How to
CONSTRUCT A STEEL FRAME HOUSE
Steel framed housing is fast becoming an attractive option in the South African market as an alternative to the established brick and mitered house.

There are numerous reasons for this,

- **Foundation** – A single slab as opposed to the traditional foundation which has to be accurately dug out according to the wall plans. The steel frame house requires a single slab. Any changes to the internal wall plans will not affect the slab design, whereas with brick walls a change to the walls will require that the foundation walls will need to be adjusted or re-dug out accordingly.

- **Steel frame erection** – A relatively quick process as opposed to laying one brick on top of the other whilst pre-leveling off each row.

- **External walls** – All panels are prefabricated with the door and window openings already in place. These openings are extremely accurate and allow quicker installation of windows and doors. Insulation is inserted into all the wall cavities making the steel framed house more efficient to warm up in winter, or to cool down in summer.

- **Internal walls** – Insulation adds to the overall comfort of the home and enhances the acoustic values. Electrical and other wire management is easily facilitated inside the wall cavity. Hinging pictures or other decor items is simple to do. Walls once clad with the Jumbo plasterboard are perfectly flat and smooth leaving the home with an elegant look.

- **Installation** – installation time is a lot quicker than brickwork. Brickwork usually also requires additional rendering to each side to acquire a flat surface to hide the bricks. Another advantage is that the contractor requires fewer personnel on site than the builder of a brick house needs to build the same size house.

The process of constructing a Steel Framed House can be divided into the following segments:

- **Initial design, foundation/slab**
- **Steel frame consisting of external & internal walls, roof structure, external wall cladding, plumbing, electrical, Insulation walls & floor/ceiling**
- **Internal wall cladding, ceiling installation, doors, glazing, kitchen & other cupboards, painting**

**Initial design**

The initial design is done by a professional such as an architect or engineer. The plumbing and electrical designs are done by the respective professionals and collated by the architect.

This design can follow a number of different routes from here e.g., it can go to open tender or could be awarded to a contractor through negotiation which is approved by SASFA.

Lafarge Steel Frames Systems can be contacted to assist with the pricing of products supplied by Lafarge such as the steel frame for the house & the roof structure, insulation, plasterboards for ceilings & walls, fixers and any other items which may be required from Lafarge Gypsum. These designs, once completed, require a Structural Engineer to certify the structure.

The design must comply with the SANS 10400 building code, the draft code SANS 517 will be implemented shortly which deals only with Steel Framed housing. The NBHRC has also added their conditions, which means that the steel framed house will be built to the latest and most stringent standards. Electrical and plumbing details should be incorporated into the building design plans supplied to the roll former such as Lafarge Gypsum, to enable the holes required for these services in the steel work.

**SASFA**

SASFA The South African Light Steel Frame Building Association which is the governing body oversees all the members, standards, training and ethics of the new & exciting industry.

Lafarge is a founder member of SASFA, and is represented on the Executive, Marketing, Technical & Training committee.

Steel Frame House before and after cladding (Photos courtesy of James Emery)
The construction Process

Foundation/Slab

This is an extremely important component for the steel frame house as it ensures that the house will be level, and that the house will not be sucked upwards/Blown over due to wind force & negative pressures that may be exerted on the house. The slab is the first component to be installed on the site. The slab is usually poured from cement and aggregate and leveled with wedged setting. In some cases ready mixed concrete can be poured direct from the ready mix trucks thus saving time. The slab pouring process is done by specialists who have experience in the mixing/pouring setting & leveling of concrete slabs. The slabs must be approved by a Structural Engineer.

Frame manufacture

The frame is manufactured from Grain 550 cold rolled 2 275 gavanised steel. The gauge is prescribed by the roll former who is adept with their own software programs which are used to determine the cutting list for the steel. Our system uses 0.8mm steel to manufacture all structural sections

The engineered design is provided by the client/architect/contractor/developer to the steel roll former. This design can be supplied to the roll former in electronic format to help speed up the process.

The software details the steel sections, and provides the roll former with the tonnage of steel that will be required for the specific project. This assists the roll former with the necessary details in order to provide the client with an accurate quotation for the steel frame structure.

Steel Frame – On site construction

The steel frame material can arrive at site in 2-3 different configurations. Firstly it can be delivered in component form which will require assembly of the components on site. Secondly components can be press assembled in their different panels, prior to delivery, and these respective panels are then delivered in their pre assembled format ready for installation. Lastly a combination of the 2 method can also be delivered to site. The second format i.e. the assembled frame configuration is the preferred method.

Contractors/assembly do not usually have a reasonable flat surface to assemble on nor do they have additional skilled personnel who are able to read the drawings correctly. The contractors also lose valuable time when they assemble on site. There are certain circumstances however when on site assembly is favourable, mainly when the site consists of a number of the same structures or when the site is a long distance from the roll former premises. Where the steel frames are transported in knock down format, the transportation costs are utilized more efficiently.

1. Using the building plans determine which corner to begin from. The ideal starting point will be where there is an external corner which may have a small room inside.
2. The installation begins with the first 2 panels of the external corner which are erected at right angles to each other, and then braced to each other in order to provide initial support.
3. The smaller internal room is now erected and braced to the 2 outer steel frame walls to allow the structure to stand under its own support.
4. The screws used to fasten the frame to each other are the Hexagonal or Wafer type.
5. The bolts used to fasten the steel frame to the ground are considerably larger such as the 10mm x 130mm Excilor or a similar Chemical anchor bolt type.
6. The external wall can now be completed continuing away from the corners repeating the bracing and anchoring as described in steps 1-4 above.

External walls

The steps 1 - 5 above will provide stability for you to complete the external wall assembly. Temporary braces can be used to support longer sides until these have been securely fastened. The external steel frame walls will have the openings for glazing and the door sections already in place. Before fixing the last wall section ensure the larger internal walls are positioned near to their final installation position. These internal steel frame walls may be too large to insert through a door or window opening. Fasten and cross brace all exterior walls. Remember to use the correct screws & spacing as well as the heavy duty bolts to anchor the steel frame to the concrete slab. Tip, always work with the building plans to ensure correctness of structure, as well the correct positioning of the panels. This will ensure less costly delays caused by having to dismantle & re-erect steel sections. This is also the correct time to level the frame on the slab to ensure the structure is square & plumb. This is a good time to begin installing the plumbing and the electrical cabling systems. This should be done by competent trained people only.
Internal Frame Walls

The internal steel frame walls can now be installed. Begin from the previously installed internal room walls and work outwards. The addition of each steel frame wall will provide additional structural strength & stability to the entire steel frame structure. Continue until all the internal walls have been erected. Ensure the panels are screw fixed to each other and braced at all corners. Insert the larger bolts through the steel floor tracks into the concrete slab at the correct spacing.

Roof structure

The roof trusses can now be erected on top of the steel structure. Starting from one side of the steel frame house, move progressively towards the opposite end of the house. Remember to follow the drawing plans closely. Install adequate screws along all intersections where required. Battens can be installed at this point to facilitate the fixing of roof sheeting, roof tiles or other specified roof cover. Do not deviate from the building plans, battens should be installed as per building plans.

The roof covering and the external wall cladding can now be installed.

External wall cladding

The external wall can be clad in various ways. Always follow the drawing plans however. Examples of external cladding can be single brick, Nutec building planks (shiplapped) or Nutec Boards. The important consideration here is to make sure that the external walls are properly sealed against the ingress of moisture by installing DPC (Damp Course) as well as moisture barrier, and, external cladding when used should be properly secured so that the cladding is not able to be blown off by the wind. Check the manufacturer’s recommendations.

Roof Sheeting/Filing

Roof sheeting or roof filing can be installed. Together with the external cladding the roof covering will now render the structure reasonably protected from the elements barring any doors and window, which will come later. This cover makes it possible for the contractor to work under all conditions and progress usually accelerates from here on. It is important to check that the battens are correctly positioned and correctly spaced prior to fixing the roof sheeting or hanging the roof tiles. The spacing will be found on the building plans.

Plumbing

All the plumbing piping in the internal walls can be completed at this point. The plumbing should be completed by competent people. There will be a separate drawing depicting all the plumbing points. If copper piping is used then grommets must be inserted in all punching openings. The 100mm plumbing pipes are position on the outside of the house and are fed through the wall at the point where they are required to join the toilet system.
Electrical
The electrical wiring in the internal walls can also be completed at this point. The wiring installation should be completed by a qualified electrician. There will be a separate drawing depicting all the electrical points. In single floor houses the lighting in the ceiling can be installed as per any standard house. Where a double story house is concerned a specialized approach is used to ensure the relevant fire rating is achieved. [See Ceiling Installation 2 story.]

Insulation of walls, Floor/Ceiling
Good insulation can be achieved by simply adding one of the available insulation materials. The insulation materials help to improve the acoustical performance of ceiling or wall system. The predicted acoustic performance of an internal wall with 100mm 14kg/m insulation with a single layer of 15mm plasterboard on either side has an E8 rating of 48 decibels.

Internal wall cladding
The internal wall cladding is installed in the same manner as a drywall partition wall is installed.

1. Establish a starting point (it is a good practice to start from one side)
2. When installing the first plasterboard ensure that the first joint will be plumb (as the wall may not be plumb). The studs are spaced at 600mm centers automatically in the steel frame wall.
3. Use small segments of plasterboard to keep plasterboards off the ground to prevent moisture from creeping up the plasterboards.
4. Fix boards to the steel frame work using 25mm drywall screws
5. Install insulation materials prior to fixing the plasterboard to the opposite side of the wall.
6. Cut the edges of the plasterboards neatly & cleanly to ensure that drywall screws near the edges of the plasterboards do not shatter the gypsum core.
7. Use Fibretape (Mesh tape) to cover all joints prior to applying the first coat of jointing compound.
8. Once the first coat of Jumbo Jointing compound has been applied, allow to set for 1 hour.
9. Apply final coat of Jumbo Jointing Compound and allow to set.
10. Once this second coat has set, use a fine grain sand paper, 180grams/in, to smooth over any unevenness or bumps on the wall.
11. Apply a primer and paint as per paint manufacturer's instructions.

Electrical
The electrical wiring in the internal walls can also be completed at this point. The wiring installation should be completed by a qualified electrician. There will be a separate drawing depicting all the electrical points. In single floor houses the lighting in the ceiling can be installed as per any standard house. Where a double story house is concerned a specialized approach is used to ensure the relevant fire rating is achieved. [See Ceiling Installation 2 story.]
During the installation of the Jumbo Plasterboard ceiling, the joining of the plasterboards will need attention. Two methods are used, A) is by means of an H strip, or B) is with a combination of Lafarge fibertape & Lafarge Jumbo jointing or skimming plaster used on tapered edge plasterboards.

A. The first method: The H strip is really simple and involves the friction fitting of an H strip over the length of the edges between 2 Jumbo plasterboards and is fitted progressively at the same time & rate that the ceiling is installed.

B. The second method: Also simple, involves the application of a combination of Lafarge Fibertape and the Jumbo Jointing Compound. The Fibertape reinforces the joint to help prevent cracking and the Jumbo Jointing Plaster smooths out the joint making it invisible. If the total ceiling is to be covered then a skimming plaster is used instead of the Jumbo Jointing plaster.

1. Ensure that the Joint area is free from dust and dirt. Centre the Lafarge Fibertape along the joint. The Lafarge Fibertape is self-adhering and is easy to apply, simply stick it onto the Jumbo Plasterboard along the joint.

2. Mix the Jumbo Jointing/Skimming plaster as per the instructions on the bag. These instructions are simple and easy to follow. Remember to mix only enough plaster that can be used in 60 minutes or less. Always mix the plasters with clean water.

3. Apply the Plaster over the Lafarge Fibertape using a 300mm trowel. Spread out the Lafarge plaster along the length of the joint, carefully smoothening out ensuring a flat finished surface. We call this process feathering. The better the feathering, the less sandpapering will be required. This is important as it will save you time and thus save you money as well.

4. Check all plastered joints for smoothness, and lightly even out any high points.

5. Allow the joints to set and dry out. (Leave overnight to make sure).

6. If no further skimming is required, inspect the joints again, scraping any protruding points. A light sanding in places may also be necessary to finalise the ceiling. The painting process can begin. (Always ask your paint supplier to provide the correct type of paint for Plasterboard ceilings).

7. If Skimming is required for the entire ceiling, then this must be done in a similar fashion as step #3. Always remember that smoother & flatter you apply the Skimming plaster, the less effort will be required to scrape & sand the ceiling afterwards.

8. Once the complete ceiling surface has been skimmed, inspect the entire ceiling surface as in point 6. Allow to set & dry out overnight.

9. Perform a final visual inspection. If smooth & flat, the ceiling is ready for the painting process.

10. For Jointing & Skimming, you will need:

   A. H-Strip Joint
      i. A hack saw
      ii. Measuring Tape
      iii. Pencil

   B. Lafarge Fibertape & plastered joint
      i. Mixing bucket & mixing stick.
      ii. Trowel & Hawk
      iii. Fine grain sandpaper
      iv. A dust mask
      v. Jumbo Jointing / Skimming Plaster
      vi. Lafarge Fibertape
Trouble shooting:
1. Double check for smoothness & flatness - (saves time & money).
2. Mix too much Jumbo Jointing & or Skimming plaster - (plaster begins to set before you have used it making smoothing difficult).
3. Do not use dirty water in mixture - (leaves stain marks in the joints & skimmed ceiling).

Ceiling Installation 2 story

- 1 x 15mm Nutec Floor Board
- Joist Spaced at 300mm Centres
- Insulation
- Steel Branding Spaced at 300mm Centres
- 2 x 15mm Fire Rated Plasterboards
- Perimeter Fire Protector
- Cornice
- Plaster 3 - 5mm

The steel frame which carries the load of the second floor in a steel frame structure requires specific protection. The protection required must be able to prevent the steel structure from exceeding 375°C during a fire as this is the point where steel begins to lose its structural load carrying capabilities. The load requirement as per South African regulations during such a test is 1.50KN/m², roughly 150kg/m² during a fire. The primary function of the plasterboard is to protect the steel structure. The insulation will assist in this regard and also has a secondary function as far as additional acoustical performance of the floor structure is concerned.

The above diagram is illustrative of such a solution and is described as follows:

1. Joists - The primary structural floor support.
2. 15mm Nutec board fixed to the top of the Joist with passivated chipboard screws.
3. Fix the steel branding/13mm Furring channel to the underside of the steel joists using Jack Point drywall screws. Use 2 screws for added safety.
4. Add the insulation, filling all gaps and press firmly into all corners. The insulation enhances the acoustical and the thermal performance of the floor.
5. Fix first layer of 15.0mm plasterboard to the underside of the steel branding/13mm Furring Channel. Ensure all joints including cross joints are supported on the backside of the joint.
6. Add the second layer of plasterboard to the underside of the first layer of plasterboard. Ensure all joints are staggered.
7. Ensure all plasterboard joints as well as cross joints are supported with steel branding.
8. Screw spacing for the plasterboard should not exceed 150mm along the joints.
9. There must be no gaps left in the insulation, this will lead to hot air leakage.
10. Place a plasterboard protection strip around the perimeter to ensure that no flames will leak through this area during a fire.
11. Cornice of choice may now be installed.
12. All light fittings must be surface mounted other wise the fire rating will be drastically compromised. A hole for a 20mm conduit is all that may be cut into the ceiling. Downlighters etc must be supported on externally fixed bulkheads where this type of lighting is preferred.
13. Once the ceiling is taped and jointed, a 3-5mm layer of skimming plaster should be applied to the entire surface.

14. The sound reduction index of the above ceiling is approximately Rw 57

It is important to remember that the plasterboard paper lining should not be broken whilst fixing the drywall screws during installation, as this will reduce the fire performance of the plasterboard.

The plasterboard jointing for the 30 minute fire rated ceiling should be done using the instructions for type B in the single story installation above.

Doors

Doors & glazing can be purpose made on site as per specification; however there are doors available complete with matching frames which are designed to fit variable wall thicknesses

Glazing

The same principle applies as per any standard house. Glazing is available from most building supply outlets.

Kitchen & other cupboards

The approach to installing kitchen cupboards, sanitaryware is the same as per any standard house as well (see Support brackets below). The main advantage with the steel frame house is accuracy however. The accuracy of the steel frame house is far superior to other types of building methods. This means that the kitchens & cupboards when planned, fit into the steel frame structure of the house more snugly with less gap filling required and ultimately less time is wasted.

Support brackets

Support Brackets should be installed in between studs where excessive loads are placed on the walls e.g. kitchen cupboards & sanitary ware

Fixings & Fasteners

A. Excalibur bolt used in a similar application as the Chemical anchor. Its primary function is to fix the steel frame to the concrete

B. Hexagonal posi drive. This screw is used to fasten steel battens (for the roof tiles) onto the roof trusses and for fastening steel frame sections together.

C. Wafer Tex screw. This screw is used to fasten steel to steel where a protruding head such as that of the hexagonal posi drive, will be in the way. An example is where external flat galvanised steel bracing is applied to the steel frame prior to the external cladding.

D. Butterfly screw for OSB boards. This screw uses the butterfly section to allow the shaft of the screw to go cleanly through the OSB board so that the cutting point on the tip can drill into the steel unhindered.
E. Jack point drywall screws. This is similar to the conventional drywall screw but has a cutting point similar to the Wafer tex screw.

F. Standard drywall screws.

G. Steel frame fasteners – A shorter stocky screw with the correct diameter to fasten the steel frame components together to make up the steel frame panels.

NB - All fasteners must be as per manufacturers specifications.

Painting
Refer to the manufacturers for the details / specifications for the various finishes. E.g., the paint type & method required to cover concrete will differ from that required to cover OSB/Plasterboard board. It is recommended that the experts are always consulted to avoid costly repairs.

General Safety
Safety should always be a priority when using any hand tool and hardware.

- Always ensure that all fixings are secure e.g., screws are fastened tightly, pop rivets are fully activated.
- Always use the recommended materials to fasten components. Consult the manufacturers where uncertainty prevails.
- Take heed of manufacturer’s maximum and minimum recommendations.
- Adaptations should only be made/approved by competent technical persons.
- Use good judgement when carrying heavy loads.
- Ensure the relevant engineer has approved and signed off the working drawings.
- Use caution when working in high wind. Wind can blow the steel panels over whilst handling is in progress.
- These are big panels and it is difficult to tell when these panels are securely fastened to the trucks. Always double check.
- Wear the necessary harnesses when working at heights.
- Ensure the previous steel frame section is secure before moving on. This will help prevent panels from falling over.
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