New light weight steel frame structures oppose to conventional masonry brick construction

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CHAPTER 1

LIGHT WEIGHT STEEL FRAME STRUCTURES APPOSED TO CONVENTIONAL MASONRY BRICK CONSTRUCTION

1.1 OVERVIEW

The only question we need to ask ourselves is are we willing to change? Building techniques have stayed the same over the last few decades and people are scared to make the change. In an ever changing market it is important to keep up to date with the current trends and when we are looking at the building industry today, it hasn't changed much. The aim of the thesis is to introduce a new and completely different way of building a low rise home. With all the advances in technology and equipment it is important that we use this to our advantage.

The new building technique that is going to be introduced is a combination of new advance materials combined with a CNC machine to create a better, safer and more energy efficient and environmentally friendly home. The aim of the thesis is to compare the current building method and materials with the newly introduced method from SASFA (South African Light Steel Frame Building Association). In the thesis two types of construction methods will be compared to assist in proving that this new method is the way of the future. In the thesis the focus will be on various key factors to prove the hypothesis.

1.2 PROBLEM STATEMENT

Is SASFA's building method a quicker and more feasible construction method than the traditional ways of building?

1.3 MAIN PROBLEM

As with any construction materials in the building industry, all materials have different characteristics and features. The main problem with this is that all materials have advantages and disadvantages. Some materials are suited for a specific application and some materials are even better for the same application. We need to ask if it is safe, is it feasible, how long will it last and what are the implications?

By making a study of two different building methods for low rise housing and other types of housing, the advantages and disadvantages will be made clear and will aid in decision making. The aim of the thesis is not a sales pitch for SASFA, but rather a study to prove that we need to look after ourselves and we need to save energy in order to help preserve the environment for the future.

1.4 SUB PROBLEMS

Because the aim of the thesis is to provide an alternative solution to what is being currently used, many facts and explanations will be needed.

Some of the problems that need to be proven are the following:

1. What does this new construction method consist of and how can it be used?
2. How energy efficient and sustainable is this new building method?
3. What are the costs and constructability differences between the two building methods?
4. Is this method a more effective and efficient construction method?

These are some of the main aspects that must be taken into consideration before the hypothesis can be proved.

1.5 HYPOTHESIS

SASFA's new Light Weight Steel Frame structures is a better, faster and more economical construction method, opposed to masonry brickwork and plaster for low rise buildings.

1.5.1 Hypothesis to sub-problems:

1. The alternative construction method is fit for purpose.
2. Light Weight Steel Frame structures are more energy efficient.
3. Light Weight Steel Frame structures cost less than conventional brickwork.
4. Yes, the new construction method is more effective and efficient.

1.6 DELIMITATIONS

The information used in this thesis will not consist of any chemical formations or formulas. Because the product is not consumable and therefore no harm can be done in using it in its normal clean state, none of the products used to construct the buildings are necessary to discuss. The cost of the products, their advantages and the constructability of the products are the most important factors. The study does not focus on shopping malls or office blocks, but only compare the differences in single, double and three story home units.

1.7 DEFINITIONS OF TERMS

The following abbreviations will be used in the study:

BOQ - Bills of quantities
LBS - Light Weight Building Supplies
LWFS - Light Weight Steel Frame structures
P&G's - Preliminary & General
SASFA - South African Light Steel Frame Building Association.

1.8 ASSUMPTIONS

Any assumptions that will be made will be stated.

Example: contractors do not prefer to use Light Weight Steel frame structure units because there are too many different materials to be bought.

1.9 RESEARCH METHODOLOGY

Information gathered for the Thesis comes from the following sources:

- by examining both construction methods in practice;
- by creating questionnaires for contractors;
- information gained from the internet;
- LBS technical department;
- SASFA course notes;
- books;
- interviewing light weight building professionals and distributors;
- visiting LBS;
- comparing different facts of both methods;

The full course notes containing all the necessary information and help from the technical department are available and appointments will be made with people that specialize in the construction industry to gain the relevant information.

CHAPTER 2

WHAT DOES THIS NEW CONSTRUCTION METHOD CONSISTS OF AND CAN IT BE USED?

2.1 INTRODUCTION

The two methods that will be introduced, are SASFA's new building method and the standard masonry brick work method that is common to the construction industry. Both methods are acceptable building methods and both comply with all the required building standards and regulations. The new method that is being introduced has been used and tested over the last 5 years. To aid in the comparison of the two different building methods, two identical homes were built on Arlington Country Estate. The one house was a standard brick and plaster house and the other house was a Light Weight Steel Frame structure constructed by developer Mr Ryan Hesketh.

2.2 MAIN COMPONENTS OF LSFB AND MASONRY HOUSES

Light Weight Steel Frame buildings consist of the following main components:

- Foundation
- Super structure
- Suspended floors
- Roof and ceiling
- Cladding and lining
- Insulation
- Services

(SASFA, Course 2008:15)

Foundations

The foundations differ from normal mortar foundations because the mass of the structure is much lower, and the steel structure can accommodate some movement without structural damage. This means that:

- much lower gravity loads on foundations and;
- a design against wind uplift.

Typical foundations / floor slabs:

- strip footings
- thickened edge slabs
- raft foundations
- posts with bearers (with suspended floor)
- pad and pier footings (with suspended floor)

(SASFA Course, 2008:16).

Strip footings are normally used with masonry houses and the loads get transported to the ground. The foundations can differ, but in the Arlington study that was done, the same foundations were used. That contractor used terry pitchon raft foundations because of the soft soil conditions.

The type of foundation that needs to be used is determined by the engineer. Masonry brick walls will have a disadvantage on weak soil conditions because the completed house is more than double the weight of a light frame steel structure house. Foundations are one of the most important elements in construction, because sagging is the greatest cause of cracks and damage to homes.

Super structure

The steel structure consists of wall panels, floor joists, lintels, roof trusses, bracing and ceiling framework. The above consist of cold formed sections, made from high-strength galvanized steel sheets. The frame resists all the imposed loads and transfers them to the foundations. This includes loads such as:

- wind loads; and
- gravity loads

The steel structure serves as a basis to fix cladding, lining and roofing.
It defines the building envelope dimensionally and accurately and it also provides positions for doors and windows and supports the doors and windows.
Such a structure must be earthed and protected against moisture (SASFA Course, 2008:18).

Although masonry brick walls are not built around a steel structure frame, steel in the form of brick force is still required to give the wall the necessary strength. Brick walls are created by using an adhesive called dagga. This is a mixture of cement, sand and water to create a bond that holds the bricks in place. The bricks are then simply placed on top of each other to form a wall.
The wall is constructed as a solid wall and openings for doors and windows are created by leaving openings in the wall. There are no channels for services left in walls and channels must be created using a grinder or hammer and chisel.
The steel structure itself cannot be classified as a wall and needs to be cladded before it can be used as a wall. A brick wall needs to be plastered before it can qualify as an interior wall. All interior walls need to be plastered in order to be accepted by current standard. When a face brick wall is being built, there is no need to improve the outside of the building or to finish the exterior of the building with cladding or painting.

Suspended floors

With Light Weight Steel Frame building, first / ground or second floors are supported by bearers or wall panels/studs.
Suspended floors determine the span between load bearing walls / bearers.
Floors have to have at least a 30 min fire rating and have to provide acoustic insulation between and 1st and 2nd floors. (SASFA Course, 2008:19)

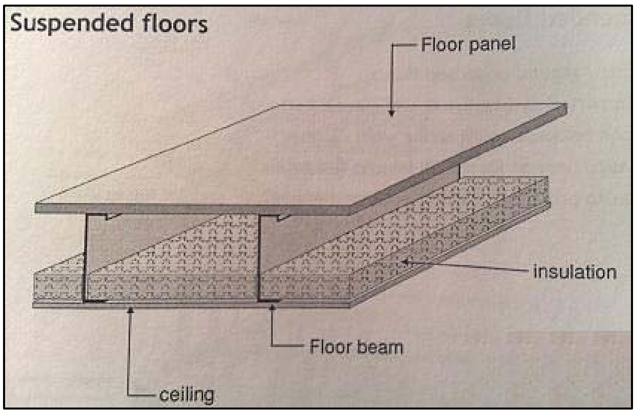

Figure 1 – Suspended floors
(SASFA Course 2008:19)

The floors differ greatly between the two methods. With Light Weight Steel frame structures, the floor structure normally consists of open web steel joists that are used to form a grid. The joists distribute floor loads as well as loads from the walls to the bearers. These slender floor joists have to be braced to prevent toppling or rolling over.

The grid needs to be cladded and a range of different floor panels are used:

- Fibre cement
- Plywood
- Light weight concrete panels
- Floors can be tiled, but special consideration of the stiffness of the floor needs to be taken into consideration. Flexible adhesives could be used.
- With masonry construction two methods can be used;
  - The concrete slab can be supported by the masonry walls.
  - Concrete columns can be created and the slab can rest on the columns.

The disadvantage of casting a suspended concrete slab is that it is very heavy and it is more expensive than the floor of a Light Weight Steel Frame structure. The concrete slab is filled with steel; this process is called rebar and gives the slab the required tension strength. Along the same way the steel floor needs to be cladded and the concrete slab needs to be covered with a screed before the slab is fit for purpose.

<u>Roof and ceiling</u>

Any roof cladding material can be used with LSFB – light weight profiled metal sheet, or heavy concrete or even clay tiles. The roof structure has to be designed accordingly.The ceiling normally consists of gypsum or fiber cement board, the thickness dictated by the required 30 minute fire rating.

The ceiling structure plays a critical role in the stabilization of the structure and the transfer of wind forces to the floor and foundations.

Roof cavities can be;

- unconditioned: insulation installed on top of ceiling; or
- conditioned: insulation installed on underside of roof cladding.

Proper insulation of the ceiling is of utmost importance for the energy efficiency (SASFA Course, 2008:21)

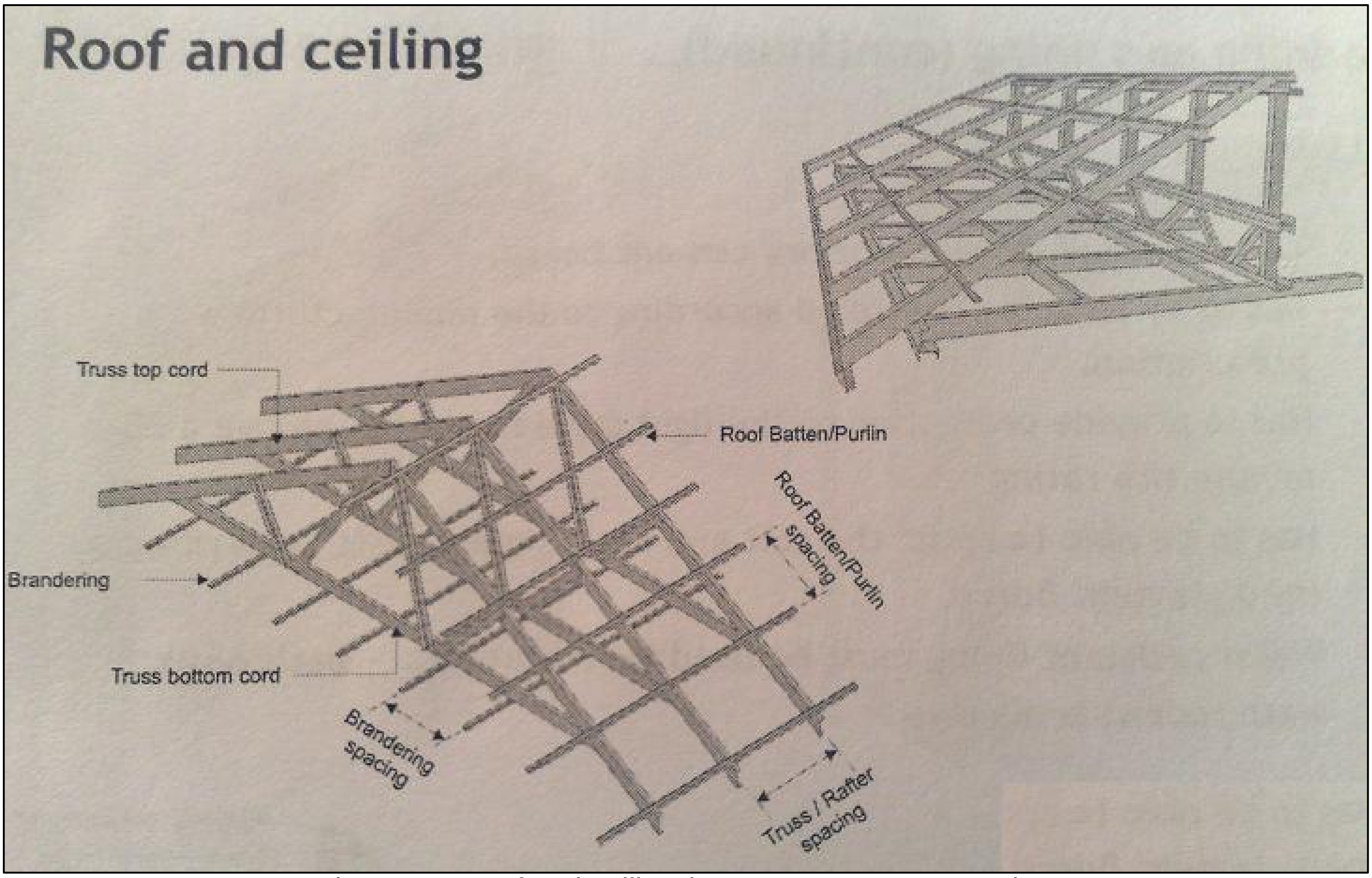

Figure 2 – Roof and ceiling (SASFA Course 2008:21)

With masonry construction any roof cladding can be used. The ceilings that are used in normal brick homes are 6mm gypsum boards and insulation is an option. The ceiling in a brick home is not of any structural importance. The function of the ceiling is merely to create an acceptable finish and to help with the thermal aspects.

Cladding and lining

Cladding is a term used for the exterior finishing of a structure, whereas lining refers to finishing of internal walls and ceilings.

- Cladding

Cladding can consist of brick veneer, or fibre cement sheets or planks.
The cladding must be installed according to the manufacturer's specifications
For structural and thermal reasons, cladding is often installed over OSB board.
The cladding has to be able to resist the soft and hard impact test prescribed by the agreement Board.

- Lining

Lining can consist of gypsum or fibre cement board.
It has to be installed and fixed according to manufacturer's
Prescription it further has to provide protection to the light steel frame
and has to comply with a 30 minute fire rating.
I also has to be able to resist the soft and hard impact tests prescribed by the agreement board.
Water resistant lining must be used in "wet rooms" – bathrooms, wash rooms and sculleries
(SASFA Course, 2008:22).

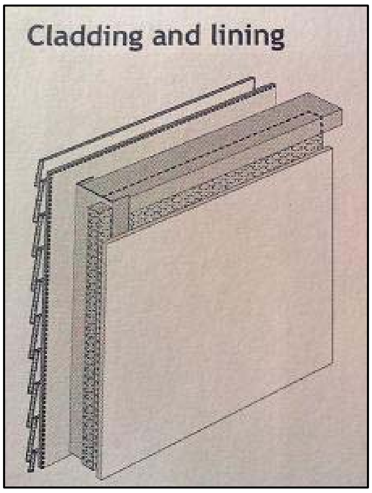

Figure 3 – Cladding and lining
(SASFA Course, 2008:21)

Masonry

Masonry walls can be cladded on the outside with boards etc. Although it is not customary in South Africa.
The walls can be constructed with face brick. Face brick are more expensive than normal bricks and it takes greater time and skill to build a face brick wall.
Brick walls are very hard and rugged and can resist all kinds of impacts
Brick walls have a 2 hour fire rating and there is no need for screws.

Insulation

Bulk insulation consists of fibre blankets or extruded polystyrene. It is used for thermal and acoustic insulation.
Increasing thickness of insulation material results in increasing R-values.
With steel frame structures insulation is typically fitted between the studs, after the exterior cladding and services have been installed, or on top of ceilings. This is an important factor of LSFB (SASFA Course, 2008:24).

With masonry brick houses insulation is only installed in the ceiling area. Brick walls are a solid mass and there is no space to install insulation in the walls. The brick wall itself provides the thermal and acoustic insulation.

Services

With Light Weight Steel Frame structures the holes where the conduits need to be installed are already provided for in the frame. This makes installation easy and neat. Some services are previously fabricated and can be simply installed on site.

Before a service or an electrical point can be installed in a masonry brick wall, the wall must be cut or prepared to make way for the conduits and pipes. This process is the process of “chasing”. Chasing consists of using an angle grinder and a chisel to create an area in the wall so that the conduits are flush with the wall after the plaster work.

2.3 HOW DOES LIGHT WEIGHT STEEL FRAME BUILDING CONSTRUCTION WORK?

By using a specially written computer programme, the frame manufacturer uses the building plans to design the appropriate floor, wall and roof frames/trusses.

The information from this programme is sent to a cold roll forming machine which, apart from forming the flat sheet into the required shape, also cuts the components to length and punches the holes, dimples, etc. required for assembly. The holes for plumbing and electrical services can also be made.

The frames get assembled on a table jig and various types of connectors are used to join the components together. The joint components are transported to the site where they are ready to be fastened on the slab. Frames are sorted and laid around the job close to their positions.

Start at a convenient external corner and set up two frames to produce a proper corner. Then fasten the two frames in the prescribed method.

Make sure the frames are plumb and braced fixed. Proceed with the frame erection process and install all permanent bracing and any temporary bracing required to keep the walls straight. After the wall frames have been secured, the roof cladding can now be installed. Both methods can accommodate any type of roof covering, steel sheets, tiles, slate etc.

Any type of roof cladding can be added to a masonry house, but with ight Weight Steel Frame building the type of roof covering must be specified in the design phase, because the weight of the roof covering determines the design of the wall frames.

Aluminum, timber or steel framed external windows and doors are fixed to the frame with nails and/or screws. After the foundation is completed and the steel super structure is completed, the structure is ready to receive the necessary cladding and roof covering. The structure should look something like Figure 4.

Figure 4 - Holiday house, Southern Cape (WSCC presentation, 2007)

Both the methods require a solid, level and square slab before the super structure can be build. There are many different types of foundations that can be used to build a house depending on the soil conditions. When you are building a simple 200m² brick house on a flat piece of land, the norm is to use a strip footing foundation to support all the walls. Because Light Weight Steel structures are half the weight of normal brick walls, the foundations do not need to be as wide and as deep as with brick walls. In most instances a raft foundation is used to carry the steel structure. Provision must be made for lateral uplift in light weight structure, as is the case with brick walls.

2.4 ADVANTAGES AND DISADVANTAGES

2.4.1 Advantages of LSFB

- Only quality certified materials are used.
- It is structurally sound – each structure is signed off by an engineer.
- It can accommodate imperfect foundation conditions.
- The thermal insulation is superior to double skin brick walls.
- It is dimensionally accurate.
- There is minimal waste.
- It is durable – has predicted life of >100 years.
- Light weight – logistical cost slashed.
- Energy efficient – range of insulation options.
- Flexible – can be built in stages, easy alteration.
- Predictable – accurate costing.
- Earlier occupation.
- Steel frame homes are environmentally friendly.
- You have freedom of design – the steel allows for more.
- Steel frame homes are fire resistant.
- Superior sound insulation.
- Reducing the cost of building on remote sites and areas.
- A very high degree of accuracy.
- Reduced building waste
- Faster building and completion.
- Steel is not an organic material.
- Steel cannot be eaten by termites, ants, rodents and the like.
- Steel framing is non-toxic.

- Steel framing sections are fastened together with screws and bolts.
- Steel frame studs and components are straight and true in form.
- Steel frame homes are far more energy efficient.
- Steel frame homes are easier to maintain and remodel.

2.4.2 Advantages of masonry brick wall

- Is the trusted building method in SA.
- More available labour.
- Create more jobs than LWFS.
- Is safer and stronger – can stop a bullet.
- Big alterations can be done on site without any lag time.

2.5 TEST OF HYPOTHESIS

2.5.1 Sub-problem 1

What does this new construction method consist of and how can it be used?

2.5.2 Hypothesis

All the elements are discussed and comply with the necessary regulations. SASFA's new Light Weight Steel Frame method can be used in SA.

2.5.3 Comments

The method stated above is simple and the same steps are followed when making use of masonry brick work. In this chapter, the various elements of this new building technique is explained. The foundations need to be laid, the structure is built and the walls are cladded. Although masonry is exactly the same, the only difference is that the walls are heavier and consist of smaller parts.

This new method complies with all the national building regulations and is approved by the NHBRC. The fact that this method qualifies under those laws clearly proves the hypothesis: that the method is fit for use in South Africa.

CHAPTER 3

HOW ENERGY EFFICIENT AND SUSTAINABLE IS THIS NEW BUILDING METHOD?

3.1 INTRODUCTION

Thousands of years ago, man needed protection from the weather and wild animals. Man longed for protection and found it in the form of caves. Due to population growth, a shortage of caves developed over time - especially suitable caves near water and food. Today man still needs protection against all of these elements, but the bar has been risen and the quality, size and esthetics have developed in such a way that the “caves” need to keep up with current trend. Man created new ‘caves’, and so the forerunner of the ‘the building’ as we know it today, developed.

In the modern time, buildings are not only erected to protect the inhabitants or goods against the elements like sun, rain, wind, hail or snow, but also to create a comfortable and safe area for people to live in.

Buildings are also intended to provide a healthy environment and a degree of comfort for the occupants, i.e. protection against heat and cold. While protection against the elements are always considered, and catered for, in a “South African” weather environment where we heat our homes for comfort and not for survival (as it happens in colder climates) the approach is typically to leave the thermal aspects to be addressed by the services – such as heating and cooling appliances instead of building them into the original construction. This is particularly true in the case of residential buildings (Barnard, 2007:1)

The current state of building technology is the result of the ongoing endeavours of modern man to improve the degree to which buildings satisfy his needs and aspirations. With the new energy rating legislation of 2007/2008, minimum levels of insulation will become mandatory in homes. When a house is not insulated, about 40% of the overall heat is lost through the roof and ceiling, while 35% is lost through the walls and floors. When it comes to bulk insulation materials, their performance is specified with an ‘R-value’. The greater the R-value, the more effective the insulation. In the Cape, the recommended R-value is 3.2 for the roof and 1.7 for the walls. The cost of energy will by all accounts continue to rise sharply in the future, which will make the current solutions for thermal comfort of operating heating and cooling appliances increasingly more expensive (Cape Town property for sale, 2008).

By understanding energy and being aware of the different aspects that influence the amount of energy used in buildings, we can reduce the cost of energy and help to protect the environment. In the building industry, energy consists of two aspects, namely embodied energy and operational energy.

3.2 TYPES OF ENERGY

3.2.1 Embodied energy

There are two forms of embodied energy in buildings:
· initial embodied energy; and
· recurring embodied energy.

The initial embodied energy in buildings represents the non-renewable energy consumed in the acquisition of raw materials, their processing, manufacturing, transportation to site, and construction. This initial embodied energy has two components:

Direct energy - the energy used to transport building products to the site and then to construct the building; and
Indirect energy - the energy used to acquire, process, and manufacture the building materials, including any transportation related to these activities.

The recurring embodied energy in buildings represents the non-renewable energy consumed to maintain, repair, restore, refurbish or replace materials, components or systems during the life of the building. (Cole & Kernan, 1996: 307-317).

Implicit in these measures of embodied energy are the associated environmental implications of resource depletion, greenhouse gases, environmental degradation and reduction of biodiversity. As a rule of thumb, embodied energy is a reasonable indicator of the overall environmental impact of building materials, assemblies or systems. However, it must be carefully weighed against performance and durability since these may have a mitigating or compensatory effect on the initial environmental impacts associated with embodied energy. (Canadian Architect, Case Study: 2008)

How is it measured?

Typically, embodied energy is measured as a quantity of non-renewable energy per unit of building material, component or system. For example, it may be expressed as mega Joules (MJ) or gig Joules (GJ) per unit of weight (kg or ton) or area (square meter). The process of calculating embodied energy is complex and involves numerous sources of data (Cole & Kernan, 1996: 307-317).

	EMBODIED ENERGY	
MATERIAL	MJ/kg	MJ/m3
Aggregate	0.10	150
Straw bale	0.24	31
Soil-cement	0.42	819
Stone (local)	0.79	2030
Concrete block	0.94	2350
Concrete (30 Mpa)	1.3	3180
Concrete precast	2.0	2780
Lumber	2.5	1380
Brick	2.5	5170
Cellulose insulation	3.3	112
Gypsum wallboard	6.1	5890
Particle board	8.0	4400
Aluminum (recycled)	8.1	21870
Steel (recycled)	8.9	37210
Shingles (asphalt)	9.0	4930
Plywood	10.4	5720
Mineral wool insulation	14.6	139
Glass	15.9	37550
Fiberglass insulation	30.3	970
Steel	32.0	251200
Zinc	51.0	371280
Brass	62.0	519560
PVC	70.0	93620
Copper	70.6	631164
Paint	93.3	117500
Linoleum	116	150930
Polystyrene Insulation	117	3770
Carpet (synthetic)	148	84900
Aluminum	227	515700
NOTE: Embodied energy values based on several international sources - local values may vary.		

Table 1- Embodied energy of materials

(Canadian Architect, 2008)

Embodied energy is an important component in the life cycle assessment of energy efficiency of a building – it can account for as much as 20% of the total energy consumption of a building, including operational energy use over a 50 year period. Different materials contain significantly differing amounts of embodied energy.

It should be noted that the figures in Table 1 refer to embodied energy / kg and per m³ of material. As the quantities in which the different materials are used differ vastly, it is more relevant to consider the embodied energy per assembly of materials. Residential homes are constructed in such a fashion that it is practical to make use of m² assessments to compare the different amount of embodied energy used to make the material that is being used.

In the table below, three different types of walls are compared; total embodied energy is calculated in an m² component. By looking at the embodied energy table it is clear that bricks have a much lower MJ/Kg than steel. It must be taken into consideration that a larger mass of bricks is used to form a brick wall and the mass is even greater when the wall is an exterior load bearing wall. In the case of Steel frame construction and timber frame construction the total mass needed to create a wall is much lower than the brick wall and thus resulting in an unfavorable comparison when considering embodied energy in unit areas.

In order to be able to compare the different methods, the embodied energy must be converted to MJ/m² in accordance to the amount of material used when constructing a residential house. The three types of walls that were studied were;

Timber frame: timber weather board, plaster board lining. Steel frame cladding as for timber frame, and double clay brick wall, plastered.

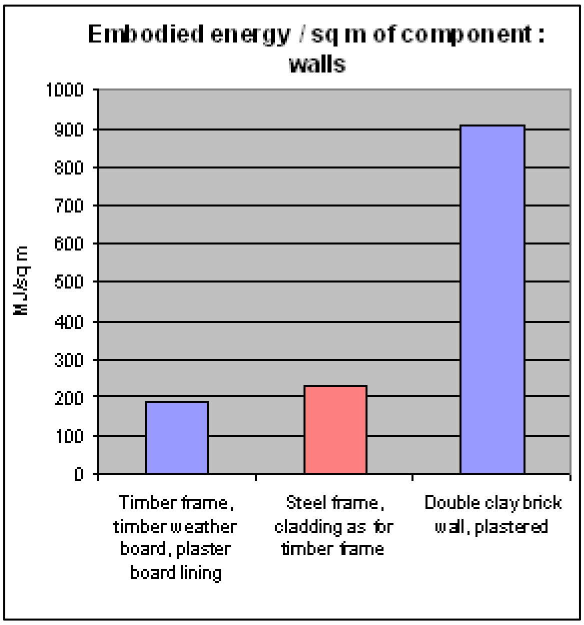

Figure 5 - Energy per sqm of walls (Barnard, 2007:3)

It can be seen clearly in the table that while bricks have embodied energy of only 2.5 MJ/kg, a much larger mass of bricks is used for an exterior load bearing wall, compared with the mass of materials used for frame building. When comparing the tests done on the different walls, it can be seen that the embodied energy used in current clay brick construction is more than 4 times that of light frame construction methods.

The relatively high embodied energy/kg of galvanized steel sheet is largely offset by the much lower mass of galvanized steel used per unit area for a light steel frame, compared with timber in a timber frame. As an assembly, the light steel frame wall contains a slightly higher embodied energy than a timber frame equivalent – this difference will, however, be offset when the recyclables of the steel in light steel frame walls is brought into the equation. The same applies for light steel roof trusses, compared with timber trusses. (Barnard, 2007:3)

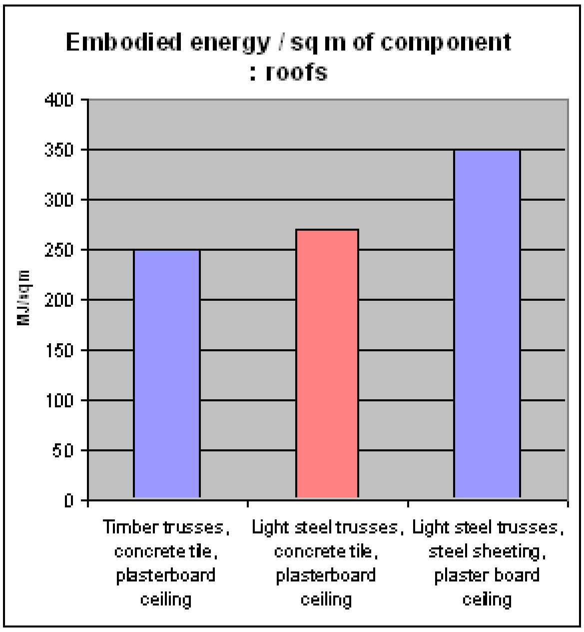

Figure 6 – Energy per sqm of roofs (Barnard, 2007:3)

Embodied energy calculations are complex, and subject to definitions of what is included, and what not. The table above has been extracted from the same source, and the figures are based on the same basic assumptions. The numbers can vary drastically depending on how far away the manufacturing plant is from the site of construction, and the resulting energy consumed in transport (Barnard 2007:3).

3.2.2 Operating energy

Operating energy is the amount of energy that is used during the life time of the building in order to create a comfortable living environment. Operating energy is a significant measure of sustainability which enables straightforward comparisons between alternative building technologies. Buildings consume energy for heating, cooling, ventilation, lighting, equipment and appliances. Passive energy systems rely on the building enclosure or envelope to take advantage of natural energy sources such as sunlight, wind, water, and the surrounding soil. Passive buildings use these natural energy sources to their advantage to reduce the costs of operating energy. Active energy systems represent mechanical, electrical and/or chemical processes. Occupants of buildings can also contribute to the heating of buildings by virtue of the heat produced through metabolic processes. Building energy demands exceeding those captured and/or supplied by renewable sources must be supplemented by non-renewable sources.

With current building standards and with the necessity and responsibility to protect the environment, it is essential to include theses forms of energy in the equation. While the residential market uses on average 'only' 15% to 25% of all electricity consumed, it becomes the major user in peak hours. The impact of millions of households on the national electricity grid was clearly illustrated during the past winter. Heating and cooling consumes between 25% and 40% of the electricity used in the average home, electric water heaters 40% and all the lighting and other appliances the rest. It is therefore clear that a reduction in electricity used for heating and cooling will make a notable contribution to the national electricity conservation goals (Barnard, 2007:2)

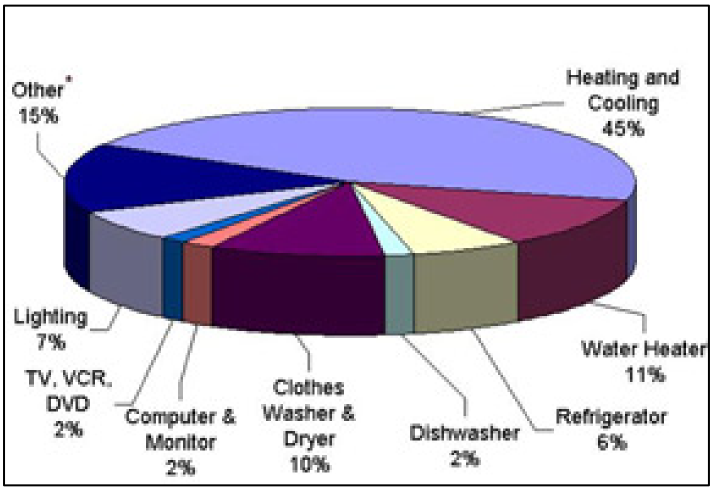

Table 2 – Typical home energy use (Energy Conservation, 2008)

According to an energy report done by the energy conservation group, it is clear that heating and cooling consist over 50% of energy used in the residential sector. Operational energy used in buildings may be defined as the non-renewable energy used to heat, cool, humidify/dehumidify, ventilate, illuminate and operate buildings, and the equipment and appliances they contain (Energy conservation, 2008)

In South Africa the climate conditions need to be taken into consideration. It is only necessary to cool down a building when the occupants of the building become uncomfortably hot and vice versa. South Africa is a large country and has a wide range of climatic conditions; these can range from Mediterranean in the Western Cape to Sub-tropical in the North East. Consequently, one is not able to summarise the country as a whole but rather by provinces individually.

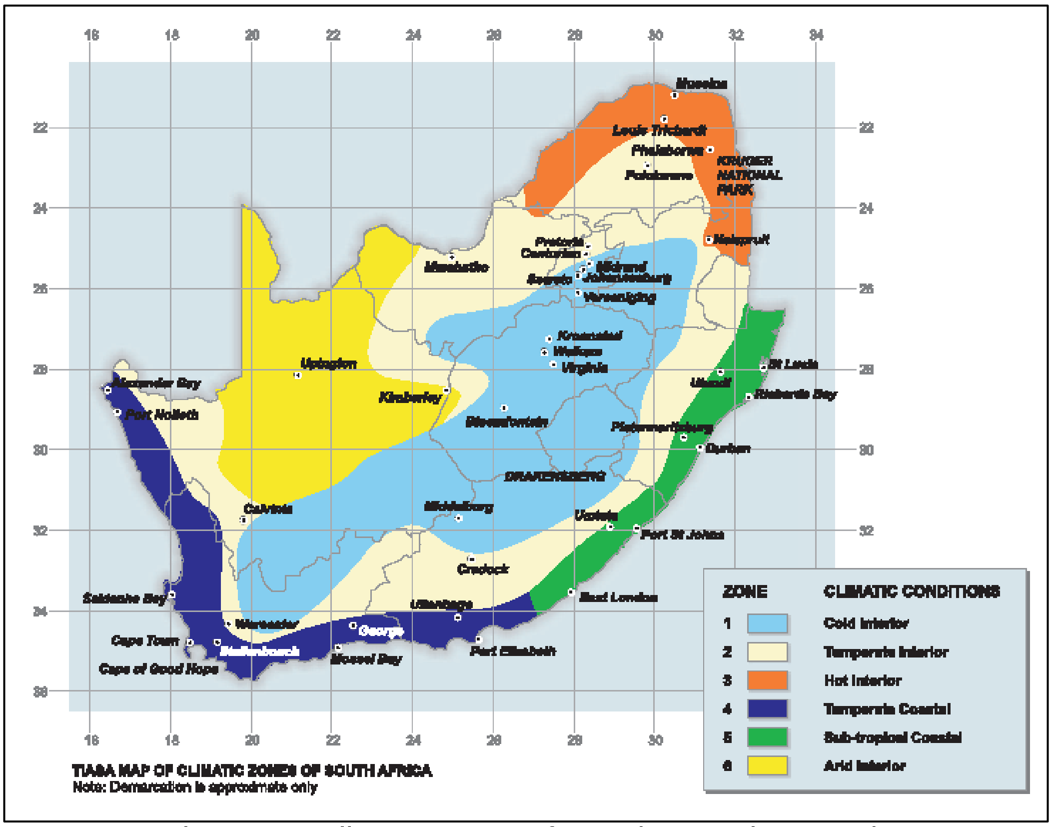

Figure 7 – Climate zones of S.A. (Barnard, 2007:5)

The map in figure 7 illustrates the different climate zones in South Africa. Each zone is different and the temperatures vary in each zone. Temperatures tend to change between 5-15 degrees in one day. This makes it difficult to accommodate for only one type of temperature. In the building industry we make use of insulation to accommodate the fluctuations of temperatures.

In order to understand how insulation works, one needs to first understand how heat moves.

In addition to the heat from the sun and burning of fuel, heat is also generated by people, animals and the use of electrical appliances (including lights). In fact, as much as 30 percent of heat produced inside a home can originate from lights and appliances.

The heat generated by all of these sources moves from place to place by three basic principles; radiation, convection and conduction.

Heat transfers through the walls, windows, roof and floor of a building using a combination of radiation, conduction, and convection, moving from higher temperature to lower temperature areas. In the summer, when it is warm outside, heat transfers through windows, exterior walls, roof, and the floor of a building to the inside. This process is referred to as heat gain. The amount of heat that the building is able to gain depends on the thermal mass of the walls and the envelope. In the winter, the opposite will happen. Heat generated by heating systems moves through the building enclosure and is lost to the outside. This process is referred to as heat loss. (Barnard & De Clercq, 2007:4)

The thermal mass of buildings can be described in the form of a R-value. R-value measures the resistance to heat flow of a material or composite element, including the effects of any air spaces and / or reflective surfaces. The higher the R-value, the better the ability of the material or composite element to resist the flow of heat through it. R-values are expressed using the unit's m^2.K/W. (SASFA Code, 2007: 14).

A double leaf cavity brick wall has an R-value of only 0.66 m^2K/W this is insufficient in terms of the new recommended R-values for walls. The recommended R-value for walls should be between 1.9 and 2.2 m²K/W, depending on the climatic zone in SA where the building is located. Brick walls do not comply with the required R-values for SA. Brick walls' R-value can be improved by cladding the interior of the house with fiber cement boards or gypsum boards. The new Energy Act states that all houses must comply and adhere to the recommended R-value of residential homes.

Mr Ryan Hesketh did a thermal test on two identical shape and size homes in the same geographical area. The one house was constructed using light weight steel and the other using masonry brick walls. Omega meters were placed in the houses, each in different rooms. The homes were completely empty and there was no movement or electrical appliances in the houses. The test was done in the middle of the winter and it was found that the steel frame structure was 5ºC warmer than the brick house; the brick house was approximately 10ºC and the steel frame structure house measured 15ºC.
The summer the results were different and the Masonry house was 5 degrees warmer than the steel frame structure house. This tests state the thermal properties of this new building technique. The secret in achieving this, is the possibility of inserting insulation between the cladding of the walls. Insulation is typically defined by its R-value, which is the measure of a material's resistance to heat flow. Because the fibre cement boards consist of a higher R-value, they are more resistant to heat flow and improve the thermal qualities of the building.

The SASFA team also conducted an analysis that was carried out by a specialist consultant to compare the expected internal temperatures in a light steel frame dwelling with that of conventional heavy construction in everyday use. Sophisticated computer software developed by the American Department of Energy was used. The results are summarized in the temperature graphs below. The 'thermal neutrality' lines indicate the temperatures at which most people will be comfortable (22ºC). The computer programme is very sensitive and if the insulation is 2mm too thin, the computer programme will change the equation and the results will change. The dotted lines above and below the 'neutrality', indicate the temperatures where people will experience discomfort (upper and lower thermal discomfort limits).

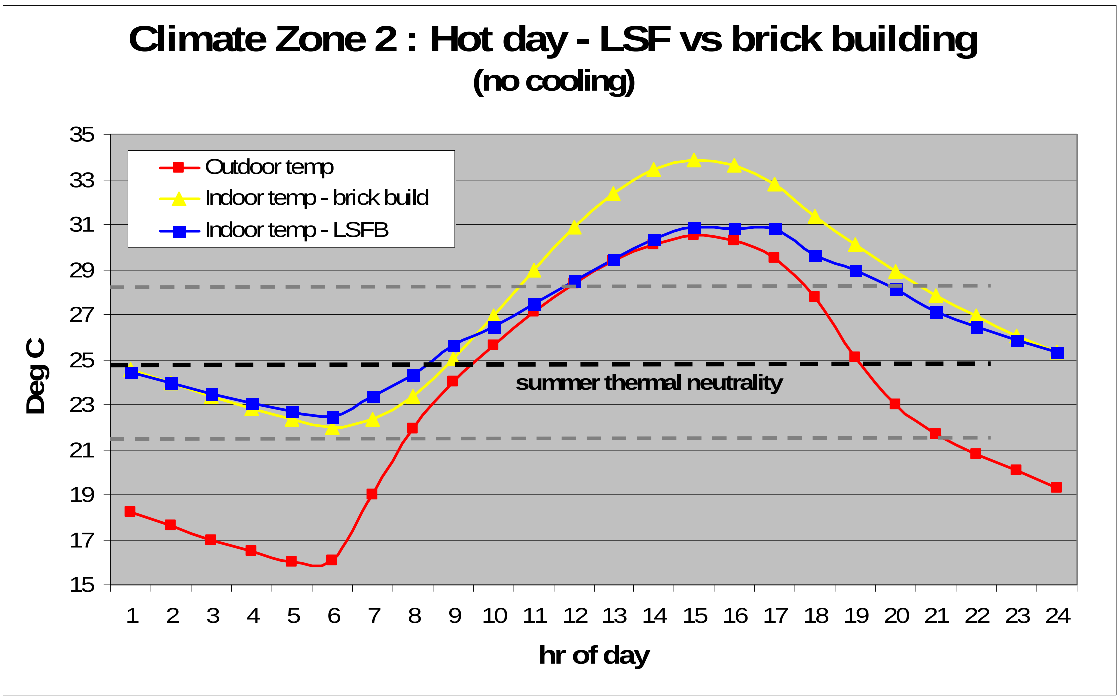

Figure 8 - LSFB internal temperatures on a hot day

(Barnard, 2007:6)

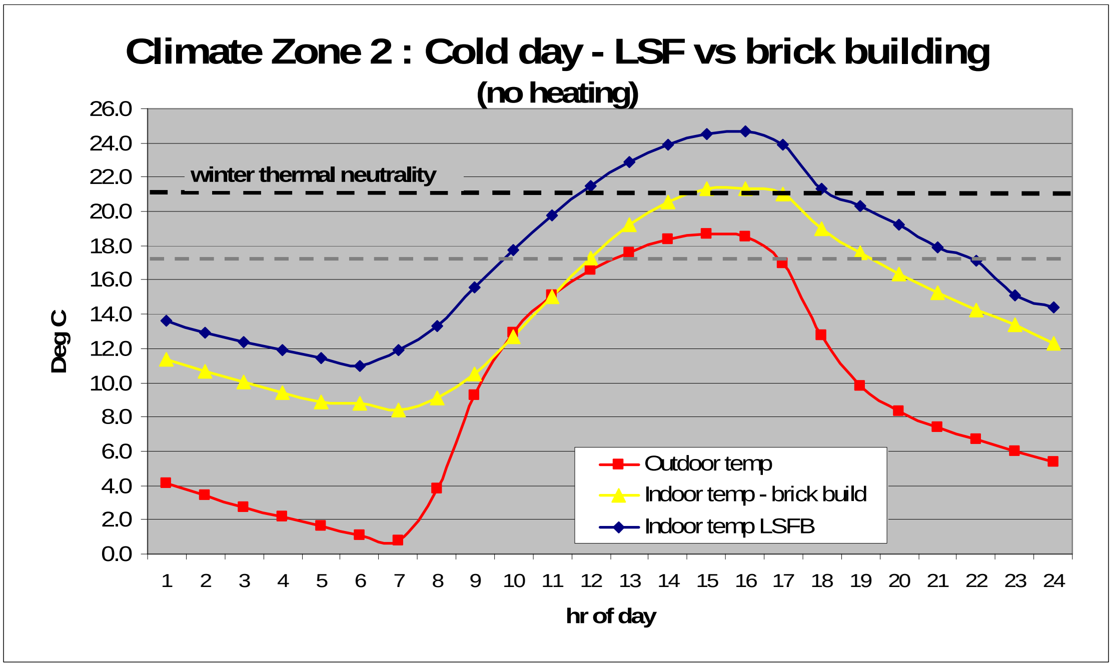

Figure 9 - LSFB internal temperatures on a cold day

(Barnard, 2007:7)

3.3 SUMMARY:

Energy savings for heating and cooling - light steel frame vs brick buildings:
(Based on deviations of internal temperatures from the respective norms)

Cooling and heating to thermal neutrality:

Hot day	: - 29%
Cold day	: - 36%
Overall *	: - 33%

Cooling and heating to lower / upper thermal discomfort limit:

Hot day	: - 61%
Cold day	: - 37%
Overall *	: - 48%

* Assuming hot: cold days = 2:1

(Barnard et al, 2007:7)

In the summer, uncontrolled heat gain can cause the inside of the building to be uncomfortably warm, necessitating the use of appliances (fans, air conditioners) to cool the interior - resulting in higher electricity consumption and costs. In the winter, when uncontrolled heat loss can make the building uncomfortably cold, heaters will be used, again resulting in higher electricity costs.

3.4 TEST OF HYPOTHESIS

3.4.1 Sub-problem 2

How energy efficient and sustainable is this new building method?

3.4.2 Hypothesis

Opposed to conventional masonry brickwork, Light Weight Steel Frame structures are up to 40% more energy efficient. Because less energy is used, fewer resources are used, thus making it more sustainable than conventional building methods.

3.4.3 Comments

SASFA's new building method makes use of fibre cement boards. Traditional building methods do not comply with the required R-value as stated by regulation. By making use of insulation between the cavities of the walls, SASFA has created a wall that is strong and fit for purpose as stated by regulation. The method uses less embodied energy and because of the insulation advantages and the high R-value, operational energy is also reduced. This concludes that SASFA's new light weight steel frame structure building method is more sustainable and more energy efficient than current building trends. The hypothesis was thus correct that new light weight steel frame structures are more energy efficient.

CHAPTER 4

WHAT ARE THE COST AND CONSTRUCTABILITY DIFFERENCES BETWEEN THE TWO BUILDING METHODS?

4.1 INTRODUCTION

The first question that is asked when buying something, is how much does it cost. The price of something is the biggest aspect that needs to be taken into consideration when buying something. It is inevitable that we investigate this aspect when investigating alternative building methods. In construction there are various costs that need to be taken into consideration. These cost include; the materials, labour, overheads and professional fees. In construction all of these aspects are important to the contractor, because if he can reduce the cost of one element, he makes more profit. The client on the other hand is not concerned with all these different costs and is only interested in the final tender price.

Interviews with different contractors and erectors were set up to gain the necessary information. The contractors that were interviewed were;

- Mr Ryan Hesketh form Dira Steel Houses
- Mr Anton Coetzee from Chad Construction
- Mr Jan Kotze form Steelwave Buildings cc

4.2 COST COMPARISON

To compare costs between Light Weight Steel Frame structures and conventional masonry brick work, two research methods were followed. The first method included gathering quotations from different contractors which quoted on both building techniques for an identical unit, and interviewing the contractors to explain their experience in costs, if there was a difference in the tender. The second method that was used, was inspecting the costs of materials using a detailed BOQ (Bills of quantities) and comparing the price of the different elements.

4.2.1 Comparing costs making use of identical units

There is currently a development being done by Arlington Construction in Fairy Glen. Mr. Ryan Heskieh, the developer, gives the clients the option of choosing between conventional masonry brick work house or a new Light Weight Steel Frame structure house. The clients are given four different types of layouts. Layout type D is the biggest of the four types of houses. House D consist of double story with a loft, 4 bedrooms and 2,5 bathrooms. The total living space of the unit is 301,7 m². Below is a 3D illustration of the House Type D unit and basic layout of each floor level.

Figure 10 - Illustration of type-D unit (Arlington representation, 2008)

All the finishes that are used in the houses are the identical regardless if the house is built from bricks or steel. The costs of finishes will not be included in the study because there is no difference is the cost of the materials or the installation of the materials.

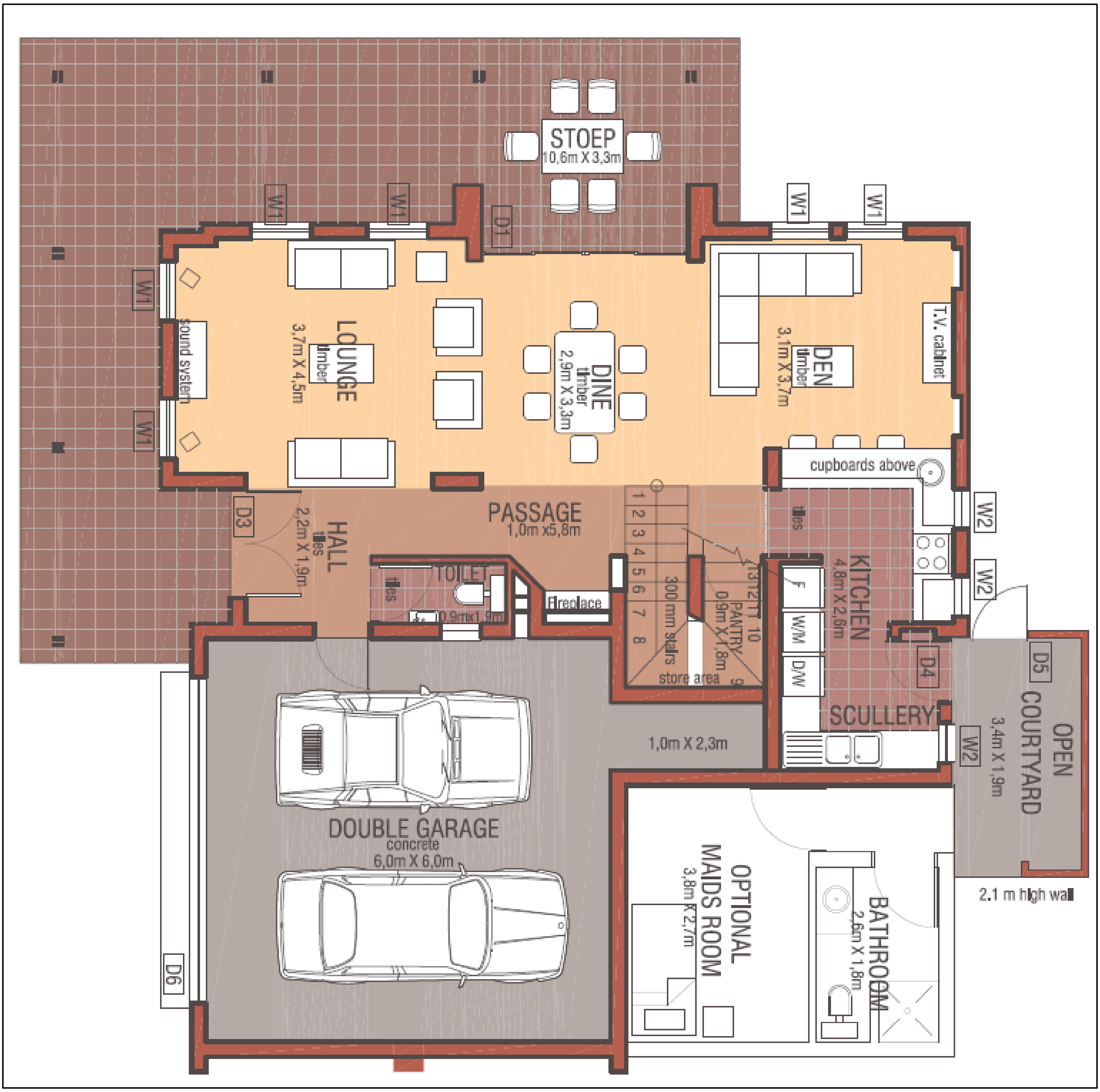

Figure 11 – Layout of type-D ground floor (Arlington representation, 2008)

Figure 12 – Layout of type-D first floor (Arlington representation, 2008)

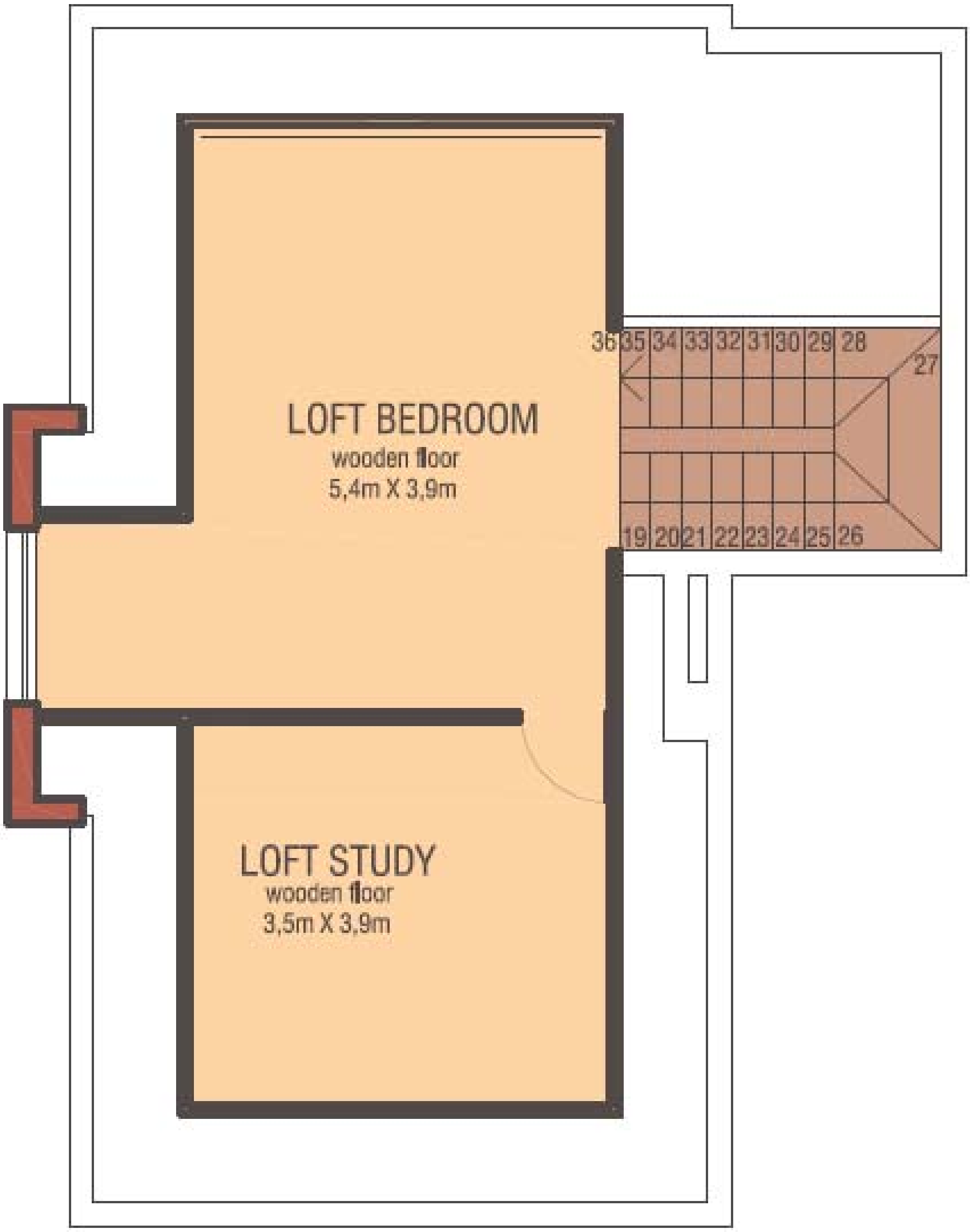

Figure 13 – Layout of type-D loft floor (Arlington representation, 2008)

As stated previously, type D is only one of the four types of units that will be compared. The other three units differ in size and layout. Four different types of units are going to be compared; these units are type A, type A loft, type C and the type D as stated above. Official quotations and brochures were evaluated and the following table was drawn up to be able to compare the different units.

Unit	**m²**	**Bedrooms**	**Bathrooms**	**Reception + study**	**Cost in bricks**	**Cost in steel**	**% saving in steel**
Type-A	146.8	3	2	1	R1,034,000	R 930,600	11
Type-A loft	202	3	2	2	R1,149,000	R1,034,100	11
Type-C	229.3	3	2.5	2	R1,269,000	R1,142,100	11
Type-D	301.7	3	2.5	3	R1,589,000	R1,430,100	11

Table 3 - Comparison in completed unit costs (Arlington quotation, 2008)

The table above shows the different units, the total living per square meters, the number of each type of room and the two different costs. All the costs between the two houses was done by one contractor and he found that the cost to construct Light Weight Steel Frame structures was 11% less, compared to the masonry brick work method. As stated previously, interviews were conducted with Mr Ryan Heskith and the other contractors to determine the ease of constructability on site in practice and what the difference in cost was to supply the steel frame structures.

4.2.2 Detailed breakdown comparison

The second method consists of evaluating the BOQ of a Light Weight Steel Frame structure house. The house that is going to be evaluated is a 200m² single story house built on the Ugie site. Following is a picture of the finished product of the house.

Figure 14 - Completed LWFS unit (Own information)

There are a number of identical houses build on this development, the finishes between the houses may vairy, but the envelope and the interior layout of the houses are the same. The bills of quantities vairy from normal masonry construction, because there are different materials and parts involved. To determine the difference in material price, the dimensions in the BOQ for the steel house was taken. The dimensions were supplied to an estimator and he calculated the cost to construct the same house using brick construction. No profit and no P&G's (preliminaries and generals) were added to the price.

The bills of quantities are categorised between the various elements. In the Light Weight Steel Frame structure some of the elements are combined, for example the roof structure is included in the steel structure whereas with masonry, the roof gets measured as a stand alone item. All of these various elements are explained in detail in chapter 1. To compare the difference in cost, the total cost of a section will be combined and compared to the same section. The costs given include material cost and labour. The costs are as follows;

Element	Cost of steel	Cost of bricks
Foundation	R 88,962.10	R 85,000.00
Super structure and roof	R 99,036.00	R 140,000.00
Walls (cladding)	R 88,828.87	R 58,000.00
Ceilings	R 26,169.66	R 29,000.00
Services	R 33,182.39	R 40,000.00
Transport	R 20,000.00	R 30,000.00
TOTAL	R356,179.02	R 382,000.00

Table 4 - Material and labor comparison (Own information)

The measurement of the house was given to an estimator and he estimated these prices according to the various measurements. The foundations are identical and there is no real difference in price. The super structure and the roof is a combination of both elements, because the LWFS is measured as one unit the quantities of the both the brick work and the roofs cost are included. The reason for the big difference in cost is because bricks do not need to be cladded before they can be finished. The walls also differ significantly in price, but the steel frame structure is more expensive because two layers of cladding on each side are needed, plus insulation and a vapor membrane must be applied. With masonry it is only the plaster that needs to be applied (Coetzee, 2008: Interview).

There is no real difference in ceiling costs. The services cost of the estimator was given according to the number of points in the house. The main reason for the big difference in cost is the extra labour cost. The amount of labour it takes to provide channels for the conduits makes the difference. The channels for the conduits are already inserted in the steel structure. The estimator made a rough estimate for the transport according to the living area of the unit. The difference in costs is also of importance. Steel structures costs of logistics are a big saving opposed to masonry brick houses, mainly because of the difference in weight. Logistics have a big influence on the cost of a project and the depletion of recourses.

The total cost of the Light Weight Steel Frame structure is 7% less than the estimated cost of the masonry brick house. The difference in cost is not as big as what was expected, but as the contractors stated, it is the saving in time and ease of construction that makes this a good alternative building method.

4.3 INTERVIEWS

A basic list of questions was asked to each contractor. The set of questions that was given to each contractor is attached, and can be seen in appendix A. Each contractor's answers were taken into account and combinations of the different answers were given.

A. All the contractors that were interviewed are currently in the process of erecting these new light weight steel frame structures. The contractors all have experience in the building industry but their experience in this particular field range from 3-6 years.
B. All the erectors currently own their own Light Weight Steel Frame construction company and know just about all there is to know about LWFS. They became aware of the product through the internet and through the marketing team of SASFA.
C. All of the contractors preferred the Light Weight Steel Frame construction method. Their reply was identical: the ease of construction, fewer labourers to control on site, the small amount of wastage and the ease of control of the various materials. The site is tidier and there is less equipment to be bought when constructing the house.
D. The main differences for the contractor/ erector is that there are less people on site, the people that are used to construct the house is smarter and more qualified, thus making supervision needs less. If the foreman is well-skilled and good at erecting the house, there is no need for the contractor to be on site the whole day. Talking about the foreman, there is a difference in masonry construction, because with steel construction the foreman is part of the building team. The team erection team only consists of about 6 staff and the steel structure of a 200m² house is erected in 5-7 days.

E. Mistakes are rarely made because each part is numbered and the structure is provided with a manual.
F. Because they are not yet aware of the product, or because their clients are scared to risk this new unknown option. Most people feel safer in a brick house. Clients lack in the technical knowledge of Light Weight Steel Frame structures, it makes it difficult to convince them to make the conversion to steel.
G. There is no difference in the cost of the house itself. There is however a cost saving in labourers and professional fees. The real saving is the saving of time. These new LWFS homes are constructed in half the time of a conventional house.
H. LWFS is a must and is the future of construction.

The conclusion that was made from the first study was that; there is a minor saving of between 5-15% when comparing the two building methods. The savings became greater when the site location is far from supplies. The other saving is the cost in labour and time.

4.4 TEST OF HYPOTHESIS

4.4.1 Sub-problem 3

What are the costs and constructability differences between the two building methods?

4.4.2 Hypothesis

The difference between conventional masonry brickwork and Light Weight Steel Frame structure are minimal. The saving in construction time and the ease of constructability is immense.

4.4.3 Comments

In the opinion of the various contractors, the difference in cost is not the main reason; they stated that in some instances, the LWFS is more expensive than the masonry brick work. It should be kept in mind that this is a new method and the recourses to supply all the required material are not yet as readily available as the materials for masonry construction. That fact that the construction period can be cut in half is what makes the new alternative so impressive. All the contractors agreed on the fact that wastage is saved and that the conditions of sites are better than with masonry construction and they prefer to use steel as an alternative. The Hypotheses was only partly correct in the fact that LWFS is more constructible, but the savings in cost can not be seen as an influencing factor at this early stage.

CHAPTER 5

IS THIS METHOD A MORE EFFECTIVE AND EFFICIENT CONSTRUCTION METHOD?

5.1 INTRODUCTION

Over the past few decades men became smarter and found quicker and easier ways to complete difficult tasks. In the prehistoric age, men spent most of their time, hunting and building homes and shelters. They also created their own weapons. If we take the bow and arrow for an example, in the prehistoric age it took a hunter about 2 days to make an arrow that could be used for hunting purposes. This included the shaft, fletches and the broad head. The broad head was one of the most important parts of an arrow and was also the part that the most time was spent on. An example of such and broad head is displayed in figure 15.

Figure 15 – Hand made Broad head (jelldragon, 2008)

Compare this with the quality and the time it takes a factory to create a single arrow that has the same function (figure 14) Modern advances has used the same concept, but used better methods and materials to improve the product. It is unbelievable; it takes a factory +/- 25 seconds to create a standard broad head that is very effective! The new product now does the same job and does it even better, taking less time and energy to create and has more advantages. In the prehistoric age man did not have all the technology, skills, equipment and knowledge that we have today. The question that should be asked in the building industry is whether we; are living in the new era or are we still living in the.

Figure 16 – Factory made Broad head prehistoric age. (jesseshunting, 2008)

In the building industry new methods have been created to improve the quality and time it takes to construct a home. The question we need to ask is; are these methods being used, or are we wasting precious time and energy and fooling ourselves in thinking that we are. An evaluation was done by myself on a building site and the project was called "The seven houses in Brooklyn". The project consists out of seven upmarket, double story houses build in the Brooklyn Pretoria area constructed by Van Niekerk Construction. The houses are almost identical with minor changes to the bathrooms. The houses are 385m² each and the houses are going to be plastered. On site the different tasks of the various staff were evaluated to determine how productive the methods they were using are.

To made the reader more aware; here is a quick brief of conditions on site. Access and storage is very limited on site. Water is only located on the one side of the site and materials are stored on the other side of the site. The houses are built adjacent to each other and there is a workforce of about 60 people on site. The workforce consists of about 12 brick layers, 30 labourers, 6 electricians, 4 plumbers and 16 plasterers. Other sub-contractors like tillers, painters etc. also come into account, but because they are the same for both methods up for discussion they would not be included in the study. The casual labourers consist of half the workforce and their main job is to aid the skilled labourers in completing their jobs (Own information).

In the modern era, the South African government are very strict and focused on job creation and equal opportunities in order to improve the lives of the citizens of the county. When we now come back to the two different types of building methods, it can be stated that the new method does not promote job creation, because a single house can be built in half the time of a conventional house and this using only 5-8 persons. When looking at it from only that perspective, call it perspective one, one can assume that 70% of jobs will be lost in the building industry.

These figures are immense and there is no way that we can afford to loose half of the jobs in the country because SASFA has introduced a new building technique. THIS IS NOT TRUE! SASFA’s new building method makes use of all kinds of new methods, materials and technologies. All these technologies need to be combined in order to be able to create a home with such accuracy and in such short time. The new method makes use of the overseas’ concept of pre-build homes under factory conditions. This does not mean that jobs are being lost; this only means that instead of all the people working on site people will be working under factory conditions.

5.2 SITE CONDITIONS

These site conditions that are being stated, consist of the environment that the work force are working in and their different duties. With conventional construction methods half of the total time is used to get the various material into their positions. This is no longer acceptable. People need to be more productive and do smarter jobs rather than harder jobs.

Most people are not familiar with the conditions on site. Here are some examples of various tasks of personnel on site. With SASFA’s new construction method most of these unsafe, unhealthy and unnecessary fiscal activities can be avoided. Materials that are moved into position are a simple example.

A conventional house weighs about 180 tons. This means that all 180 tons need to be put into their position. A Light Weight Steel Frame structure of the same size weighs about 80 ton when completed. The assumption can be made that 100 tons of materials (depending on the size of the building) do not have to be moved or placed into position. Another aspect that needs to be taken into consideration is the fact that materials are moved 4 times from the factory until placed in position on site (Technical team, 2008).

Example:

Bricks. First the bricks need to be moved from the drying yard to the storage area. Secondly, they are moved from the storage area and loaded onto the vehicle for transport to the site. Thirdly, the bricks get off-loaded on site and the labourers need to transport them to the brick layer. And finally, the brick layer places the bricks into their position. This means that the amount of material that actually gets moved should be multiplied by 4!

A brick layer is a skilled person and should be using his skill the entire duration of the day. Instead of using his skill he still has to do the work of a machine. He still moves over a ton of materials on his own in one day. This is concluded from the common fact that a standard brick weighs about 1.5kg and a good bricklayer should lie +/- 700 bricks a day. Do the calculation; 1.5kg X 700 = 1150kg. Not only does he place the bricks into position, he must also place the dagga between the bricks. Is this improving the working conditions and using skilled manpower? In the Stone Age rocks were carried and placed into position, we are still using the same method that they used in the prehistoric age. We are living in the future and we must seek faster, better and simpler ways and means to achieve the same or better result. (Own information)

LWSB is a new building method in SA that consists of constructing a new home that was pre-fabricated under factory conditions. The method makes use of pre-constructed panels that are simply jointed together on site. Walls are simply carried into position and fastened with screws. OBS board is also screwed onto the frame and fibre cements boards are screwed onto the OBS board. After the above mentioned process is completed, the wall is fit to be finished. The materials that are used are totally different in both instances. Brick walls consist of small bricks placed into position and steel frame buildings make use of boards being fastened onto a prefabricated steel grid. The differences between the two methods are clear and this is important because this gives the steel frame construction certain advantages.

5.3 ON SITE CONSTRUCTION ADVANTAGES OF THE LIGHT WEIGHT STEEL FRAME BUILDING

5.3.1 Housekeeping on site

Housekeeping is a term used to describe the neatness and tidiness of the construction site. Safety is a necessity on site and making use of good housekeeping creates a better and safer working environment. Below are two examples of construction sites, notice the difference in tidiness of the working environment. The LWFS site (figure 17) is cleaner, no wastage is lying around in the construction area and the area around the site is clean and it is easy to move around on site. Materials are neatly stacked on site, and because the main components are so big, it is easy to keep control over materials. By looking at the pictures of the two different construction sites other advantages and disadvantages between the two construction sites can be made.

Figure 17 - Arlington construction site July 2008 (own information).

Below (figure 18) is an example of a masonry brickwork construction site.

Notice the difference in tidiness and the amount of materials lying around. In the pictures the main walls are only shown. Plastering the walls should also be kept in mind because this is a huge part of completing the wall to the required standard. LWFS needs to be cladded before it can be classified as a wall. This process is the same process when installing dry walling onto a metal grid. Below are some activities that contribute to the advantages of Light Weight Steel Frame structures. The "ancient" methods can be eliminated by using LWSF.

Figure 18 - Seven Houses Brooklyn Chambers May 2008 (own information)

One aim of the future is to improve our society, creating better jobs and better life styles for all the people in the country. Below are a few examples of activities that can be eliminated when constructing a house with light weight steel.

5.3.2 Mixing dagga and plaster

Before construction can start, the dagga and plaster must be mixed and carted to the required position. Its takes three labourers to mix a batch of dagga, depending on the size of the site. Mixing dagga is a simple process and can easily be done by using a machine. When labourers are used, this is what they will have to do the whole day and they do this for the entire time of the construction period. When using LWFS, there is no dagga, instead hand-held drills and screws are used to fasten the different components.

Figure 19 - Labourers mixing dagga (Own information)

5.3.3 Carting materials to the required position

Before any materials can be used they must be moved to the position where they are required. More than half of the labour force on site is used to bring the materials to the required area.

Figure 20 - Moving materials into position (own information)

All this time, costs and waste of intelligence are wasted with these prehistoric activities on site. When using LWSF, two labourers pick up a frame, place it into position and the frame simply gets screwed together to stay in that position. No carting of bricks, no carting of dagga and no setting up of profiles.

5.3.4 Chasing

Chasing is a method of making use of an angle grinder to make way for the electrical conduits in a brick wall. This technique is displayed in figure 21; the picture is displaying a man busy chasing into a brick wall with a cloud of dust surrounding him. This is an unsafe, unhealthy and troublesome technique.
The technique causes pollution to the environment and surrounding areas. This whole process can be eliminated when making use of LWFS, because the route that the conduits need to follow are determined and created during the design stage.

Above are just some examples of inefficient activities that are currently used on used. These methods are not productive and they do not complement new age building. Workers need to be supplied with better jobs and better salaries.

Figure 21 - Labour Chasing Channels (own information)

It is impossible to complete a house in half the time and with 15% of the workforce without doing additional work. Light Weight Steel Frame Structures are pre-constructed in different location. Another aspect that must be taken into consideration is the fact that light weight steel frame structures are constructed in factories and are transported to the site.

The reduced number of workers on site does not necessarily loose their jobs, but they are rather shifted into different positions in other locations. No jobs are lost because new jobs are created in the form of mass production inside a factory environment. This is an improvement in working conditions for normal labourers on site. There are advantages in making use of factories. Labourers also gain certain advantages like a higher sense of skill is learned, labourers are given more civilised tasks, cleaner working conditions, safer working conditions, factories could be better located and higher salaries could be earned (own information).

5.4 TEST OF HYPOTHESIS

5.4.1 Sub-problem 4

Is this method more effective and efficient construction methods?

5.4.2 Hypothesis

The conventional masonry brickwork that is still being used is not the most effective and efficient construction method.

5.4.3 Comments

Current conventional masonry trends used on building sites are not the most efficient and effective construction methods and this is no longer acceptable. In order to become a competitive first class country, we need to supply our staff with better salaries and this means better jobs. Current on site construction techniques are no longer acceptable in this modern era. Michael Wakefield said; in times of change the leaders inherit the earth, while the learn nest find themselves equipped for a world that no longer exist. (Scerbo, 1998:122) Currently we are the learn nest and we are not making use of effective and efficient construction methods.

CHAPTER 6

SUMMERY AND CONCLUSION

6.1 PROBLEM STATEMENT

The building industry is one of the biggest and oldest industries in the world. The main problem of the thesis is to investigate an alternative building method to improve current homes, to save time and money and to help protect the environment.

6.2 SUMMARY

The construction method makes use of light weight steel frames, which are erected to form a skeleton and gets covered with gypsum of fibre cement board. The process is simple, the conventional plans are given to the steel factory, the factory enters al the different dimensions and specifications into a computer based cold roll machine and the computer calculates the exact amount of steel needed. The computer is a CNN based machine and cold steel is rolled into different parts. Each part has a reference number in order to enable the erector to erect the skeleton. A full manual, that is a detailed booklet show how to construct the various sections of cold steel.

The erection of the frame is completed after about 5-10 days depending on the difficulty and size of the unit. The unit is then cladded with the various cladding materials. The method of construction is very simple and quick. The various parts are simply screwed together. This new method introduces new advantages relating to cost and time savings and improved quality. Comparing the advantages and disadvantages of conventional masonry brick work to his new form of building it is difficult to understand why conventional methods are still being used.

Currently there is a shortage of energy and it is in our best interest to save as much energy as possible. LWFS structures save up to 40% more energy than the conventional building methods. This is possible by using more advanced materials and techniques. Energy is not only saved by the production of the various materials, but also with the operational costs. The other advantages of low operating costs are that the longer the building is being used the more energy and money is being saved.

Costs and constructability are big factors in the construction industry, because both of these elements are aspects that determine the success of the project. The cost comparison that was made did not show exceptional results. The main differences between the two methods are the ease of constructability and the huge amount of construction time saved. Light Weight Steel Frame structures are preferred by contractors who have worked with both methods of construction.

Times are changing and the methods that are being used are outdated. SASFA has introduced a new construction method giving the building industry a way out of its ancient activities. The construction method reduces the unproductive and unsafe tasks on the site and replaces those activities with factory condition jobs. Our aim in the country must be to improve the quality of life for all the people of this county and by improving skills and providing better job opportunities we can make this a reality.

6.3 CONCLUSION

It is a definite possibility that SASFA new Light Weight Steel Frame structures can become more competitive in SA. The fact that there are already various contractors making use of this new technique, makes it clear that this new construction method works and that there is a demand for it in SA.

In the study only a number of aspects were investigated and the results were in favour of LWFS. This pre-fabricated construction method can become the construction method for the further, the ease of construction and time difference are aspects that will and are driving people to move towards new construction methods.

As the market for this type of construction grows, the demand for products and skill will become more in the country. This will cause the cost to reduce further and will eventually make this method of construction even more economical than conventional masonry buildings.

6.4 SUGGESTIONS FOR FURTHER RESEARCH

The study only touched on a few of the advantages and disadvantages of Light Weight Steel Frame structures. A further study can be done between the various types of housing for example low cost vs medium cost vs. up market houses. A study can be done in the savings of logistics, because there is less material to be transported as the distance of transporting can influence the cost of the project dramatically. Waste is always a big factor and is in effect money that is thrown away; the difference in wastage can be compared. The durability of LWFS can always be studied further. There are many factors that can still be explored and the possibilities are endless.

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7.1 LIST OF TABLES

7.2 LIST OF FIGURES

7.3 BIBLIOGRAPHY

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ANNEXURE A:

Annexure A:

Open Ended Questionnaire – LWFS as alternative building material

A. Are you familiar with the construction industry how long have you been in construction and what is your current profession?

B. Are you familiar with Light Weight Steel Frame structures and where have you been introduced to it?

C. Being skilled in both brick and steel construction, which method do you prefer and why?

D. What are the main differences for the contractor between the two methods?

E. Are their many mistakes or alterations on site?

F. As a professional in the industry why do you think architects and contractors don't opt for the light weight steel frame option?

G. Is there a difference in cost between the two methods?

H. Do you think that LWFS is a worthy alternative for masonry brickwork?