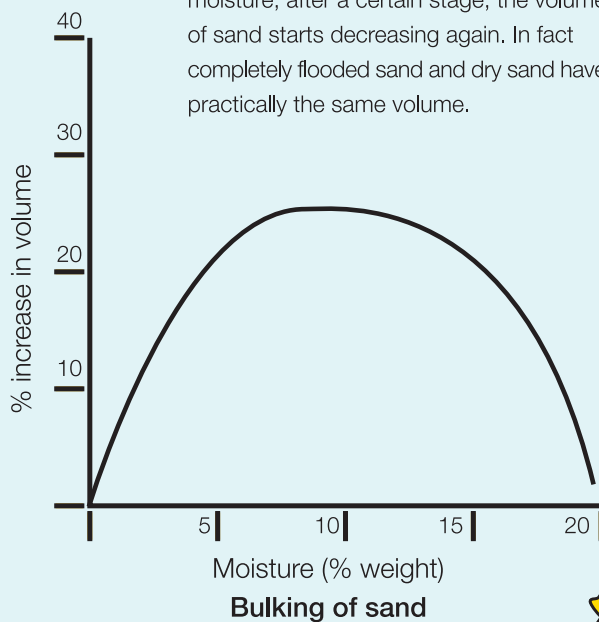
1. A glass of water is taken and some quantity of sand is placed in it. It is vigorously shaken and allowed to settle. If clay is present in the sand, its distinct layer is formed on top of sand.
2. Sand is taken from a heap and it is rubbed against the fingers. If fingers are stained, it indicates that sand contains earthy matter. Usually 3-4 percent of clay is allowed in sand.



2.2.1 Bulking of Sand

The presence of moisture increases the volume of sand. For example, at moisture content of about 5 to 8 percent, the volume of sand increases by as much as 20 to 40 percent as compared to dry sand. This means that you need to add 30% extra sand under this condition. Needless to mention, you will need to correct the volume of water in the mix accordingly.

But if we keep on adding more and more moisture, after a certain stage, the volume of sand starts decreasing again. In fact completely flooded sand and dry sand have practically the same volume.



2.3 Stone Chips or Coarse Aggregates

Stone pieces (crushed rocks) are used as coarse aggregates. At many places, 10 mm pieces of stone are called grit and 20 mm pieces coarse aggregates. Generally 20 mm and 10 mm aggregate ratio in the range of 60:40 to 70:30 is used for concrete work.

Your coarse aggregate or stone chips

- Must be clean, dense, hard, durable and structurally sound (neither flaky nor elongated) and capable of bonding well with cement
- Should be cubical in shape
- Should be stored properly and different fractions must not be mixed together



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2.4 Steel Rods or Rebars

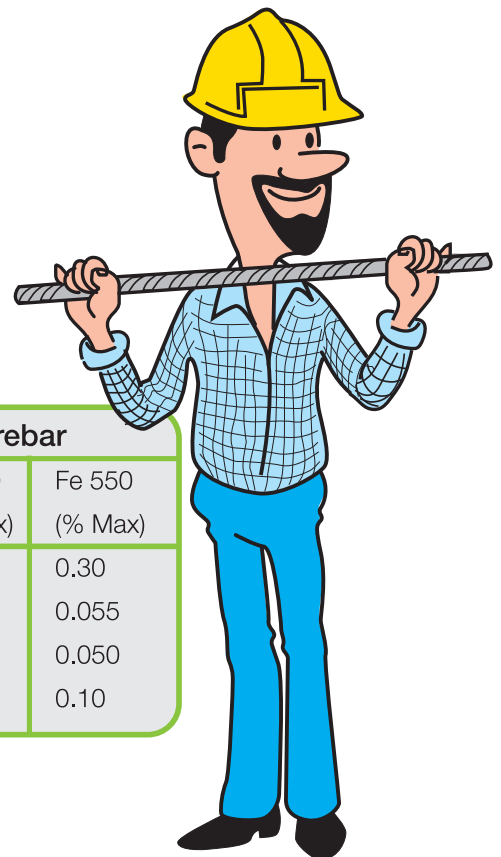
Rebar is a short form of reinforcing steel rods. It is the most important component of RCC structure. Since concrete cannot take tensile loads, steel rebars are cast into it to carry the tensile loads. There are many grades of rebars in the market but nowadays Fe 415 and Fe 500 grades of TMT rebars are most commonly used. Rebars range in diameter from 4 to 50 mm. For general house constructions, bars of diameter 6 to 20 mm are used.



For any steel rebar, weight per running metre is equal to $d^2 / 162$ kg, where d is diameter of the bar in mm. For example, 10 mm diameter bar will weigh $10 \times 10 / 162 = 0.617$ kg / m. In India, quality and properties of steel rebars are governed by the code IS:1786.

Any construction rebar must have the following chemical compositions

Constituent	Grades of rebar		
	Fe 415 (% Max)	Fe 500 (% Max)	Fe 550 (% Max)
Carbon	0.30	0.30	0.30
Sulphur	0.060	0.055	0.055
Phosphorous	0.060	0.055	0.050
Sulphur + Phosphorous	0.11	0.105	0.10



Strength and elongation of rebars must comply with the following standards

Grade of Rebar	Minimum Yield Stress (N/mm ²)	Minimum Ultimate Tensile Strength (N/mm ²)	Minimum Elongation (%)
Fe 415	415	10% over Yield Stress but $\nless 485$ N/mm ²	14.5
Fe 500	500	8% over Yield Stress but $\nless 545$ N/mm ²	12.0
Fe 550	550	6% over Yield Stress but $\nless 585$ N/mm ²	8.0

You should ask for the test certificate from the steel supplier to verify the quality.

2.4.1 A Misconception about Rebars:

“Reddish Rebars are not Good”

Sometimes, due to contact with moisture and air, rebars develop a reddish colour. Reddish rebars can very well be used in construction if they are in proper physical form, weight and strength.



2.5 Water

Water is as important as any other material. It helps cement in hydration and distributes the cement evenly. Water also lubricates the concrete mix and gives the workability required for proper compaction. Water should be free from any salt, silt, organic compound, etc. Potable water is recommended for the purpose of construction and curing.

You must remember to use the minimum quantity of water for mixing of concrete and mortar, and maximum water for curing.

3 Construction Practices

3.1 Foundation Work

3.1.1 Soil Testing and Type of Foundation

For designing strong and economical foundations, soil testing is very important. Generally the soil strength is more for that soil which has high density and fewer voids. For example, rocky soil is better than clayey soil. If the bearing capacity or strength of soil is less, then it can be improved by various methods. For instance, in case of black cotton soil or soil types with low load bearing capacity, use pile foundations or continuous foundations. Take help from your engineer in this regard.

3.1.2 Layout and Excavation

Layout is the marking of boundary lines for digging the foundation. Use a right angle and line-string to mark perpendicular lines at various distances for foundations and columns, as shown in your design drawings. Excavation should be done as per the drawing.

Underground water may seep in excavation pit. The water should be collected in the trenches / sumps and then drained out using a de-watering pump or bucket. Excavation up to hard strata is ideal. Clean and water the bottom surface, before it is rammed. It is advisable to lay 2-3 inch thick plain cement concrete below the RCC foundation.

3.1.3 Back Filling

Best material for back filling the foundation is mooram. If it is not available then either good quality clay or sand may be used. Filling should be done in layers of maximum 6 inch thickness, sprinkling each layer with water before compaction, using a ram or plate compactor.



3.2 Steel Reinforcement

Plain concrete without reinforcement is like a body without bones. Steel reinforcement is one of the best forms of reinforcement to take care of all kinds of stresses generated in a structure. To make the structure strong and long lasting, the steel rods must be of good quality and strength. It is advised that the same type and grade of steel should be used in a structural member. Ask your engineer to do the reinforcement detailing for earthquake resistant construction, if your house is located in seismic zone III, IV or V. Special rebars which have better UTS / YS ratio can be used in such constructions. TATA TISCON Super Ductile rebar is one such rebar available.



3.2.1 Bar Bending Schedule

You should ensure that bar bending schedule of steel reinforcement bars are prepared in advance before cutting and bending of rebars. This schedule contains all the details of size, shape and dimension of rebars to be cut. A good bar bending schedule will help you in buying the rebars in most economical quantity and minimise steel wastage.

3.2.2 Lap or Development Length

Lap length is the length overlap of two rebars tied to extend the reinforcement length. Lap length of about 50 times the diameter of the bar is considered safe. Laps of neighbouring rebars should be staggered and should not be provided at one level / line. At one cross section, a maximum of 50% rebars should be lapped. In case, required lap length is not available at junction because of space and other constraints, rebars can be joined with couplers or welded (with correct method of welding).



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3.2.3 Anchorage Length

This is the additional length of steel of one structure required to be inserted in the other at the junction. For example, main bars of beam in column at beam column junction, column bars in footing, etc. The length requirement is similar to the lap length mentioned earlier or as per the design instructions.

3.2.4 Transverse Reinforcements or Stirrups

Transverse reinforcements are very important. They not only take care of structural requirements but also help main reinforcements to remain in desired positions. They play a very significant role while abrupt changes or reversal of stresses occur during earthquakes, etc.

They should be closely spaced as per the drawing and properly tied to the main / longitudinal reinforcement.

Transverse Reinforcements or Stirrups

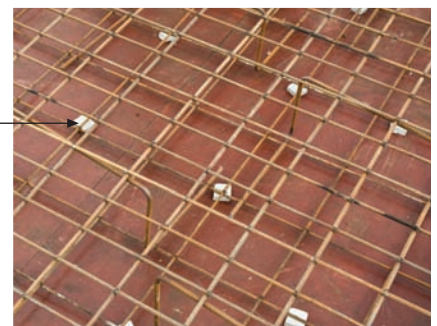


3.2.5 Cover Blocks

Cover blocks are placed to prevent the steel rods from getting exposed to the atmosphere, and to place and fix the reinforcements as per the design drawings. Once the steel is exposed to the atmosphere, corrosion starts. Sometimes it is seen that the cover gets misplaced during the concreting activity. To prevent this, tying of cover with steel bars using thin steel wires called binding wires is recommended. Covers should be made of cement sand mortar (1:3). Ideally, cover should have strength similar to the surrounding concrete, with the least perimeter so that chances of penetration of water through periphery is minimised. Provision of minimum covers as per the Indian Standards for durability of the whole structure should be ensured.

Shape of the cover blocks could be cubical or cylindrical. Normally, cubical cover blocks are used. As a thumb rule, minimum cover of 2 inch in footings, 1.5 inch in columns and 1 inch for other structures may be ensured.

Cover Blocks



3.2.6 Checklist for Steel Reinforcement before Pouring of Concrete

Reinforcement should be free of loose rust, oil paints, mud, etc. It should be cut, bent and fixed properly. The reinforcement shall be placed and maintained in position by providing proper cover blocks, spacers, supporting bars, laps, etc. Reinforcements shall be placed and tied such that concrete placement is possible without segregation, and compaction is possible by an immersion vibrator.



Shuttering



3.3 Shuttering and Deshuttering

The formwork or shuttering should be rigid and strong enough to support wet RCC. It should be leak proof and the face of the formwork should be treated with ‘form release agents’ or mixture of grease and diesel so that deshuttering is easy. Formwork should not be removed until concrete has achieved sufficient strength. Under normal circumstances where ambient temperature is above 15° C and adequate curing is done, the following deshuttering period is considered safe:

Type of Formwork	Minimum Period before striking the Formwork
Vertical Formwork of columns, walls, beams	16-24 hours
Total Deshuttering including support to slabs:	
Span / Length up to 4.5 m	7 days
Span / Length more than 4.5 m	14 days
Total Deshuttering including support to beams:	
Span / Length up to 6 m	14 days
Span / Length more than 6 m	21 days

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3.4 Concreting and Curing

3.4.1 Batching

Use wooden or steel measurement boxes of size 350 x 250 x 400 mm (35 litres) to measure the volumes of cement, sand and aggregates for preparing the concrete mix. This box can contain 1 bag of cement weighing 50 kg. Materials should be loosely filled in box while batching. For example, to prepare M 20 (1:1.5:3 approx.) mix of concrete, you require one bag of cement, 1.5 boxes of sand, 3 boxes of stone aggregates and 21 litres of water.

3.4.3 Placing

Concrete should be poured within 30-60 minutes of preparation. Addition of extra water is not recommended. Concrete should be poured in layers without breaking the continuity with the maximum free fall of concrete not exceeding 1.5 metres.

3.4.2 Mixing

A mixer should be used for a minimum of two minutes to ensure uniform distribution of the material. Avoid hand mixing wherever possible and if at all it is required, use a solid, impervious platform for mixing. First cement and sand should be dry-mixed and then stone aggregates should be added.



Concrete mixing on impervious platform



Use of vibrator for compaction

3.4.4 Compaction

Compaction, especially around steel bars, and the corners of the form work should be carried out using vibrators. Good compaction is necessary for getting strong concrete.

3.4.5 Curing

Curing prevents moisture loss from the concrete or mortar and maintains the required humidity for reaction of cement in achieving its strength. Curing should be started after 12-24 hours on drying surfaces and should be continued for a minimum of 7-14 days. Cure horizontal surfaces by pond formation, and vertical surfaces by jute soaked in water.



Pond formation curing

3.5 Bricks and Brickworks

3.5.1 Important Points regarding Bricks and Brickwork



1. Bricks should be well burnt, uniformly copper coloured, uniform in shape, standard in size and free from cracks.
2. Size of a brick recommended by BIS is 190 mm X 90 mm X 90 mm. With mortar, the size of such bricks becomes 200 mm X 100 mm X 100 mm. Average weight of a brick should be approximately 3-3.5 kg.
3. Bricks should produce a metallic ringing sound when struck with each other.
4. Bricks should not absorb water more than 20-22 percent by weight when soaked in water for a period of 24 hours.
5. The Bricks should be hard enough and must not break into pieces when dropped flat on hard ground from a height of 1 metre.
6. Bricks when soaked in water for 24 hours should not show deposits of white salt when allowed to dry in a shade.
7. No brick should have a crushing strength below 5.5 N/mm².
8. Cement sand mortar of 1:4 (1 part cement and 4 parts sand) should be used for 4 inch thick central partition wall and 1:6 for 9 inch thick exterior wall.

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Brick wall must be vertical and a systematic bond must be maintained throughout the brickwork. While placing the bricks, the depression should be on top. It provides space for the mortar to bond well with other bricks. Vertical joints shouldn't be continuous but staggered. Joint thickness should not exceed 1 centimetre and joints should be thoroughly filled with cement mortar. Cement mortar joints should be raked and properly finished. Not more than 1 metre wall height should be constructed in a day. All brickwork should be properly cured for at least 10 days.



3.6 Plastering

Plastering is necessary because it protects the exposed surfaces and masonry joints from external environment and provides lateral stability to wall by binding all bricks or stones together. Remove loose mortar from joints and moisten the surface before plastering. Use chicken wire mesh while plastering joints between concrete work and brickwork. Cement sand mortar recommended for outside plaster, internal

plaster and roof plaster are 1:4, 1:5 and 1:3 respectively. At a time the quantity of mortar mix should be prepared in such a way that it is consumed within one hour of preparation. Curing by water for 10 -14 days should be sufficient for all plaster work.



4 Painting

Painting not only beautifies your home but also enhances its durability and protects it from heat and rain. There are many paints like cement paint, distempers, enamel paints or acrylic emulsion paints. Depending upon your budget you may select the type of paint for your house. You may choose different paints for different rooms.

For example, use an economical finish for passages and a good finish for drawing rooms and bedrooms. Use distempers on the ceilings, kitchen and toilets.



4.1 Steps for Interior Painting

1. Check cracks, water leakage, etc.
2. New surface to mature for a month.
3. Apply 1 coat of primer.
4. Apply acrylic based putty or POP and rub with sand paper.
5. Apply another coat of primer and dry for 10-12 hours.
6. Apply 2-3 coats of paint with an interval of 4-8 hours.



4.3 Calculating Paint Requirement

The following table provides the area coverage by 1 litre paint of various types.

Type of paint	Area coverage per coat (in square metre per litre)
Primer	20
Distemper	20
Enamel Paint	40
Acrylic Emulsion	32

If you know the area to be painted and the number of coats to be applied, you can easily calculate the paint requirement. For example, distemper requirement for two coats and 100 square metre area will be = $(100/20) \times 2 = 10$ litres.

5 Water Seepage and Damp Proofing

Water seepage is very detrimental to your home. The table below provides the main reasons behind this problem and their remedies.

Reasons for Leakage / Seepage	Remedies
Accumulation of water on roof, etc.	Provide drainage
Poor quality of construction material	Use good quality material including cement, sand, stones and rebars
Poor compaction of concrete resulting in air voids	Use vibrator for compaction
Improper construction joints	Avoid joints wherever possible
Other cracks due to overloading	Use proper design for house construction
Capillary in brickwork	Use Damp Proof Course (DPC) at plinth level
Leakage from water retaining structures like water tank, etc.	Use water proofing material for water retaining structures. To use the water proofing material, read the instructions given in the product catalogue carefully or take the help of a construction professional

4.2 Steps for Exterior Painting

1. Repair the cracks, etc. with 1:3 mortar.
2. Spray water and clean surface with wire brush.
3. Apply one coat of white cement base primer.
4. Apply 2-3 coats of finish paint with a minimum interval of 24 hours.
5. Each coat should be cured for 2-3 days.

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6 Flooring

The floor of the house provides a horizontal surface for residents, the furniture and equipment. All good floors should provide strength and stability, resistance to dampness, excellent appearance and freedom from maintenance, etc.

6.1 Some Common Floor Finishes

6.1.1 Cement Concrete Flooring

It is a 3-4 inch thick RCC flooring with cement punning on top. It is economical and easy to maintain.

6.1.2 Terrazzo (Marble chip) Flooring

Following are the steps in preparing a Terrazzo floor-

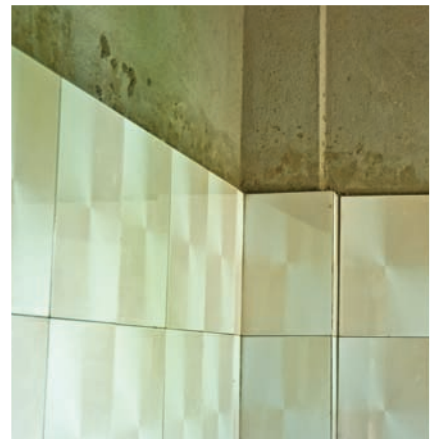
- Place a 4 inch thick base of concrete mix (1:5:10 or 1:4:8 ratio)
- Provide a further layer of 1 inch thick 1:2:4 concrete
- After 18-24 hours put a 1/4-1/2 inch layer of cement, marble powder and marble chip
- Carry out curing for a minimum of 7 days and then grind the surface

6.1.3 Tiling Flooring

Tile flooring looks beautiful and can be laid quickly. Tiles are divided into two categories- Wall tiles and Floor tiles.

There are many types of tiles viz. Cement Concrete tiles, Terrazzo tiles, Ceramic tiles, Vitrified tiles, Marble tiles, Granite tiles and Kota Stone tiles. Follow the following steps to lay tiles-

- Soak tiles in water for 3-4 hours
- Prepare mortar of 1:6 or 1:8
- Spread the mortar on wet, rough, clean and firm base with thickness 1/2-1 inch
- Fix the tiles
- Joints should be 1-1.5 mm. Fill them with matching cement pigment paste
- Cure for 7 days





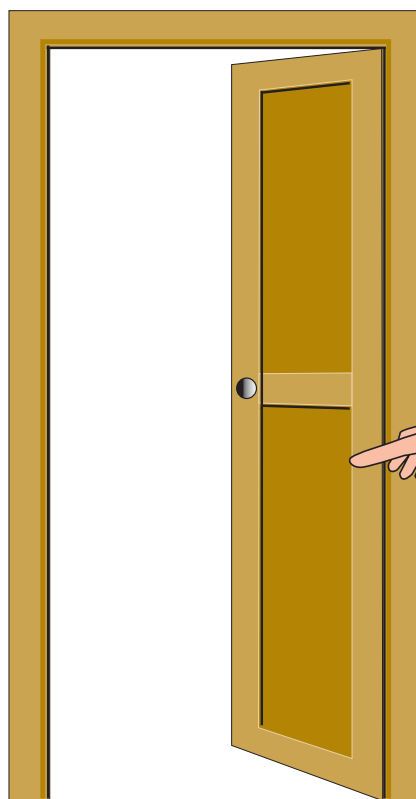
7 Electricals

No home is complete without electricity. Follow these simple tips on electrical installations for better quality of life and safety.

1. Always buy ISI certified electrical components.
2. Identify the locations of switch boards in advance, keeping in mind aesthetics to make interior decoration easier.
3. Always create adequate earthing arrangements to prevent electrical shocks.
4. Do not create more temporary connections than necessary.
5. Ensure that your home has proper wiring and insulation.
6. Ensure that every power board has a separate fuse or MCB (Mini Circuit Breaker). MCB is a magnetic tripping device that is activated during a short circuit or overloading. Tripping helps to safeguard your electrical wirings.
7. Lay the power supply cord away from water, oil and heat.
8. Keep all electrical items out of reach of children.
9. Do not touch an electric iron or heater when barefoot.
10. Always employ licensed / registered electrical contractors for electrical work.
11. For protection against electrical shocks, use RCCB / ELCB (Residual Current Circuit Breaker / Earth Leakage Circuit Breaker).

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8 Doors and Windows

Generally doors are side hung type with single or double leaves / shutters, made with timber, plywood, steel, FRP, aluminium, etc. Recommended sizes of the doors are as below.

Living Room	3 ft x 7 ft
Bath Room and W.C.	2.5 ft x 6.5 ft
Garage	8 ft x 8 ft

Ensure that wooden frames of doors have got anti-termite treatment. A minimum of three holdfasts should be fixed on each side of the door frame, one in the centre and the other two at 30 cm from the top and bottom of the frame.

For natural lighting, a window area of about 10% of the floor area is sufficient, but in hot and humid regions, the window area should be 15% to 20% of the floor area. Preferably each room should have two windows for cross ventilation of air, which increases the comfort and also saves on electricity.

9 Water Supply

Generally one person requires 135 litres of water per day. Accordingly you can calculate the total daily water requirement depending on the number of members in your house. Keep in mind the following while laying the water supply system of your house.

1. Ensure that there is no contamination of water supply. Avoid cross connection between pipes carrying drinking water and waste water.
2. Ensure that there is no backflow from any appliance towards the source of supply.
3. Reduce joints and bends in the pipeline to the bare minimum. All joints in pipes should be leak proof and tested under pressure.
4. The pipeline should be protected against damage. Underground pipelines should be painted with bitumastic paint and enclosed in cement concrete with adequate earth cover.
5. You may use copper pipe, galvanised iron (GI) pipes or plastic (HDPE) pipes. However, GI pipes are most commonly used. They are available in three grades viz 'A', 'B' and 'C', grade 'C' being the costliest and heavy duty. In the construction of a house, Grade 'B' (medium grade) pipes are generally used.
6. Build water storage tanks on the roof top or in the basement, depending on the water pressure of the connection. The capacity of the storage tank depends on the number of occupants, water supply hours, and water pressure.
7. Fixtures like water closets, wash-basins, pipes, etc. should be of good quality and from reputed manufacturers.
8. The diameter of the service pipe (the connecting pipe from the distribution mains of the municipal water supply to the house) can be fixed on the basis of occupants in the house, as given in the following table:

Number of Occupants	4	8	24	60
Diameter of Service Pipe (in mm)	12.5	20	25	30

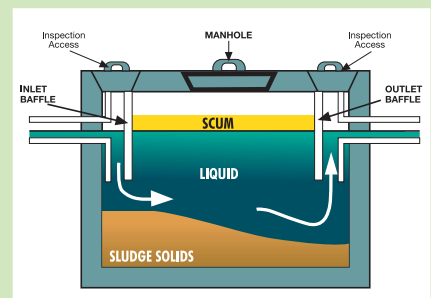
10 Sanitary Work

It is advised that a detailed house drainage plan about position of baths, water closets, wash-basins, etc. along with the position of taps, manholes, soak pits / septic tanks and public sewers should be developed and submitted to authorities if required.



10.1 Septic Tank

Septic tank is a sedimentation tank used to treat sewage, when a sewage system (public sewer) is not available. The solids in sewage are deposited at the bottom of the tank which also gets fully or partially digested by anaerobic bacteria. Effluent is discharged in soak pit or below ground level through sand drains. The resultant sludge, in the case of soak pits, may be cleaned periodically. A vent pipe to let gases escape and a baffle wall with openings should also be constructed at a short distance from the inlet.



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10.2 Soak Pit and Sludge Soak Pit

A soak pit is used to treat effluent from the septic tank. A covered pit dug in the ground, is a soak pit dug in the previous soil and filled with brick bats to allow easy absorption of the effluent.

On the other hand, a sludge soak pit is one in which the sewage effluent from the house drain is directly discharged. The adjoining pervious soil soaks the water in the sewage and the sludge is digested in the pit. Such soak pits are very common where the sub soil is very pervious. Generally, the pit is lined with masonry with open joints, and a rigid slab covering.

A diameter of 2 m - 3 m and a depth of 2.5 m - 4 m is considered adequate for each individual house. Generally, soak pits have a life of about 20 years for a family of 6 persons. As and when the soak pit gets filled up, it can be emptied by removing the rigid slab cover.

11 Protection from Heat and Cold

Good heat insulation in the building or adoption of some proactive measures can give you relief from both severe summer heat as well as the winter cold.

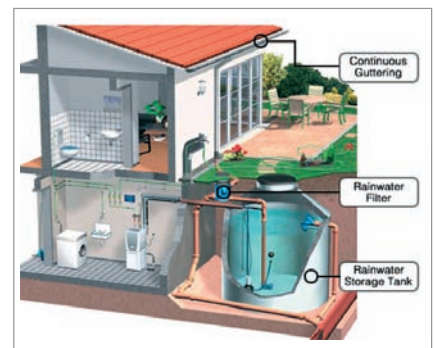
- Shading of windows could be done by using louveres, sun shades, verandah, curtains – using materials like heat absorbing glass, painted glass, etc.

- Heat insulation of roof can be done externally by materials like a mud phuska. Also false ceilings with an air gap can be built internally for heat insulation
- Thicker walls (say 23 cm) are good for heat insulation. Cavity walls or walls build with hollow bricks are also effective for preventing heat. External surfaces must be painted with light colours to reflect heat and light

12 Rainwater Harvesting

There is tremendous potential for water harvesting in our country. Consider your own building with a flat terrace area of 100 square metres. Assume that the average annual rainfall in your area is 100 centimetres. Thus, even if only 50 percent of the total rainfall is harvested, you will be able to harvest $100 \times 1.0 \times 0.5 = 50 \text{ m}^3$ i.e. 50,000 litres of water a year. This volume is more than a year's domestic water requirement for 1 person (135 litres per person per day X 365 days per year = 49275 litre).

In many cities in our country, there is a major thrust in this area and provision for rainwater harvesting is compulsory. Find out whether your house belongs to such an area.



13 General Precautions for the Upkeep of Home

1. Avoid accumulation of water on the surface and provide a proper slope so that water doesn't percolate into the structure. Provide a good drainage facility.
2. Don't let small plants and vegetation grow on the water pipe, roof or wall cracks.



14 The Griha Pravesh

Check the following points before your **Griha Pravesh**

- Inspect the house completely along with your engineer after construction
- Check for any leakage of water
- Check functioning of all electrical items
- Check that your house and compound are neat and clean
- You may do the final coat of painting and floor polishing after the **Griha Pravesh** so that it does not become dirty during the function
- Inspect doors, windows, gates, etc. and their locking positions for safety



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