

A look at alternative wall construction systems and
the appropriateness of these wall systems in RDP
housing.

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Declaration by student

I, the undersigned, hereby confirm that the attached treatise is my own work and that any sources are adequately acknowledged in the text and listed in the bibliography

Signature of acceptance and confirmation by student

Abstract

Title of treatise : A look at alternative wall construction systems and the appropriateness of these wall systems in RDP housing.

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Alternative wall construction methods are developed almost on a daily basis. With the South African government unable to deliver quality Reconstruction and Development Program houses (RDP houses) in the specified time frames and budgets, the different involved parties are getting irritated and dissatisfied.

The objective of treatise is to identify alternative wall construction methods, instead of the traditional brick and mortar method, that can be used speed up the construction of RDP houses and to remain within the specified budget and to still deliver a product of high quality.

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CHAPTER 1

A LOOK AT ALTERNATIVE WALL CONSTRUCTION SYSTEMS AND THE APPROPRIATENESS OF THESE WALL SYSTEMS IN RECONSTRUCTION AND DEVELOPMENT PROGRAM HOUSES

1.1 Background

We are privileged to live in a time where the possibilities are almost endless. New things are discovered everyday. Rapid progress is being made almost in all fields. Over the last few years many improvements have been made in the construction industry. New materials and methods are being used, making construction quicker, cheaper and of better quality.

South Africa is a third world country. This means a great part of the population is very poor. A great number of people in South Africa do not have proper housing. Many people are waiting to receive Reconstruction and Development Program houses (RDP houses). These houses are supplied by the South African government to people that can not afford, or struggle to afford to build their own houses. In most cases these houses are constructed with the traditional brick and mortar method.

Around the world many different ways and many different materials are being used for wall construction. In South Africa we are used to the traditional brick and mortar method for constructing walls. To the home builder of today there is a wide list of options available when it comes to wall construction.

One of the biggest problems facing the South African Government today is supplying RDP houses within the specified time and budget constraints. Is it possible that alternative wall construction methods can help with completing houses quicker and more cheaply?

This thesis is a look at different wall systems, if they are suited to the South African construction industry and especially if they can be implemented in RDP housing schemes. Research will be conducted into some alternative wall construction systems that are being used in South Africa, which methods can be used in the future and if it feasible and practical to use it in RDP schemes.

1.2 The Problem

A look at alternative wall construction systems and the appropriateness of these wall systems in RDP houses.

We are living in a rapidly changing world. Many improvements have been made in construction methods and materials over the past few years. New wall construction systems have been introduced into the market. With the introduction of these new wall construction systems came the introduction of new materials. The different wall construction systems and materials have different attributes, advantages and disadvantages. This is a look into the different attributes, advantages and disadvantages of the different wall construction systems and how they compare to the attributes, advantages and disadvantages of the traditional brick and mortar method. Secondly can these wall construction systems be implemented in RDP housing schemes?

1.3 Sub-problems

Four different sub problems will be discussed, all with their own hypothesis.

1.3.1) Sub-problem 1

How do the construction sequences of these methods differ from the methods traditionally known and used in South Africa, and are these methods easier and quicker to construct?

Hypothesis

The methods and materials used for the construction of these alternative wall construction systems obviously differ from brick and mortar wall system. The alternative construction method is easier and quicker to construct than the traditional brick and mortar method.

1.3.2) Sub-problem 2

How do these alternative wall construction systems compare to traditional brick and mortar methods concerning the cost implications, is it cheaper and which one is the cheapest?

Hypothesis

These alternative wall systems can differ considerable; it can be cheaper, but also more expensive. The alternative wall construction methods are cheaper than the traditional brick and mortar method and it will be more cost effective to construct RDP house with these methods.

1.3.3) Sub-problem 3

In what way do the material properties of these systems differ from brick and mortar? How does these wall systems compare with brick and mortar wall systems when it comes to durability, fire rating, sound properties, acoustics and aesthetics and what are the benefits and advantages of these methods?

Hypothesis

The alternative wall construction methods will out perform the traditional brick and mortar method when it comes to durability, fire rating, sound properties, acoustics and aesthetics; these methods have more advantages and benefits.

1.3.4) Sub-problem 4

Are these systems appropriate for the South African market, will it be accepted?

Hypothesis

These alternative wall construction methods are viable and feasible to implement in RDP housing and that they will be accepted in the South African market.

1.4 Hypotheses

1.4.1 The Problem

A look at alternative wall construction systems and the appropriateness of these wall systems in RDP housing.

1.4.2 Hypotheses

Alternative wall construction methods can be used in RDP housing instead of the traditional brick and mortar method; it will make the construction of RDP housing quicker and cheaper. This in turn will help the government to deliver more houses in a shorter period of time and at a lower cost.

1.5 Delimitations

Information that will be looked at in the thesis is the method of constructing the different wall systems, the cost implications of the different systems, the different advantages and disadvantages of these systems. No chemical testing or reporting will be done. The manufacturing procedures of some of the different materials will be mentioned. The study focuses on the use of alternative wall construction systems in RDP housing (low-rise houses) and not in shopping malls or high-rise buildings.

1.6 Definitions of terms

The following abbreviations will be used in the study:

RDP - Reconstruction and Development Program
OSB -Oriented Strand Board

1.7 Research Methodology

Information gathered for the thesis comes from the following sources:

- Interviews with professionals familiar with these different wall construction systems.
- Interviews with distributors distributing these different wall construction systems.
- Visiting sites where these systems are being used and examining the wall construction systems in practice
- Information gathered on the Internet
- Information gathered in books
- Handing questionnaires out to contractors and the public
- Comparing different facts of the different systems.

CHAPTER 2

WHAT DOES THIS NEW CONSTRUCTION METHOD CONSIST OF, AND HOW ARE THESE WALLS CONSTRUCTED?

2.1 Introduction

Two alternative construction methods will be introduced apart from the brick and mortar method common to the construction industry in South Africa. All of the alternative construction methods that will be discussed comply with the required building regulations and standards. The new methods that are being introduced are not well known in South Africa, although they are being used by some contractors. The study is complicated further by the fact that these alternative wall systems are used in different buildings, for different purposes, situations and in different areas in the country. Each of the different wall construction methods will be discussed and also the materials used in the construction process.

2.2 Brick and Masonry method.

The brick and mortar method of wall construction is the method that is the best known and most often used in the South African Construction Industry. There is an abundance of tradesmen available trading in this trade and suppliers are readily available.

2.2.1 Construction Material.

There are many different types of bricks available on the market and there are a lot of different suppliers that manufacture bricks. The function of different bricks also differs. Bricks are generally produced from clay that is baked at very high temperatures. The bricks are normally manufactured in standard sizes of 230mmx115mmx85mm. Bricks can be used for different purposes, for example stock bricks are manufactured with the idea of wall construction. After the wall is constructed with the stock bricks it receives some sort of a finish for example the brick might be plastered and then painted.

Face bricks are manufactured with another goal in mind, face bricks are purely used to give a specific finish and are not for structural strength and do not receive any other type of finish.

2.2.2 Construction Method

A brick and mortar wall is constructed in the following way. Bricks are stacked on top of one another with mortar between them to bind them together and to hold them in place. Brick force can be placed between the layers of brick to increase the strength and load carrying capabilities. The more brick force that is used the stronger the wall will be. Brick force is normally placed every third to fourth layer, but more or less can be used, depending on the purpose of the wall and the required strength.

There are a number of different ways and patterns to stack bricks, but for the purpose of this paper it will not be discussed. After a brick and mortar wall has been constructed it can receive many different finishes, the wall can be plastered and painted, it can be plastered and tiled or the wall can receive some sort of a cladding. Brick walls can receive a smooth plaster finish, a rough plaster finish or bagging. Brick and mortar walls have very good structural strength so it is not usually necessary for any structural steel.

Before a brick wall can be constructed the wall must be set out, making sure that all the corners and lines are square, the wall is plumb and it is set out to the correct measurements.

Before the brick wall is constructed DPC (damp proof course) is placed in the correct position, where the wall will be constructed. The wall is built with bricks on top of the DPC (damp proof course). Making sure that brick force is being put in at about every three to five courses. The bricks are stacked on top of one another. Most bricklayers can lay between eight hundred (800) and a thousand two hundred (1200) bricks per day. Competent supervision is needed when a brick wall is constructed. (Own information)

Brickwork has been used for a very long time and has proven over and over again that its durability has no match. The strength of bricks are measured in mega paschal (MPa). The wind bearing capacity of the wall depends on the type of bond that was used during the construction of the wall. Brick walls are water resistant, impact resistant and give good sound and heat insulation.

Bricks, cement, DPC, brick force and building sand are readily available in South Africa from almost all building suppliers.

2.2.3 Wall construction duration

A study was done on a construction site where a six metre long, by two point seven metre high (6m x 2.7m) double skinned brick wall was constructed. It took a skilled bricklayer and a labourer roughly eight and half hours to construct the brick wall that consisted of 891 bricks. The construction site where the wall was constructed was at the AIG Insurance Offices that are situated at No 10 Queens Road, Parktown, Johannesburg.

2.3 Framed Wall Construction

The second method that will be discussed is a framed wall construction system. The wall is constructed with OSB (oriental strand board), Nutec panels, Gypsum board, galvanised steel frame and Aerolite. This is an alternative wall construction method to the brick and mortar construction method. The framed wall construction method can be a cheaper and quicker method of wall construction than brick and mortar. (SASFA, Course 2008:4)

There are many different framed wall systems available on the market. They all work on the basic principal of constructing a frame out of wood or galvanised steel, the frame in most cases is the clad with Oriental Strand Board (OSB) and gypsum boards on the inside and Nutec panels on the outside.

2.3.1 Members of a framed wall system.

2.3.1.1 Oriented Strand Board:

OSB is made up of strands of wood which are layered and mixed with resin in a specific orientation. (McKeever and Phelp, 1994: 5)



Figure 1- OSB (osbguide 2006:3)

- **OSB Characteristics and Qualities**

OSB is an extremely versatile product. OSB boards are designed to be highly reliable. These boards are designed to be ecologically friendly.

The boards are impact resistant, have very good thermal and acoustic properties and performance, they are moisture resistant and environmentally safe.

It is a high quality alternative wall construction method. (McKeever and Phelps, 1994: 5)

- **Fabrication of these panels**

The OSB boards are manufactured from splinters of wood that are mixed with a wax. The boards receive a waterproofing on the exterior. This mixture of splinters, wax and waterproofing are formed into large continuous mats. These mats are pressed under extreme pressure in layers and under high temperatures. (McKeever and Phelps, 1994: 5)

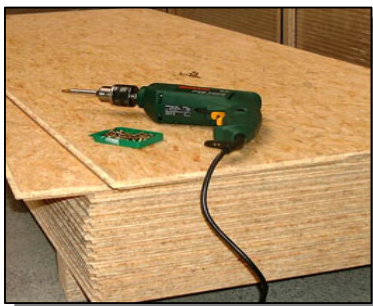


Figure 2: OSB Boards (osbguide, 2006:3)



Figure 3: OSB Boards (osbguide, 2006:2)

2.3.1.2 Nutec Panels

- **Nutec panels as external cladding**

Everite cladding products are suitable for a wide range of internal and external wall applications throughout the market. Nutec Building Planks are light-weight and can be supported by light-weight metal, galvanised steel frames or light timber structures.

(www.everite.co.za)

- **Flat Sheets**

Flat sheets are made of Nutec in medium and high density material in plain and textured finishes. (www.nutec.co.za)

- **Medium Density Sheets**

Medium density sheets are available in thicknesses of; 4 and 6 mm used mainly for ceiling applications; 9 and 12 mm used for cladding prefabricated buildings and internal partitions. The 6, 9 and 12 mm boards are also available in textures to allow greater scope of decorative application for both interior and exterior cladding. (www.nutec.co.za)

- **High Density Sheets**

These sheets have great strength as they are subjected to 10 ton compression strength. The sheets are smooth on both surfaces. 9 mm boards are used mainly as an all purpose external building board where moisture resistance is required and as the outer skin of sandwich panels with an insulating core. 10 mm used as special size fascia board, external vertical cladding and louvers as a protective screening. 15 mm used for structural applications where greater strength is required. 20 mm for structural applications such as cable trench covers, toilet and shower partitions and flooring. (www.nutec.co.za)

- **Nutec Building Panels/Planks**

Nutec Building Planks are available in both plain and textured finishes offering economical and exciting cladding solutions, from upmarket commercial complexes to external cladding of timber frame houses and gable cladding. The planks are normally installed in a shiplap pattern. (www.nutec.co.za)

FIG. 2 Flushing Jointing Application

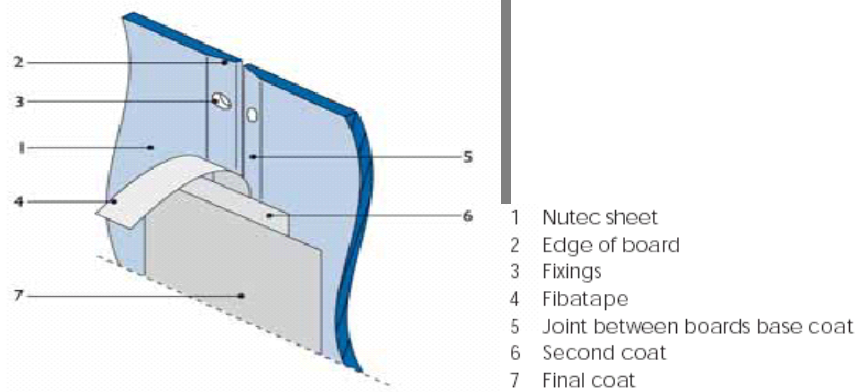


Figure 4- Flushing joint application (www.nutec.co.za)

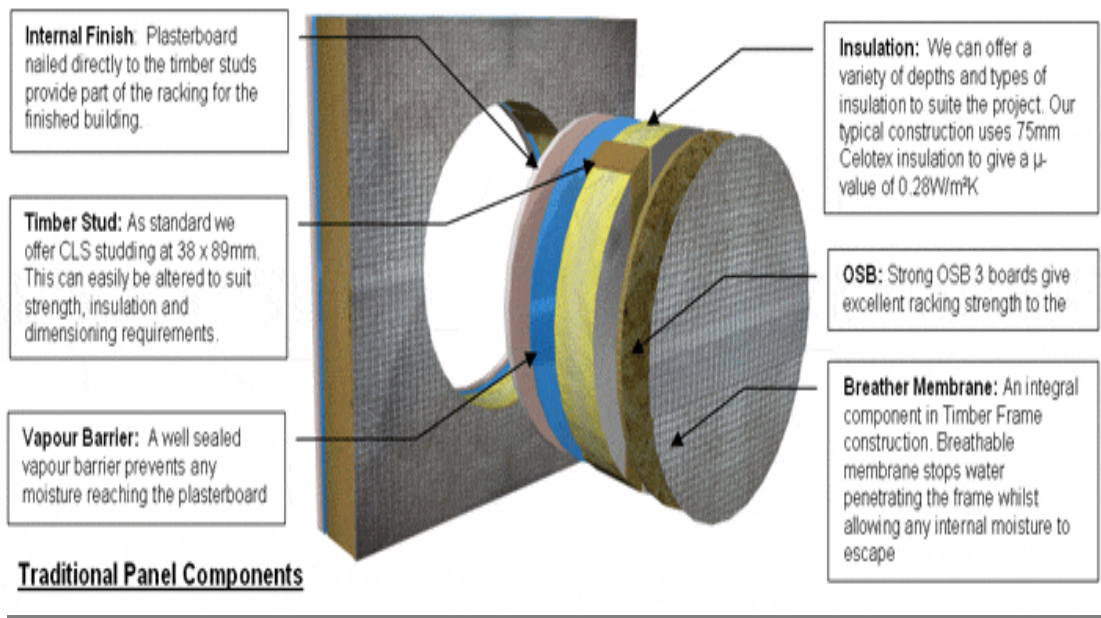


Figure 5 –Traditional Nutec panel components (www.nutec.co.za)

2.3.1.3 BPB Gypsum

A Gypsum board also known as dry wall is made out of a paper liner that is wrapped around an inner core made of gypsum plaster. The raw gypsum that is mined or obtained from flue gas desulphurisation must be calcined before it can be used. The gypsum that is being used in the inside is mixed with a few additives to increase the fire resistance and lower the water

absorption. Most commonly used additives used are: fibreglass, plasticiser, foaming agent, potash etc.

The wet gypsum is being placed between two layers heavy paper and then dried in a drying chamber, when it comes out of the chamber it is strong enough to be used as a building material.

The most common size for the gypsum board is 1200mm x 2400mm. There is also a few other sizes available but are not used that often. The thickness that is used for walling is 12.5mm. Then there is also two most used edge treatments: tapered edge where the end is a bit smaller than the middle of the board to ensure for joining materials to be flush with the board, and straight edge where the in and the middle of the board are the same size.

Because the gypsum contains water of crystallisation it has very good fire resistance. As the board receives heat the water is vaporized and retards the heat transfer. Because of this the room will never exceed boiling point. If the wall has more than one paper at a side it is even more fire resistance. The board is not waterproof and therefore it should be used only internally.

The product is a high-grade material with mineral wool as the main raw material. It has undergone the processes of burdening, forming, drying, cutting, tenon-making and surface finishing. (www.pgbison.co.za)

2.3.1.4 Aerolite

Think Pink Aerolite is a pink, high quality Glass wool thermal and acoustic insulation that is bonded with an inert, thermosetting resin. The strong, resilient, flexible blanket is supplied in compression packed rolls that are easy to cut and install.

It is made out of 50% recycled products such as broken glass and window panels. It forms an efficient thermo barrier that reduces heat up to 5°C in the summer, and reduces heat loss up to 87%; therefore the Aerolite can easily be installed even in hard to reach places.

Because of the glass it is made of it is also fire resistance and cannot burn, this make it one of the safest insulations to buy.

Aerolite insulation is manufactured from pure spun glass bonded with an inert thermo-setting resin to form a strong, easy-to-handle blanket. (www.aerolite.co.za)

2.3.1.5 Galvanised steel

Galvanised steel is steel, or iron that is passed through a molten bath of zinc at a temperature of about 460°C, when it is then exposed to the atmosphere again zinc reacts with oxygen to form zinc oxide. This is also known as “Hot-dip” galvanising.

This type of material is used in areas where corrosion is a problem, because the fairly strong material that is formed and the steel protect the steel from the elements.

The steel can still be welded but care should be taken for the fumes of the zinc. Galvanised steel can handle high temperature of up to 200°C and therefore it is also very good at fire resistance.

2.3.2 Wall construction method and construction duration.

The first step in the erection process of a Framed wall construction, is to erect a steel frame or wood frame structure. The OSB boards can then be fixed onto the steel or wood frame. The steel frame provides the necessary strength and frame onto which the OSB panels can be fixed. The OSB panels have no structural strength and only serve as a cladding. Before any of the panels can be fixed onto the steel frame all the services for example the plumbing must be installed in the cavity created by the steel frame.

The panels are individually fixed to the steel frame with butterfly screws to hold in position and to mount them against the steel structure. The panels come in standard sizes of 2500mm x 1250mm. The OSB boards can be manufactured in different thicknesses. The boards most often used when constructing an OSB wall are 15mm thick.

It is very important to remember that when the panels are being fixed to the structure that all positions of all the services must be clearly marked; so that when the panels are fixed it would not be a problem to find the services and to install them in the correct position.

The places for the window frames and door frames must be clearly marked out before hand, and if possible it is a good idea to cut the board beforehand for windows, this will make the

installing of the windows a lot easier. When this is done care must be taken to do it very accurately otherwise the window might not fit after the panel has been installed.

Panels can be fitted one side first, usually the outside, then if needed insulation can be put into the framework for extra isolation, for example Think Pink Aerolite is a very good insulating material that can be placed between the walls. After the insulation is installed in the cavity, the interior OSB board can be fitted against the steel frame. Door and window frames should be installed before the insulation is installed so that the position is known, and that any unnecessary cutting and waste can be avoided.

OSB panels can be treated with most wood sealers and protectors. Different finishes can be obtained by applying different sealers, varnishes and paint. (osbguide 2006:4)

When the panels are installed, aluminium strips can be placed over the joints to give it a nice finish. Panels on the outside must be protected from the elements, Formica or Nutec boards can be used to cover the panels, and this should give sufficient protection.

Nutec exterior panels can be ideal for the cladding of the outside walls. The Nutec panel can not be fixed directly onto the OSB board so it is necessary to build a frame out of brandering that is attached to the OSB onto which the Nutec boards can be attached. (www.nutec.co.za)

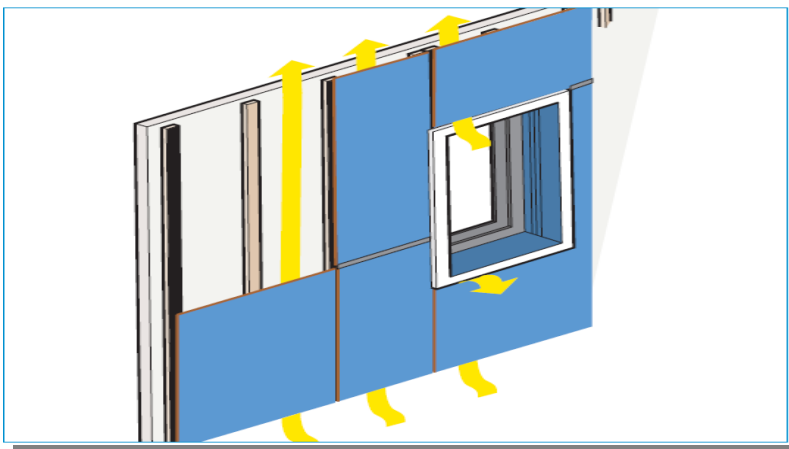


Figure 6 – Example of Nutec panels cladded onto OSB boards. (www.nutec.co.za)

The interior boards are well suited to be used in kitchens and bathrooms, making the use of tiles and wallpaper unnecessary. To fix the OSB boards a frame can be built out of wood, aluminium or galvanized steel, with vertical and horizontal struts and braises not more than

600mm apart from each other. OSB boards are manufactured in various sizes and many vivid colours. (osbguide 2006:1-4)

The OSB boards have two sides; one side is meant to be used for the inside and the other for the outside.

Inside: These panels come in a wood finish, to mention one; therefore it will blend in nicely with the naturally treated OSB panels. Natural Oak will fit extremely well, in the case of an RDP house. The measurements of these panels are 2440 x 1220 x 6mm thick. They will need an aluminium, wood or galvanised steel frame to be fitted against.

Outside: Cladding of the outside OSB panels will go nicely with something like a chocolate brown, the panels measurements are 2500 x 1300 x 8mm thickness. (osbguide2006:1-4)

It is very important to remember that when constructing a wall with OSB boards and Nutec panels that the materials have lead times so they should be ordered in advance.

Because of the easy installation method the construction, a wall like this takes up much less time than the construction of a brick and mortar wall.

The time spent on the installation of these boards is about a third or less of that is spent on bricklaying and plastering.

A study was done on a construction site where a wall was constructed with the framed wall system. It was difficult to find a wall of the same length as the one that was used in the brick and mortar method.

As with the bricks and mortar a 6.25m long wall by 2.7m high was constructed. It took a skilled carpenter and a labourer roughly five and half hours to construct the framed wall as opposed to the eight and a half hours it took the bricklayer and the labourer to construct the brick mortar wall. The construction site is located at Silverlakes Estate, Pretoria.



Figure 7 - OSB boards mounted against frame (osbguide2006:3)

ADVANTAGES	DISADVANTAGES
Insect resistant	Needs very level foundation
100% Recyclable	Needs to be erected with precision and under supervision
N0 CFC's	Not a traditional material
Air tight	Lack of experience building with it in SA
Made from replenish able sources	Specialised plumbing and electrical needs
Channels for electrical cabling	Perceptions
Easily installed	Shipping costs
Factory precision	
Surprising strength	
Straight walls	
Low wastage	
Design flexibility	
Added floor space	
Added roof space	

Table 1: Table showing the advantages and disadvantages of framed wall construction (www.siphomesystems.com)

2.4 Polyblocks as Permanent Formwork

A Polyblock is type of permanent formwork used for the construction of perimeter walls, retaining walls, infill panels for steel frame construction. These Polyblocks are also suited for the construction of high rising developments of different sizes.

Polyblocks are hollow building blocks that are filled with concrete. These Polyblocks can take a number of finishes; they can be plastered or be left unplastered. The poly plastered can be manufactured in different colours. (Polyblock leaflet: 1)

2.4.1 Characteristics and technical details of Polyblocks.

Polyblocks can be used as external walls, parameter walls, internal walls and lintel blocks.

TECHNICAL DETAILS

Density	20gm/lt
Fire retardant	Yes
Thermal conductivity	R value 1,76
Blocks required/m ² of wall	2,78
Block wall thickness	30mm
Block size configuration	See above
Concrete required/m ² of wall	See above
Wall weight	See above
Concrete strength specification	15MPa
Rebar specification	Y8 or Y10

Table 2: Technical Detail of Polyblocks (Polyblock leaflet: 2)

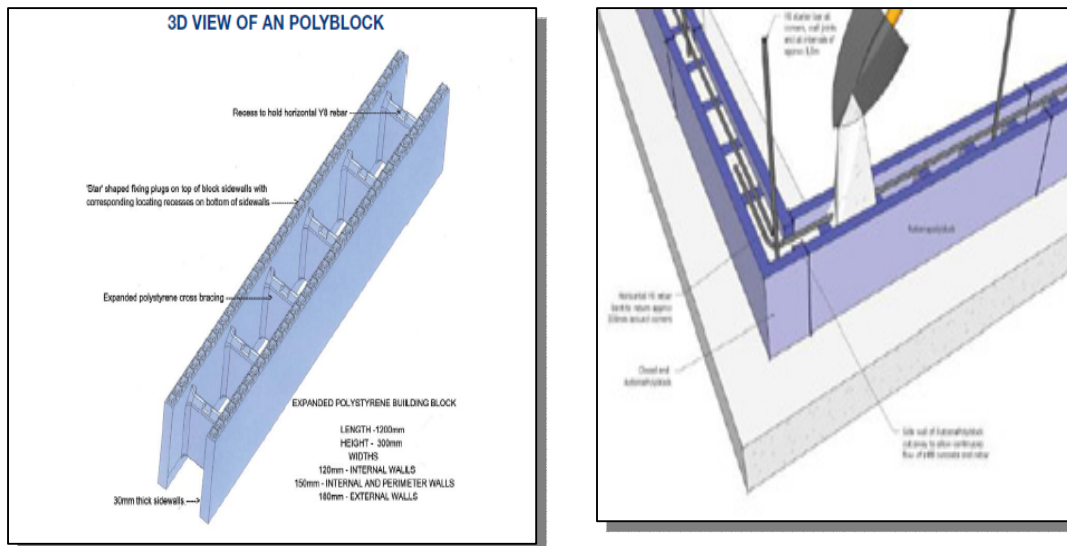


Figure 8 – 3D Views of a Polyblock (Polyblock leaflet: 4)

2.4.2 Wall construction with Polyblocks onsite.

1. Standard strip or raft foundations are needed to be built for the Polyblock system. The foundations should be stepped by 300mm to suit the height of the blocks.
2. Starter bars of 1 metre in length should be placed in the foundations at a depth of 100mm at corners, wall joints, on either sides of windows and doors with spacing's of 1.2m and 1.5m between bars.
3. Place the first row of Polyblocks to floor level and ensure each row thereafter is level.
4. Insert first Y8 horizontal rebar continuously above first block bending around corners by 300mm
5. After every 3 layers fill with 15Mpa concrete.
6. Wait for concrete to set and place formwork for windows and doors.
7. Use timber or fibre cement formwork to hold concrete in places.
8. Polyblock lintels can also be used to hold cement in place instead of formwork if wall is 180mm wide.
9. Above windows and doors insert 2 x Y8 rebar lengths continuously on top of first block above openings to create ring beam and lintel.
10. Attach hoop iron or wire to the ring beam to secure roof substructure and fill with concrete to wall top.
11. When wall work is complete and internal concrete fully set, plaster with Polyplast plaster solution to 6mm thickness
(Polyblock leaflet: 1-3)



Figure 9- Polyblocks on site (Polyblock leaflet: 3)

- **Polyplast**

Polyplast is the substance used to cover the Polyblocks once laid in place. It consists of water based acrylics and short length fibre that is mixed with plaster sand to form a workable plaster that is applied to the blocks, it does not shrink or crack, has excellent adhesion, is long lasting and provides the necessary impact resistance.

According to ABP Building Products there are 3 types of Polyplast each used for separate reasons:

POLYPLAST - This is most commonly used.

It is used with a standard mix ratio of 1 part Polyplast to 10 parts plaster sand.

POLYPLAST 'W' - this is a diluted version Polyplast and is used where plaster sands are excessively dry to facilitate the mixing process. Mix ratio is 1 part Polyplast 'W' to 7 parts plaster sand

POLYPLAST 'C' - uses a different, cement compatible, acrylic resin system to allow cement addition to the mix to speed up the drying. Mix ratio is 1 part Polyplast 'C' to 1 part cement to 10 parts plaster sand.

POLYPLAST 'C' is for use in areas of high humidity or high rainfall where the drying and cure time of the plaster is likely to be inhibited. (Polyblock leaflet: 3)

- **The application of Polyplast on site:**

1. The area needed to be covered should be measured
2. Polyplast should be applied with a thickness of 15-16mm
3. Mix Polyplast with plaster sand to a ratio of 1:10 in a concrete mixer for best results
4. Plaster in two steps:
5. Step 1 - using a 5mm notched trowel apply a 'scratch' coat over the entire surface.
This can be done quickly. Allow to dry overnight.
6. Step 2 - using a metal float-apply a smooth finishing coat over the notched surface.
Final finishing is best done with a wooden or rubber float using water sparingly on the surface.

7. Finish with a rubber float or Tyrolean brush
8. The Polyplast does not need to be painted in areas where excessive rainfall or humidity is present. A clear sealer is recommended over the Polyplast if not painted.
9. Polyplast takes up to 7 days to cure completely but rainfall and high humidity can retard the process. (Polyblock leaflet:3)



Figure 10 - Application of polyplast onto a wall. (www.abpbuildingproducts.co.za)

- **Finishing Plastered Walls**

Polyplastered wall has a natural looking appearance after the walls have been plastered; therefore it is not necessary to paint the walls. The colour of the end product is affected by the plaster sand that was used. To improve the water resistance of the plaster a sealer can however be used. The following two sealers are specified by ABP Building Products:

- Dilute Polyplast with 4 parts of water and apply by brush, roller or spray.
Do not use a higher resin to water ratio as this will not provide a transparent film and the result will be a slightly milky finish .
- Use Plaster seal which is a clear styrene acrylate sealer(Polyblock leaflet:3)



Figure 11 - Finishing of Polyplastered wall (www.abpbindingproducts.co.za)

2.4.3 Construction Duration

As with the two previous walls' construction methods mentioned, a construction site was visited in Mpumalanga where a school was constructed with the polyblock method. It took a skilled worker and a labourer roughly seven and a half hours to construct a wall that is 5.9m in length and 2.7m in height.

2.5 Test of Hypothesis

2.5.1 Sub-problem 1

How do the construction sequences of these methods differ from the methods traditionally known and used in South Africa and are these methods easier and quicker to construct?

2.5.2 Hypothesis

The methods and materials used for the construction of these alternative wall construction systems obviously differ from the brick and mortar wall system. The alternative construction method is easier and quicker to construct than the traditional brick and mortar method.

2.5.3 Comments

The methods stated above are simple. In this chapter, the various elements of these new building techniques are explained. The foundations need to be laid, the structure is built and the walls are cladded or finished. These new method complies with all the national building regulations and is approved by the NHBRC. Research has shown that these walls are constructed quicker than the traditional brick and mortar method, and this clearly proves the hypothesis that these walls are constructed quicker and more easily than the traditional brick and mortar method. The fact that these methods are constructed quicker and more easily proves the hypothesis: that the method is fit for use in South Africa.

CHAPTER 3

WHAT ARE THE COST DIFFERENCES BETWEEN THE THREE BUILDING METHODS?

3.1 Introduction

In this chapter the cost of constructing a wall with the different construction methods will be discussed. For the purpose of this paper a wall of 6 m (metre) in length and 2.7m in height (a wall of 16.2 m² in totals) will be used as an example to discuss and explain the different costs and cost implications. To illustrate the difference in cost a rate of the cost of construction per square metre (m²) will be determined. The different rates will be evaluated to see which one of the mentioned construction methods is the cheapest. Only the cost of constructing a wall on a floor slab will be taken into consideration and not the services installed in the wall or anything else for that matter. There are many different ways to price a per square metre rate and to determine the cost of the construction of the different walls. The method to determine the price per square metre is my own method.

When constructing a wall, or for that matter a building, there are many different aspects that can have an affect on the cost, for example: material, labour, overhead cost and management cost. The first thing a client or a customer normally wants to know is what the cost implication is, what does he or she have to pay? For a client the final tender price is very important because he wants to know what the cost implications are of erecting a specific structure. The contractor differs in this matter, he needs to know the cost of material, labour, overheads and management cost because all these factors have an effect on the percentage profit the contractor is going to make when erecting the structure.

As earlier mentioned for the purpose of this chapter a cost analysis of the materials needed to construct a wall of 6m in length will be done, the information gained from this example will be used in the second example - the cost incurred to construct the walls of RDP house will then be done. The cost of materials and labour necessary to construct the wall with the

different wall construction methods will be compared to one another. For the purpose of these examples the cost of foundations, services in the wall and the finishes are not used, also there are no windows and doors in the wall being constructed. There will be no waste factors taken into consideration. The labour constant that are applied for the degree of construction difficulty are the same for every method to help make the cost comparison as accurately as possible.

3.2 Construction Cost Comparison

The RDP house is going to be constructed in a rural area; the bricks that will be used for the construction of the walls will be cheap bricks, normal stock bricks. This will cause the construction of the walls to be cheaper than when using face bricks.

3.2.1 Cost of wall constructed with brick and masonry method.

The prices that was used for the calculation was obtained from Chamberlain Hardware stores on 26 June 2009.

220mm Brick wall (6mx2.7m) = 16.2 m²

Material (mortar)

Sand 1.27x0.042 (factor per m ³) @ R 236.75	=R12.63
Cement 8.5x0.042 (factor per m ³)@R 59.90	= R6.11
Labour mixing 9x0.042@R14.00	= <u>R5.29</u>
	R 24.03

Material bricks

Brickforce@R12.96 per m ²	= R 12.96
Stocks 105@ R950/1000	= <u>R 99.75</u>
	R 136.74

Labour Building

Bricklayer 1.41x1.20@R25.00	=R42.30
Labourer 1.41x1.20 @ R14.00	= <u>R23.69</u>
	R 202.73

Plant (1%)

= R2.02
=R204.75

Overheads (4.5%)

=R9.21
=R213.96 per m²

3.2.2 Cost of wall constructed with Polyblocks

The prices that was used for the calculation was obtained from ABP building products on 26 June 2009.

2.78 Polyblocks/m ² @ R24.50 per block:	R68 x 16.2 m ² =	R1101.60
Y10 Reinforcement 2kg/ m ² @6.50kg:	R13 x 16.2 m ² =	R210.60
Concrete Infill @R650/m ³ (0.05 m ³ / m ²):	R650 x 0.05 m ² x 16.2 m ² =	R526.50
External Polyplast 15mm thick @R16/ m ²	R16 x 16.2 m ² =	R259.20
Internal Polyplast 15mm thick @R16/ m ²	R16 x 16.2 m ² =	R259.20

Total cost for material: R 2357.10 for 16.2 m²

Total Cost per m² for material R 145.50 per m²

Add:

Labour Building

Bricklayer 1.41x1.20@R25.00	=R42.30
Labourer 1.41x1.20 @ R14.00	= <u>R23.69</u>
	R211.49

Plant (1%)

= R2.11
=R213.60

Overheads (4.5%)

=R9.61

Total cost m²: = R 223.21 per m²

3.2.3 Cost of wall constructed with framed wall system:

The prices that was used for the calculation was obtained from Lightweight Building Solutions stores on 28 June 2009.

- **Frame:**

Galvanized drywall channel @ R193.40 per no 1- per lm: $R193.40 \times 6m$ = R1160.04
(76mm x3.6mm)

Galvanised head channel @ R233.70 per No 1-per lm: $R233.70 \times 2$ =R467.40
(76mmx3.6mmx3m long)

Drywall Stud
(51mmx2.7mm) @ R32.7 per No 1- no 1 per lm: $R32.70 \times 6$ = R196.20

Drywall track @ R36.13 per No1- per lm: $R36.13 \times 2$ =R72.26
(51mmx 2.7mmx 3m long)

- **Internal Cladding:**

12mm BPB Gypsum board used @ R135.9 x 6No =R815.40
in internal walls (2.4m x 1.2m Wide)

- **Insulation:**

50mm Aerolite insulation in @R12.50per m² x 16.2 m² =R202.50
between panels

- **External cladding:**

OSB Board Chipboard @R264.22x6No = R1586.64

9mm Nutec wall panel on external @R293.33x6No = R1759.98
walls (2.4m x 1.2m wide)

	= R6260.42/16.2 m ²
Total cost per m ²	= R387.44 per m ²
Add:	
Labour Building	
Carpenter 1.41x1.20@R25.00	=R42.30
Labourer 1.41x1.20 @ R14.00	= <u>R23.69</u>
	R453.43
Plant (1%)	= <u>R4.53</u>
	=R460.96
Overheads (4.5%)	= <u>R20.74</u>
Total cost m ² :	= R 481.70 per m ²

3.3 Cost comparison of Construction of RDP house walls

If a RDP house is to be constructed with one of the mentioned construction methods the rate per m² is multiplied with the total square metres of the walls of the RDP house to determine the total cost of constructing the walls. The total square metres of the RDP house's walls that can be seen in addendum A is 89 m².

The cost of RDP house will add up to R 19 865.69 if the RDP is constructed with the Polyblock system. This will include material and labour.

These costs only include the walls and not the other building elements such as roofs, doors, windows and foundations etc.

The RDP house walls will cost R42 871.30, if the house is constructed with the framed wall system. The total cost of the RDP house walls constructed with bricks and mortar amounts to R 19 042.44

3.4 Test of Hypothesis

3.4.1 Sub-problem 2

How do these alternative wall construction systems compare to traditional brick and mortar concerning the cost implications, is it cheaper and which one is the cheapest?

3.4.2 Hypothesis

These alternative wall construction methods are cheaper to construct than traditional brick and mortar method.

3.4.3 Comments

Neither the Polyblock method nor the framed wall construction method of wall construction is cheaper to construct than the traditional brick and mortar method. The material used to construct the wall is more expensive.

In the case of the framed wall system and the Polyblock methods the cost to construct a wall was more than constructing a wall with the brick and mortar method. The cheapest way to construct an RDP house is to use bricks and mortar.

The hypothesis was thus incorrect in that none of the mentioned wall construction methods are cheaper than the brick and mortar method.

CHAPTER 4

PHYSICAL PROPERTIES OF THE DIFFERENT METHODS.

4.1 Introduction

Since the beginning of time man always needed protection from the elements, like wind, rain, cold and heat. They also needed protection from natural enemies like wild animals. Man hid and found protection from these factors by living in caves. Caves became man's home. Due to a growth in mans' population a shortage in suitable caves arose – especially in caves close to food and water sources. (Barnard, 2007:1)

Today not much has changed; man still needs protection against the elements and wild animals. The purpose of buildings has also somewhat changed, building are no longer just used to protect the inhabitants or goods but also to create a comfortable and safe area for people to live in.

The only thing that has changed is that the bar has been lifted; quality size and aesthetics have developed in such a way that “caves” need to keep up with the current trend. Man found ways to create new “caves”. These caves are the forerunners of building as they are known today. (Barnard, 2007:1)

Buildings have been developed in such a way that they are intended to create a healthy living environment and a degree of comfort for all occupants, i.e. protection against heat and cold. While protection against the elements is 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)

Building endeavours today are focused in such a way that mans' needs and aspirations are always satisfied.

With the new energy rating legislation of 2007/2008 “green building”, 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.

The ‘R-Value’ specifies the insulation performance of bulk materials, therefore the higher the R- value the more effective and efficient is 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.

4.1.1 Types of Energy:

There are different types of energy that is found in buildings. These energies are known as Embodied energy.

There are two forms of embodied energy in buildings:

- 1) initial embodied energy; and
- 2) recurring embodied energy.

MATERIAL	EMBODIED ENERGY	
	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 3: Material’s embodied energy (Canadian Architect, 2008)

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)

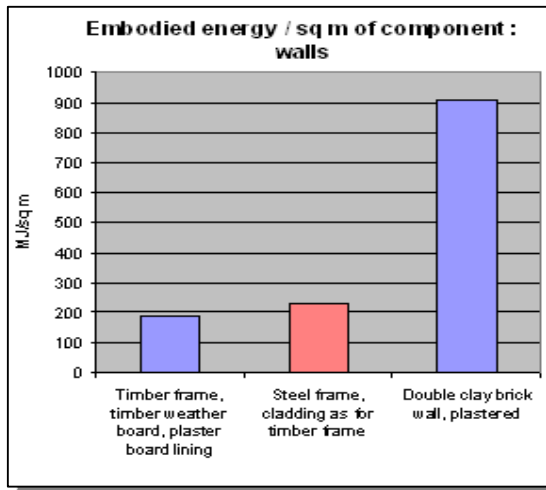
How is it measured? Typically, embodied energy is measured as a quantity of non-renewable energy per unit of building material, component or system. For example, it may be expressed as mega Joules (MJ) or gig Joules (GJ) per unit of weight (kg or ton) or area (square meter). The process of calculating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

Embodied energy is an important component in the lifecycle 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 3 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. (Barnard, 2007:3)

In the figure 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 unfavourable 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 12 - Energy per sqm of wall (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 four times that of light frame construction methods.

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).

4.1.2 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. (Barnard, 2007:2)

With current building standards and with the necessity and responsibility to protect the environment, it is essential to include these 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).

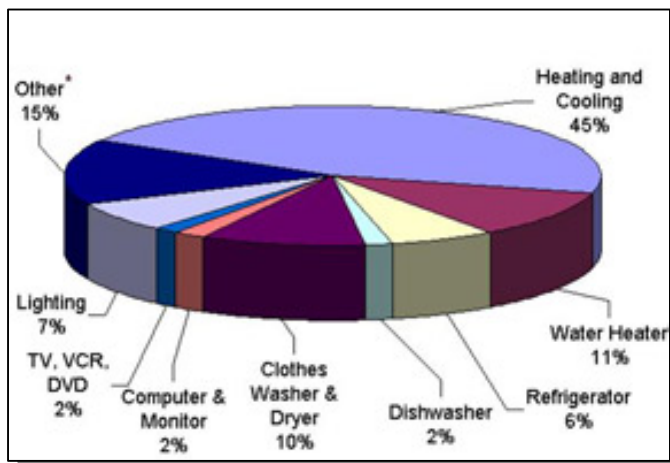


Figure 13 – Typical home energy use (Energy Conservation, 2008)

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 summarize the country as a whole but rather by provinces individually.

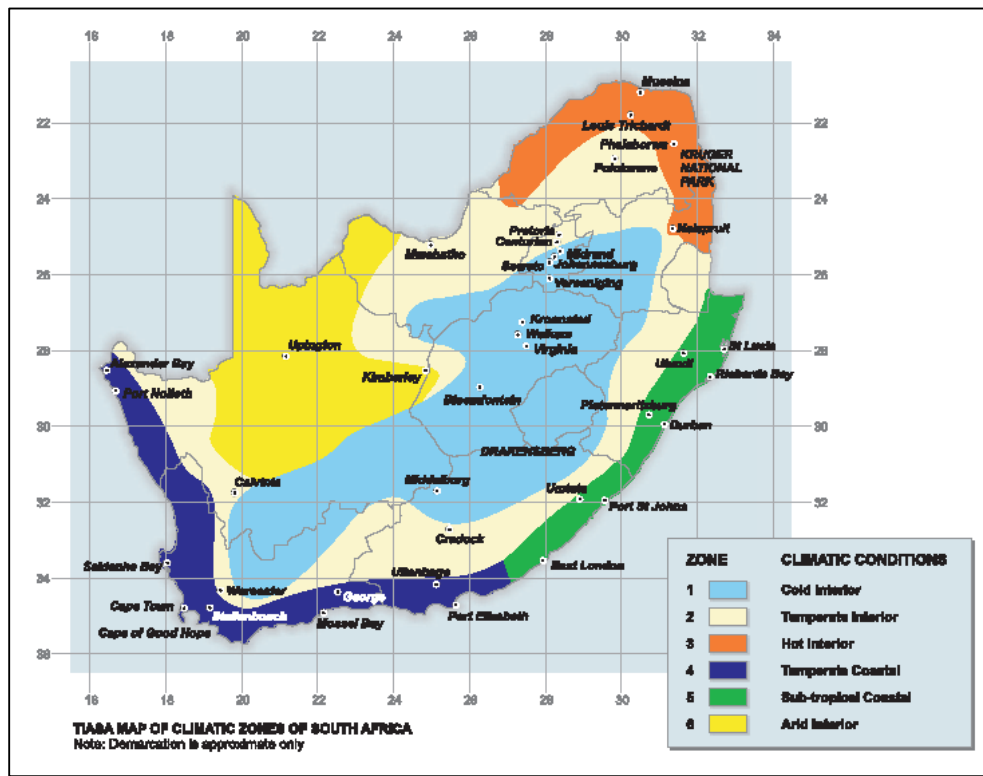


Figure 14 – Climate zones of S.A. (Barnard, 2007:5)

The map in figure14 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 Clerc, 2007:4)

The thermal mass of buildings can be described in the form of an 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 $\text{m}^2\cdot\text{K}/\text{W}$. (SASFA Code, 2007: 14).

A double leaf cavity brick wall has an R-value of only $0.66 \text{ m}^2\text{K}/\text{W}$ 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 $2.2 \text{ m}^2\text{K}/\text{W}$, depending on the climatic zone in South Africa where the building is located. Brick walls do not comply with the required R-values for South Africa. Brick walls' R-value can be improved by cladding the interior of the house with fibre 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.

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.

4.1.3 Fire Resistance

Fire resistance levels are specified in the National Building codes of South Africa. The system provides an accurate method to predict the ability of a brick wall to maintain its strengths and properties during fire.

The Fire Resistance Level (FRL) specifies the Fire Resistance Periods (FRP) for structural adequacy, integrity and insulation.

These components can be defined as:

- Structural Adequacy - The ability of a wall to continue to perform its structural function.
- Integrity - The ability of a wall to maintain its continuity and prevent the passage of flames and hot gases through cracks in the wall.
- Insulation - The ability of a wall to provide sufficient insulation, such that the side of the wall away from the fire does not exceed a predefined rise in temperature.

The fire resistance level of the wall is expressed in minutes and a fire rating lists the three components in the same order as they are given above.

For example, an FRL of 90/90/90 means a minimum fire resistance period of 90 minutes each for structural adequacy, integrity and insulation.

Fire resistance of walls depend not only on the thickness of walls but also on the height, length, boundary conditions of the wall and how the wall is connected to other building elements. The fire resistance period of a wall is specific to a wall type and this will determine its structural adequacy. (www.cbpi.com)

4.1.4 Insulation

The fire resistance level for insulation is determined by the material thickness of the wall, as shown in the table below:

Material thickness (mm)	60	90	110	130	160	180
Fire resistance period for insulation (min)	30	60	90	120	180	240

Table 4: Fire resistance period for insulation (www.cbpi.com)

Solid or cored units: if they have voids with a volume of less than 30%.

The material thickness for a solid or cored unit is the actual thickness of the units in the wall. For example, a 110mm solid or cored brick will give a 90 minutes fire resistance period for insulation, using the table above.

Hollow units: if they have voids with a volume greater than 30%

The material thickness of a hollow unit is calculated as the net volume of the units divided by the area of the exposed unit. For example, the equivalent material thickness of a brick of dimensions 230mm x 119mm x 110mm containing 35% coring can be calculated as below:

$$\text{Net volume} = 230 \times 119 \times 110 \times (100-35) \% = 1956955\text{mm}^3$$

$$\text{Area of exposed vertical face of the unit} = 230 \times 119 = 27370\text{mm}^2$$

$$\text{Equivalent material thickness} = 1956955 / 27370 = 71.5\text{mm}.$$

Therefore, the corresponding fire resistance period for insulation is 30 minutes (from the table above). In contrast, a solid or cored unit of the same size has the much higher value of 90 minutes.

In addition, the type of wall impacts on the material thickness. For a single leaf wall the material thickness is based upon the type of unit used, as described previously. The material thickness for a cavity wall is equal to the sum of the material thicknesses of the separate leaves. For example, the FRP for insulation for a cavity wall built with 90mm solid or cored bricks will be 240 minutes as the material thickness is $2 \times 90\text{mm} = 180\text{mm}$. whereas, a single leaf of 90mm solid or cored bricks has a FRP of 60 minutes.

Note: the FRP is 240 minutes for materials with thicknesses over 180mm. Chasing and recesses can affect the fire resistance periods for a wall. (www.cbpi.com)

4.1.5 Acoustic Properties

Sound Transmission Measurements

The Building Code of South Africa requires that building elements have certain levels of insulation from airborne noise and impact sound. The weighted sound reduction index (Rw) describes the acoustic performance of a construction system. It is a single number quantity for the airborne sound insulation rating of building elements. As the acoustic performance of a material or construction improves, the higher the Rw value will be. (www.cbpi.com)

Rw ratings are determined by laboratory tests of a specimen of the construction system. The specimen is fixed within a frame to form the wall between two test chambers. A high noise level is generated in one room and the difference in sound level between the source room and the receiver room represents the transmission loss through the test specimen. The measurements are conducted over a range of sound frequencies. The Rw rating is then determined by comparing the results with reference curves. (www.cbpi.com)

Correction factors (C and Ctr) can be added to Rw to take into account the characteristics of particular sound spectra and indicate the performance drop of the wall in the corresponding sound frequency range. The factor C relates to mainly mid to high frequency noise, whilst Ctr relates to lower to medium frequency noise. Some typical noises have been grouped by their corresponding correction factor in the table below. (www.cbpi.com)

The weighted sound reduction index is quoted as $Rw(C,Ctr)$, where C and Ctr are correction factors representing different noise sources. As an example, if a wall is measured as $Rw 54(-1,-4)$ the value of the index when the lower frequency correction factor (Ctr) is applied is:

$$Rw + Ctr = 54 + (-4)$$

$$Rw + Ctr = 50.$$

In practice, any small gaps and cracks which permit even minor air leakage will provide a means for sound transmission, leading to lower field performance. This degradation should be recognized and an appropriate allowance made when selecting a tested system to achieve a particular Rw rating when installed.

Correction Factor	Type of Noise Source
C	Living activities (talking, music, radio, TV) Railway traffic at high speeds Highway road traffic (>80km/h) Jet aircraft at short distance High and medium frequency factory noise
C_{tr}	Urban road traffic Railway traffic at low speeds Propeller driven aircraft Jet aircraft at large distance Low and medium frequency factory noise

Table 5: Acoustic Properties Correction Factors (www.cbpi.com)

The noise levels received from adjoining premises are dependent upon the level and type of noise generated and the acoustic performance of the construction between the two dwellings.

The Building Code of South Africa classifications for acoustic performance are categorized based on the building type. Class 1 buildings include single dwellings that do not have another dwelling above or below it, such as a stand-alone house or a row of townhouses. RDP houses falls into this category.

Common walls separating Class 1 buildings are required to have an $R_w + C_{tr}$ of not less than 50. In addition, the construction must be discontinuous, if the wall separates a habitable room (living room, dining room, bedroom, study and the like) from a wet room (kitchen, bathroom, sanitary compartment or laundry). Discontinuous construction requires:

- A minimum 20mm cavity between two separate leaves
 - No mechanical linkage if the leaves are not masonry.
- (www.cbpi.com)

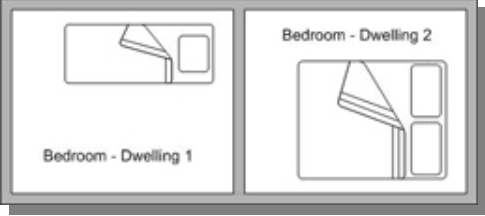
Building Class	Construction	Requirements
Class 1	Habitable - Habitable 	$R_w + C_{tr} \geq 50$

Table 6: Building Class (www.cbpi.com)

4.1.6 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 framed wall houses (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.

4.2 Construction Details to Achieve Maximum Performance

For a wall to achieve its optimum acoustic performance, the construction must be solid without gaps through which air, and therefore sound, can pass. Masonry units must be laid with all joints filled solid including those between the masonry and any adjoining construction. Flanking transmission (through unfilled joints and gaps) is the major reason so

many wall constructions fail to achieve their tested performance when in the field. Even a very small penetration will dramatically reduce the insulation performance of a wall. This is one reason why it is beneficial to finish masonry wall construction with render, or a cement-based paint. The render or paint acts as a sealant for the porous masonry and also fills any weaknesses in the mortar joints.

Another common sound path occurs at wall junctions such as at floor or ceiling level and also at the intersection with another wall. Larger voids should be solidly backfilled with mortar.

However, where this is difficult to carry out successfully, an expanding foam sealant which is non-shrinking, durable and has a long life span can be injected into the gap.

To maximize the acoustic performance of a wall, it is important to avoid the following:

- gaps and cracks through which sound can pass,
- gaps around service penetrations,
- poorly sealed doorways,
- back-to-back power outlets and cupboards, and
- Chasing for services.

4.3 The Masonry and Brick Wall Method

4.3.1 Methods of Manufacturing

Clay bricks are formed in a mould (the soft mud method), or more frequently in commercial mass production by extruding clay through a die and then wire-cutting them to the desired size (the stiff mud process). The shaped clay is then dried and fired either by burning in a kiln or sometimes, in warm and sunny countries, by sun-drying to achieve the final, desired strength. The action of heat gives rise to a sintering process that causes the clay particles to fuse and thus develops extremely strong ceramic bonds in the burnt clay bodies. Such bonds are highly stable. As a result, bricks can withstand the severe weathering actions and are inert to almost all normal chemical attacks.

4.3.2 Basic Advantages of Brick

1. Aesthetic Appeal
2. Thermal & Acoustic Insulation
3. Zero Maintenance Cost
4. Fire Resistance
5. Flexible in Application

1. Aesthetic Appeal

Brick possesses natural and infinite pleasant colours of burnt clays. Its colour formation is achieved through a complicated physio-chemical reaction during the firing process. In contrast to the colour of stained body, brick colour is permanent and will not fade during the weathering process. Different clay compositions, firing temperatures, or kiln atmosphere can lead to different colours. By proper control of these factors, bricks can be made to exhibit endless variety of natural and attractive colours. Bricks' natural colours combined with the extreme flexibility in applications produce aesthetic results which are always personal and everlasting. (www.yourhome.co.za)

2. Thermal & Acoustic Insulation



Figure 15- Thermal and acoustic insulation (www.yourhome.co.za)

Thermal Insulation: Brick generally exhibits better thermal insulation property than other building materials like concrete. Perforation can improve the thermal insulation property of bricks to some extent. Besides, the Thermal mass and moisture that the brick has absorbed can help to keeps the temperature inside the house relatively constant. In other words, brick absorbs and releases heat slowly and thus keep the house cool during daytime and warm during nighttime. (www.yourhome.co.za)

Acoustic Insulation: As far as acoustic insulation is concerned, brick wall provides good sound insulation property due to its dense structure. The thickness and density of brick will deaden noise transmission and will deflect noise from streets, neighboring homes, and jet planes. The sound insulation of brick work is generally accepted as 45 decibels for a 115 mm thickness and 50 decibels for 230mm for the frequency ranges from 200 to 2,000 Hz.

(www.yourhome.co.za)

3. Zero Maintenance Cost



Figure 16 – Illustration of Brick and termites (www.yourhome.co.za)

Clay bricks do not require maintenance. When you build a home, you might save a few hundred rand by using a substitute wall material. However, major exterior maintenance such as painting can cost as much as several thousand rands, depending on your home size. Clay brick may cost a little bit more cost initially, but the very first time that you paint, you might well spend more than the additional cost of the brick.

In addition, you do not need to worry about the clay brick from rotting, denting, warping, rusting, splitting, peeling, fading, and termites. As your home gets older, it naturally becomes more beautiful. (www.yourhome.co.za)

4. Fire Resistance

The fire resistance of a building material refers to the length of time a walling element is about to resist a fully developed fire. In every case, clay brick walls obtain maximum fire ratings. To the owner of a clay brick building, this means peace of mind and substantial savings over time on insurance premiums. (www.yourhome.co.za)

DESIGN OF CLAY BRICKWORK FOR FIRE		
Fire resistance period, minutes	Required material thickness for insulation Mm	Maximum slenderness for structural adequacy
30	60	25.0
60	90	22.5
90	110	21.0
120	130	20.0
180	160	18.0
240	180	17.0

Table 6: Design of clay brickwork for fire (www.yourhome.co.za)

5. Flexible in Application

The high compressive strength of fired clay bricks has been exploited for millennia to build structures ranging from single-storey huts to massive public buildings and enormous bridges and viaducts. In particular, it can be used for load bearing structures which greatly simplify the construction process so as to save materials, time, and labour. Besides, brick can be made into convenient shape and size to facilitate the construction work. (www.yourhome.co.za)

4.3.3 Advantages of clay brick walls

- Durability and ease of maintenance resulting in long term cost savings: A home built in clay face brick is virtually maintenance-free when compared to plastered painted external walls which require regular maintenance.
- Better resale value and aesthetic appeal: Clay face brick retains its aesthetic properties for a lifetime. Furthermore, unsightly cracks and poor workmanship cannot be temporarily disguised as is the case with a painted wall.
- Insulating and inert properties: clay masonry insulating properties are known to be superior to virtually all other material with respect to fire resistance and thermal and

acoustic insulation; the inert properties of clay provide for a low coefficient of expansion, in turn fewer cracks occur when building with clay brick.

- For the contractor and developer there are inherent advantages in specifying and working with clay bricks.
- Clay bricks comply with building regulations.
- Clay brick is a familiar product to semi-skilled artisans as it is a traditional building material.
- Clay bricks have shown exceptional versatility when used in complex designs and applications.
- Dimensional Accuracy & Symmetry - Brick and masonry is batch produced moulds and therefore the size can vary in only one plane, usually the height, as opposed to other products on the market that can vary in length, width and height. The SABS 1215 allows for a variation of +/- 3mm on the specified height. Brick and Masonry is also symmetrical, so the units are rectangular and not wedge-shaped or bent.
- Consistency - because Brick and masonry is batch produced, the quality of the units is consistent within a particular batch. There are no issues with some bricks being hard and brittle, others being soft and crumbly. All units are manufactured to the same high standard. It is also smooth and lends itself to fairface and bagged applications.
- It can be made almost totally waterproof. The size and shape of units available is only limited by having the correct mould. It can be made to have special textures. The units can be fluted or plain. The list of possibilities is almost endless.
- Energy efficiency - also naturally energy efficient, the secret being in its mass. The thermal mass of brick slows down the passage of heat moving through a wall and allows the masonry structure to absorb heat instead of passing it through to the inside of the building, keeping the inside cool. As the wall is cooled by nightfall, the absorbed heat is released, gradually warming the inside. Likewise, this thermal barrier helps to keep a concrete masonry structure warmer in the winter months. This effect of ensuring that buildings stay warm in winter and cool in summer lessens the need for artificial climate control and therefore wasted energy. From manufacture to transport to construction, concrete masonry is modest in its energy needs and generous in its payback.
- Modular system - another major architectural benefit of concrete masonry is the modular masonry design concept.

- The modular system of brick walls allows for efficient design co-ordination of sizes of building components, such as door and window frames. Units such as bricks and blocks are the dimensions which permit other components to fit into the space provided in a controlling reference system in a particular direction. Modular co-ordination enables components to be built on site without modification, as well as reducing the range of sizes required. Large savings arise from the ease of building in units which fit into the space provided without having to be cut or modified.
- Thermal & Acoustic insulation - the thermal insulation properties are covered above under the heading Energy Efficiency. Brick wall is a highly suitable material for attenuating noise as it is an extremely dense material which reduces the transmission of airborne sound. Resistance to sound transmission will obviously increase with wall thickness. It is also important to remember that the acoustic performance of a building is related to the capacity of all the elements in the building to reflect, absorb or transmit sound.
- Resistance to cracking - all brick units of whatever type is subject to some degree of movement... Bricks derived from fired products such as clay tends to expand over time. The degree of movement in a particular masonry unit is regulated by the SABS, and can be controlled to some degree through the use of control joints.
- Fire resistant - brick is fire resistant. The SABS 0145 Tables 4 & 5 specifies the fire resistance ratings for load bearing and non load bearing walls constructed from bricks. Obviously the thicker the units the higher the fire resistance rating will be, with the exception being that solid units have a higher rating than hollow units. The class of mortar used will also impact on the fire rating as it is the performance of the wall that is important, not just the materials contained therein.
- Weatherproof – bricks can be manufactured almost totally waterproof with the addition of specialised admixtures. This is not usually necessary since quality brick is usually manufactured to a "low suction" tolerance due to its high density. Water penetration of a wall is usually through fine cracks at the interface between the brick unit and the mortar, and only rarely through the masonry unit or the mortar. The greater the bond between mortar and brick, the greater the resistance to leakage. The bond depends largely on the "waterproofness" of the brick and the water retention properties of the mortar (which can be improved through the addition of lime to the mix).

- Cost Effective - when looked at from an overall perspective, bricks are completely cost effective. When the initial cost of the bricks, the maintenance cost of the building, the cost of heating and cooling the building, as well as the final salvage value of the building are taken into account, brick is arguably one of the most effective materials used in construction.
- Durability - brick are highly durable material, and are manufactured to resist local exposure conditions for the intended life of the building. Durability is generally related to compressive strength, which in turn is related to density. Surface protection such as paint and plaster adds tremendously to the durability of any walling material.
- Environmentally friendly - the use of bricks also benefits the environment and promotes sustainable building practice.

(www.masonrymagazine.co.za)

4.4 The Polyblock building system

The Polyblock system is also generically known as Insulated Concrete Forms (ICF's) or Lightweight Concrete Forms (LCF's). The Polyblock system has been used in countries where thermal insulation and energy efficiency is of the essence for more than 30 years. The system is compliant with the new 'green' eco-friendly building codes.

The system is in essence a hollow expanded polystyrene block that acts as formwork for a reinforced concrete infill and stays in place to thermally insulate the building.

The system is completed by plastering with a special expanded polystyrene plaster: Polyplast or (internally only) by lining the walls with gypsum board. (Polyblock leaflet: 1)

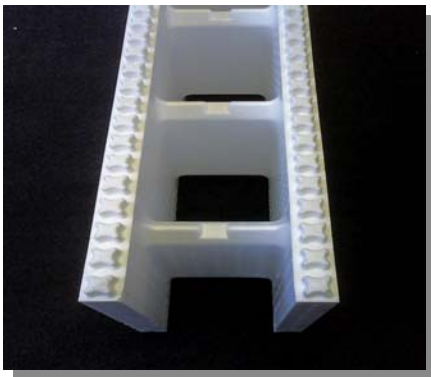


Figure 17- 1800mm Polyblock (Polyblock leaflet: 1)

A Polyblock is type of permanent formwork used for the construction of perimeter walls, retaining walls, infill panels for steel frame construction. They can even be used for high rise developments. It is a hollow EPS building block that is filled with concrete that can be plastered over or left unplastered if a coloured Polyblock is used.

4.4.1 Advantages of building with Polyblock

- Thermal insulation is significantly better than with brick and block construction including cavity walls. This gives better living conditions, building comfort and allows reduction in energy costs. Thermal insulation(R value) of a Polyblock wall is rated at 1, 76 which are 4 to 5 times better than a conventional cavity brick wall and 10-12 times better than a single skin brick wall.
- Wall strength 2-5 times higher than an equivalent brick wall. The concrete strength used as the Polyblock infill is 15MPa vs. normal brick/mortar strength of 7 MPa.
- Ease of building. Can train unskilled workers to use the system quickly. There is minimal requirement for skilled artisans.
- Speed of construction. Walls can be built up to 5 times faster than normal clay/cement bricks. Depending on the complexity of the building a 30-60m² of Polyblock wall can be constructed per day compared to 10m² of brick with the same size work crew.
- Services can be installed easily. Plumbing and electrical services can be run through the hollow core before concrete filling or easily cut into the polystyrene surface without angle grinding or chiselling
- Walls are 50% lighter than equivalent sized brick walls allowing reduction in structural support systems
- Lower maintenance costs as the structure is a monolithic reinforced concrete wall in permanent expanded polystyrene formwork. The reinforcing configuration ties the system together preventing cracks in the walls. The expanded polystyrene Polyblocks insulate the wall and thus prevents excessive wall movement due to temperature change that can lead to cracking.
- Expanded polystyrene is impervious to water giving much improved resistance to water and damp penetration
- The Polyblock system is Agrément certified (Agrément number 2007/336) and NHBRC approved. This eliminates risk in buildings with the system and facilitates project finance

- Costs of building are reduced due to the speed and use of unskilled labour. Building occupancy can be achieved earlier.
- Expanded polystyrene building systems such as Polyblock have been used for over 35 years elsewhere in the world and are standard all over the world primarily due to their thermal insulation properties.

(Polyblock leaflet: 2)

4.4.2 Application Areas

Polyblock should be considered as the building system of choice if any of the following conditions exist:

- Lack of skilled artisans
- Unstable ground conditions
- In areas with high rainfall or excessive damp
- Sites with logistical supply problems where bricks are difficult to obtain or to transport to site
- Speed of delivery and early occupancy are critical
- Wall weight is an issue
- There are extremes of temperature

(Polyblock leaflet: 2-3)

Project and building types that lend themselves to Polyblock include:

- Phased residential developments; cluster housing and simplex and duplex apartments
- Mine housing
- Schools and clinics
- High rise building conversions from commercial to residential
- Steel frame industrial buildings
- Perimeter, security and retaining walls

(Polyblock leaflet: 3)



Figure 18 - 1800m² Limpopo Polyblock Educational Centre (Polyblock leaflet: 3)



Figure 19 – Polyblocks on site (Polyblock leaflet: 3)

4.4.3 Characteristics

Polyblocks can be used as external walls, parameter walls, internal walls and lintel blocks

TECHNICAL DETAILS	
Density	20gm/lt
Fire retardant	Yes
Thermal conductivity	R value 1,76
Blocks required/m2 of wall	2,78
Block wall thickness	30mm
Block size configuration	See above
Concrete required/m² of wall	See above
Wall weight	See above
Concrete strength specification	15MPa
Rebar specification	Y8 or Y10

Table 7: Technical Detail of Polyblocks (Polyblock leaflet: 2)

4.4.4 Product Benefits

1. Permanent thermal insulation
2. Lightweight
3. Quick to build
4. No need for skilled labour
5. Structurally sound
6. Improves speed of construction

(Polyblock leaflet: 3)

4.5 Framed wall system.

In the construction world today the trend is towards more cost effective, energy efficient and alternative ways of constructing homes and structures. One of these alternative ways that is available on the market is by making use of framed systems.

A framed wall system that makes use of

- Light steel frames / wooden frames
- Insulation
- Gypsum boards
- Nutec panels

4.5.1 Products that are used in a Framed wall system:

4.5.1.1 Oriented Strand Board

In today construction market builders and contractors don't need any surprises; they need products that can perform up to the required standards. They need performance.

OSB (Oriented Strand Board) is engineered for superior construction, stiffness, strength and durability. All these attributes helps to make your project a structural success. OSB boards offer economy and value. The product is priced very competitively, and has almost no imperfections because of the high manufacturing standards. Because of the low percentage of imperfections, waste is reduced and profit increases. (osbguide2006:4)

OSB manufacturing removes natural imperfections commonly found in other wood panels, imperfections like knot holes, core voids and splits. OSB is a uniform product, so virtually all waste is eliminated. Since OSB is engineered to perform it provides racking, impact resistance, strength, stiffness, and thermal and acoustical performance.

OSB is very workable; it covers large areas quickly and provides rigidity and stiffness. OSB is approved by all major building codes. It requires no special treatment, only the same degree of care as other wood panels. Panel edges are treated with a special formulated moisture resistant coating. Edges are available in square –edged, tongue and groove for fast and easy installation. (osbguide2006:5)

OSB panels is well suited for residential construction projects were strength, stiffness and durability are required. Its reliability means less expense and fewer call backs.

(osbguide2006:5)

A) Product Description

Oriented Strand Board (OSB) is a performance-rated structural panel engineered for uniformity and strength. It is an exciting and versatile product, extremely workable, offering both aesthetic and structural qualities. A continuous production process creates these endless panels which allow for a wide variety of standard and bespoke board sizes to be produced. (osbguide2006:1)

B) Features and benefits

- The layered wooden strands inter-cross to provide all over strength and durability
 - Moisture resistance
 - Product specifically developed for extreme versatility
 - Ecologically designed and highly reliable
 - No loose knots or cracks
 - No lamination problems
 - Perfect calibrated thickness
 - Impact resistance
 - Excellent thermal and acoustic isolation properties
 - Instantaneous resistance in "framing construction"
 - Competitively priced
 - Environmentally safe
- (osbguide2006:3)

C) Applications

OSB is utilised in a wide array of applications including commercial and residential construction and renovation. It is a widely accepted structural panel among architects and contractors. These include:

- Walls and ceilings
- Floor base for wall-to-wall carpet applications, wooden floors , bricks etc
- Beams
- Mud walls and work barracks
- Stairs

- Roofing
- I-Joints
- Eave Living
- Furniture carcasses
- Acoustic boxes
- Different types of packaging
- Bins and site fencing
- Display material

(osbguide2006:6)

D) Properties:

- Minimum air penetration
- Lower operating costs with regards to maintaining a comfortable interior environment for the occupants.
- Minimum twisting, delaminating or even warping
- It does not rot or decay
- It has good nailing strength
- Easy to be sawn, nailed, drilled, grooved, planed, filed and even polished
- OSB panels have no gaps, voids
- Due to its standardised all in one nature, it reduces the construction time
- It can be used on floors, walls and roofs

(osbguide2006:6)

E) Durability:

- They have a tighter building envelope, and the walls have higher insulation properties.
- It is strong against corrosion and has a high resistance to fire
- It is waterproof and it can be exposed to the harsh outdoor conditions

(osbguide2006:6)



Figure 20: Lightweight steel structure house being constructed (osbguide2006:5)

F) Characteristics

- The layered wooden strands inter-cross to provide all over strength and durability
- Moisture resistance
- Product specifically developed for extreme versatility
- Ecologically designed and highly reliable
- No loose knots or cracks
- No lamination problems
- Perfect calibrated thickness
- Impact resistance
- Excellent thermal and acoustic
- isolation properties
- Instantaneous resistance in "framing construction"
- Competitively priced and
- Environmentally safe

(osbguide2006:6)

The building industry today is demanding greater efficiency in terms of costs and time execution. OSB meets these challenges making it the perfect material for structural cladding, roofing and sheathing. Its physical properties and high impact resistance make it ideal for walls, floors and cladding in both steel and timber frame construction.

OSB's high workability makes it easy to saw, drill, nail, paint, polish and wax. From an architectural standpoint, it offers total flexibility and creative freedom in traditional design schemes and more modern and innovative projects. OSB is the easiest, fastest, cleanest and most cost effective structural material in standard and economic type housing as well as light commercial construction. (osbguide2006:6)

4.5.1.2 BPB Gypsum board internal cladding

A Gypsum board also known as dry wall is made out of a paper liner that is wrapped around an inner core made of gypsum plaster. The raw gypsum that is mined or obtained from flue gas desulphurisation must be calcined before it can be used. The gypsum that is being used in the inside is mixed with a few additives to increase the fire resistance and lower the water absorption. Most commonly used additives used are: fibreglass, plasticiser, foaming agent, potash etc.

The wet gypsum is being placed between two layers heavy paper and then dried in a drying chamber, when it comes out of the chamber it is strong enough to be used as a building material.

The most commonly size for the gypsum board is 1200mm x 2400mm. There is also a few other sizes available but are not used that often. The thickness that is used for walling is 12.5mm. Then there is also two most used edge treatments: tapered edge where the end is a bit smaller than the middle of the board to ensure for joining materials to be flush with the board, and straight edge where the in and the middle of the board are the same size.

Because the gypsum contains water of crystallisation it has very good fire resistance. As the board receives heat the water is vaporized and retards the heat transfer. Because of this the room will never exceed boiling point. If the wall has more than one paper at a side it is even more fire resistance. The board is not waterproof and therefore it should be used only internally.



Figure 21: BPB Gypsum Plasterboard. (www.pgbison.co.za)

The product is a high-grade material with mineral wool as the main raw material. It has undergone the processes of burdening, forming, drying, cutting, tenon-making and surface finishing. (www.pgbison.co.za)

A) Features and benefits

This product integrates such features as good fireproof property, sound absorption, decoration and heat insulation. The product is pollution free and is an environmentally friendly construction material. (www.pgbison.co.za)

B) Applications

- New homes / buildings
- Used in supermarkets
- Schools
- Banks
- Hospitals
- Airports

(www.pgbison.co.za)

C) Durability

Building materials, components and construction methods are sufficiently durable to ensure that the building, without reconstruction or major renovation, satisfies the functional requirements throughout the reasonable life of the building. BPB Gypsum Fire-stop Plasterboard is a gypsum plasterboard containing fire retarding additives in the core to improve its fire protection. The product is intended for use in wall and ceiling linings and partitions. In addition to the markings detailed above, the face of the Fire-stop is coloured pink with a grey liner on the back face and is labelled Fire-stop. (www.pgbison.co.za)

D) Advantages of BPB Gypsum Board: Interior cladding

- Also known as Rhinowall
- Natural gypsum, recycled paper
- ISO 14001 listed, SABS and government approved
- Waste is about 10% less than that of masonry construction

- Rhinoboard sound proofing varies between 43dB and 52dB compared to a 110mm Brick wall at 44dB
- 15mm thick, 1,2m x 2,4m fixed @ 600mm centres
- Using a screw gun and self drilling drywall screws for fast and simple erection
- No foundation required for light steel framed houses
- Rhinowall can support hanging shelves, cupboards and pictures etc. as long as wooden noggins or steel supports are fixed in place
- Rhinowall does not transmit or loose heat
- Renovation time is radically reduced
- A single layer of Rhino Fire-stop on each side has a one hour fire rating. 3 Times the legal requirement
- Rhinowall has a lifetime guarantee in the absence of abuse
- Green moisture resistant boards can be used in showers and kitchens
- Rhinowall is proven rodent proof.(www.pgbison.co.za)

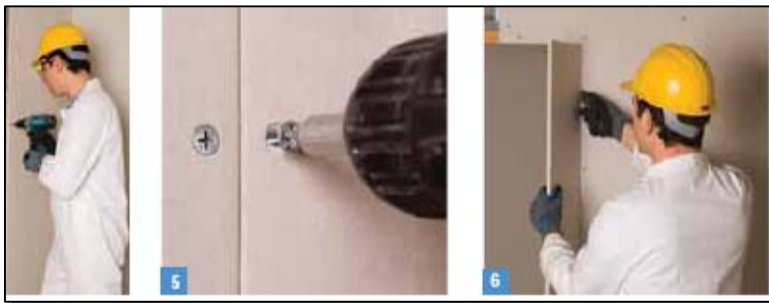


Figure 22: BPB Gypsum Plasterboard being installed (www.pgbison.co.za)

4.5.1.3 Aerolite as insulation



Figure 23: Aerolite Think Pink (www.isootherm.co.za)

A) Product Description

It is a high quality Glass wool thermal and acoustic insulation that is bonded with an inert, thermosetting resin. The strong, resilient, flexible blanket is supplied in compression packed rolls that are easy to cut and install. Aerolite is manufactured according to ISO 9001:2000 and is SABS tested and approved. (www.aerolite.co.za)

B) Features and benefits

- Lifelong energy savings
 - Lightweight & easy to handle
 - Exceptional acoustic properties
 - Good thermal resistance values
 - Safe application and use
 - Aerolite carries NO health hazard
 - Aerolite does NOT contain asbestos
 - Rolls are compression packed which enables the rolls to fit through a standard size trap door.
 - Maintenance free
 - Long product life - will not readily age
 - SABS tested & approved
 - Non combustible.
 - Inert - free of flame retardant chemicals.
 - Exceptional tear strength.
 - Safe application and use.
 - Does not absorb water.
 - Long product life - product will not age.
- (www.aerolite.co.za)

C) Fire properties

- Non-combustible - tested to SANS 10177 Part 5
- Class 1 fire index rating - tested to SANS 10177 Part 3

- Class A1, S1, D0 according to DIN EN 13823

[A = general classification, S = smoke generation, D = droplets]

All non-combustible products are acceptable in any application - no deemed to satisfy tests are necessary (SANS 10400)

(www.aerolite.co.za)

D) Thermal properties

Contributes to indoor comfort and contributes to lifelong savings by reducing heat loss/gain due to its inherent thermal insulation properties. (www.aerolite.co.za)

E) Acoustic Properties

Offers exceptional acoustic properties & enhances indoor environmental quality by absorption of noise. Aerolite ceiling insulation reduces the sound transmission to and from a room.

This is especially important as noise levels leaving and entering the different rooms will be greatly reduced. (www.aerolite.co.za)

F) Applications

1. New homes / buildings
2. Retrofit in existing homes / buildings
3. Top up insulation for pending legislation (energy efficiency)
4. Commercial buildings

(www.aerolite.co.za)

G) Durability

- Odourless, inert and fully compatible with all standard building materials & components.
- Will not accelerate corrosion of steel, copper or aluminium.
- Will not sustain vermin

- Will not breed or promote fungi, mould or bacteria (especially important to us as we are utilizing a wooden frame and OSB boards (wood) for cladding)
 - Non-hygroscopic
 - Rot proof
 - Dust settlement will not hamper the products performance.
- (www.aerolite.co.za)

H) Recyclable

Approximately 50% of the raw material used in the production of Isoverm products are recycled. The recycled material can be post-consumer glass (from housing) or waste glass from flat glass manufacture, which would otherwise go to landfill. (www.aerolite.co.za)

I) Environmental

The manufacturing process doesn't use or contain CFC's or any other damaging gases. In addition the unique compression packaging means more insulation in a smaller space - the result is better vehicle utilisation, reducing the environmental impact of transportation. (www.aerolite.co.za)

J) Physical properties

R value (m ² K/W]	Thickness [mm]	Length [mm]	Width [mm]	k-value [W/mK]
1.25	50	10000	1200	0.040
1.88	75	8000	1200	0.040
2.50	100	8000	1200	0.040
2.88	115	7000	1200	0.040
Mini Roll				
1.25	50	4000	400	0.040

Table 8: Aerolite Think Pink Physical properties (www.aerolite.co.za)

K) Specifications

- (50/75/100/115 mm) thick flexible non-combustible light weight "Think Pink Aerolite" fibreglass insulation material.

- 11 kg/m³ density.
- Install strictly in accordance with manufacturers detail & specification.
- Sizes as per architect.

(www.aerolite.co.za)

4.5.1.4 Coloured Nutec Fibre cement on OSB as exterior cladding

A) Product Description

Nutec flat sheets are manufactured from a combination of Portland cement silica and organic fibres and do not contain any asbestos fibres. These materials have considerable strength in their own right and will not deteriorate with age. Everite Nutec flat sheets were introduced in the late 80's. Nutec is the name for the new asbestos free flat sheets. Nutec has similar characteristics to fibre cement flat sheets but are superior in many ways.

As a partition board it offers major advantages over conventional materials in terms of strength and resistance to biological attack.

Cement board mainly consists of cement and glass fibres formed in blocks of 1200mm x 2400mm and 12.5mm thick. That is the same as the gypsum board.

It is an extremely strong and stable board and can carry most tile mortar and finishes. It is also a board that provides impact resistance and strength to the wall. It is also possible to curve the thinner board that has polymer in. The board is not actually waterproof but has a high water resistance and can dry quickly afterwards and therefore can be used externally. However there is waterproof cement board available for showers etc. This board is made out of Portland cement and glass fibre matt reinforcing at both faces. It also has a high long performance because it won't easily break in the presence of moisture. (www.nutec.co.za)

The major disadvantage of this type of board is that it is very heavy and cannot be easily handled by one person. It has to be cut with carbide-tipped tools and saw blades.

The gaps between boards can easily be fixed by applying silicone before the finish.

(www.nutec.co.za)

B) Features and benefits

- An economical all purpose building board which is unaffected by moisture and therefore ideal for internal and external use in almost any application.

- Relatively light in weight and can be supported on light gauge metal frames or light timber structures. These factors facilitate easy handling and erection and are major benefits on projects where low mass construction is an important factor
- Non-combustible and provide perfect protection against flying sparks.
- Resistant to corrosion and are unaffected by ultraviolet light.
- Designed to have good thermal properties when compared with other building materials.
- Manufactured to the highest internal quality standards and compliance is insured by strict quality assurance programmes in the production process as well as stringent testing in our laboratory.
- All Nutec flat sheets carry a SABS mark for compliance to the specification SANS 803.
- Nutec flat sheets are supplied in their natural colour, but are compatible with a large variety of in-situ applied coatings and paints. This will allow the designer an almost limitless combination of colours and textures for external and internal applications.
(www.nutec.co.za)

C) Characteristics

- Made from Portland cement, silica and organic fibres
- 9mm Plain medium density will be used
- Unaffected by moisture
- Relatively lightweight, supported by light gauge metal frame
- Good thermal properties
- Considerable tensile strength
- Smooth textured finish 5 – 20mm thick
- All Nutec flat sheets carry the SABS approval to the specification of SABS 803
- Best painted with pure acrylic PVA paint
- Timber like tongue and groove finish, vermin, rot and termite proof. And is maintenance free
(www.nutec.co.za)

D) Properties

- Non combustible
- Resistant to corrosion and ultraviolet light, water, wind, hail, fire, fungus, rodent and acid
- Resistant to water
- Non Combustible
- Corrosion resistant
- Good thermal and sound properties
- Economical and unaffected by moisture, and therefore ideal for internal and external use in almost any application.
- Relatively light in weight and can be supported on light-weight metal frames or light timber structures. The product is therefore easy to handle and erect and these are major benefits on projects where low mass construction is an important factor.
- Non combustible and provide perfect protection against flying sparks.
- Corrosion resistant and unaffected by ultraviolet light.
- Good thermal properties.
- Manufactured to the highest internal quality standards.
- All Nutec Flat sheets carry a SABS mark for compliance to the specification SANS 803.

(www.nutec.co.za)

4.5.1.5 Galvanised steel

Galvanised steel is steel, or iron that is passed through a molten bath of zinc at a temperature of about 460°C, when it is then exposed to the atmosphere again zinc reacts with oxygen to form zinc oxide. This is also known as “Hot-dip” galvanising.

This type of material is used in areas where corrosion is a problem, because the fairly strong material that is formed and the steel protect the steel from the elements.

The steel can still be welded but care should be taken for the fumes of the zinc. Galvanised steel can handle high temperature of up to 200°C and therefore it is also very good at fire resistance. (www.steelframehouses.co.za)

A) Benefits of galvanised steel.

Cold-formed steel framing is a versatile structural product for use in load-bearing and curtain wall construction, floor and roof assemblies, mansard and truss frames, as well as interior non-structural partitions. (www.steelframehouses.co.za)

B) Non-Combustible Construction

The use of steel framing products, protected with fire resistive materials, offers the designer numerous rated non-combustible assemblies. Increases in floor areas and/or building heights may be attained. Non-combustible fire ratings may also yield long term insurance savings. (www.steelframehouses.co.za)

C) High Strength-to-Weight Ratio

In curtain wall applications, the reduced dead load of the exterior wall as a result of using steel studs in lieu of masonry may result in primary structural frame and foundation material savings. Exterior retrofits are less likely to require expensive reinforcement of the existing structure. In load-bearing construction, a lightweight steel framing system is a benefit when the site is plagued by poor soil conditions. Multi-story residences requiring unique ground level construction (parking structures, meeting or dining facilities, etc.) benefit from the reduced dead weight applied to the supporting structure. (www.steelframehouses.co.za)

D) Design Versatility

Whether used as curtain walls, floor joists or roof rafters, or in mansard and truss frames, axially loaded partitions, headers, beams, etc., steel framing works well independently or in combination with other structural systems. Steel framing is adaptable to numerous applications traditionally constructed with hot rolled structural steel, wood, masonry or other conventional materials. (www.steelframehouses.co.za)

E) Low In-Place and Performance Costs

Steel framing systems are conducive to prefabrication at or away from the job site. Quite often, exterior curtain walls are partially or entirely prefinished. Quality is improved due to the controlled work environment of the fabrication shop while its efficiency of construction may result in earlier building enclosure and ultimate occupancy. In a similar manner, load-bearing walls, platforms, and trusses may be prefabricated to the close tolerances required of

these systems. Steel Framing will not shrink or crack. It does not rot and is impenetrable to termites, vermin and insects. Factory punched holes permit easier installation of pipe, cable, telephone and electrical services. (www.steelframehouses.co.za)



Figure 24: Galvanized Steel Structure (www.steelframehouses.co.za)

F) Characteristics

It offers quality, cost and energy efficiency as well as speed of erection for low-rise residential and non residential buildings. Steel frame buildings consist of structured wall frames and roof trusses manufactured from cold-framed thin gauge galvanised steel sections. Steel is a versatile product and has a wide range of applications. Steel touches every sphere of our life. The only demerit of steel is its natural tendency to corrode. Corrosion eats away steel, causing significant economic loss.

Zinc coatings provide an effective way of protecting steel against corrosion. Zinc coated or galvanized steel offers a unique combination of high strength, formability, light weight corrosion resistance, aesthetics, recyclables and low cost that is unmatched by any other material. As a result, galvanised steel is an ideal material for a multitude of applications like buildings, manufacture of automobiles, household appliances to residential, commercial and industrial construction.

G) Size

High strength galvanised sheet in thickness of 0.58mm to 1.2mm with Z275 zinc coating designation, is normally used. (www.steelframehouses.co.za)

H) Durability

Protective coatings of either True Core® 45% zinc/55 % aluminium alloy, or zinc, defend the steel against corrosion. (Zinc coated steel is commonly known as “galvanised iron”).

The coatings are tough, continuous, of uniform thickness, tightly adherent, and strongly resistant to corrosion. They are applied to both sides of the steel by the hot-dip process. In this process the steel strip is passed through a bath of molten metal, the amount of coating applied being closely controlled.

Steel framing is the only framing material for which any kind of structural durability warranty is offered. The more traditional galvanized steel also gives satisfactory performance within the building envelope.

Forming and fabrication does not impair the coatings. Because the protective coatings are tough, and their bending properties understood, the forming processes involved in shaping the building frame components do not impair the effectiveness of the protective coatings. The coatings are also tough and resist damage during fabrication and handling on site. Some steel framing systems are partially or completely joined by welding. The high temperatures reached in localized areas during the welding process remove a small amount of the metallic coating. The fabricator restores the corrosion-resistance of the affected areas by applying a suitable zinc-rich paint (commonly called “cold galvanizing”)

Advantages of Zinc Coating

Zinc coatings have a two fold advantage which is as follows:

- The zinc coating protects steel from corrosive attack in most atmospheric conditions, acting as a continuous and lasting shield between steel and atmosphere, as long as the zinc sheath remains unbroken.
- It acts as a galvanic protector, sacrificing itself slowly in presence of corrosive elements, by continuing to protect the steel even when moderate size areas of the bare metal is exposed. This ability of zinc results from the fact that zinc is more electro-chemically active than steel. Of all industrial coating materials, zinc alone possesses this dual capability. Due to the above qualities of zinc coating, the

manufacturers and consumers of galvanised steel all over the world are now demanding a higher content of zinc coated steel in construction, automotive and goods sectors. (www.steelframehouses.co.za)

I) Strengths

- Quick to erect – reduces capital lock up
- Lightweight – can be used difficult land conditions
- Transportation – ease of delivery
- Engineered components – recognised by quality assured standards
- Clean site – little to no waste and easy to decorate
- Prefabricated – reduce the need for skilled labourers on site.
- Design responsive – can go up to 6 storey's
- Completed building – can be cladded in any desired finish
- Insulation – warmer than that of brickwork
- Environmentally friendly building method
- Low maintenance and running cost

K) Weaknesses

- The possibility of infestation by insects such as termites is a concern over the life span of the wood.
- Various types of rot can form
- Wood burns more readily than some other materials making timber frame buildings somewhat more susceptible to fire damage.
- Method of construction is relatively untested in South Africa, which results selecting the trusted methods.
- The wood needs to be carefully preserved by means of varnish and needs coats to be placed on a regular basis of 3-5 years depending on the area.

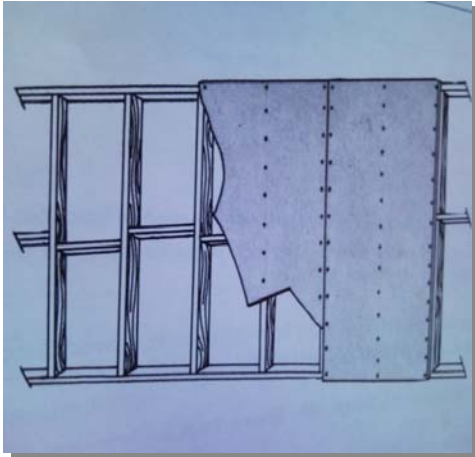


Figure 25: Framed wall System (www.framerite.com)



Figure 26- Framed wall System on site (www.metalformingtechnologies.com)

L) Advantages of Framed wall system

- 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.

(www.steelfd.co.za)



Figure 27- Framed wall house (www.steelhd.co.za)

4.6 Comparison between different wall construction methods.

	<u>Brick and masonry method</u>	<u>Polyblock method</u>	<u>Framed wall system</u>
R - Value	0.66	1.76	2.88
Fire Resistance	240/240/240	240/240/240	240/210/240
Acoustic Properties	50 dB	56 db	52 dB
Strength	7 MPa	15 MPa	3.5 - 6 MPa

Table 9- Table of properties (Own Information)

4.7 Test of Hypothesis

4.7.1 Sub-problem 3

How do these wall systems compare with brick and mortar wall systems when it comes to durability, fire rating, sound properties, acoustics and aesthetics and what are the benefits and advantages of these methods?

4.7.2 Hypothesis

Some of the above mentioned systems will out perform the traditional brick and mortar method when it comes to durability, fire rating, sound properties, acoustics and aesthetics; these methods have more advantages and benefits.

4.7.3 Comments

The difference between conventional masonry brickwork and Polyblock wall system and framed wall system structure are minimal. The durability, fire rating, sound properties, acoustics and aesthetics of the different wall system do not differ as much as expected. Some of the above mentioned systems out perform the traditional brick and mortar method in some aspects as when it comes to durability, fire rating, sound properties, acoustics and aesthetics.

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, the framed wall method uses less embodied energy and because of the insulation advantages and the high R-value, operational energy is also reduced. This concludes that the framed wall system and the polyblock method are sustainable and more energy efficient than current building trends. The hypothesis was thus correct that the framed wall system and the polyblock method do perform better or just as well in most of the aspects such as fire rating, sound properties acoustics and aesthetics.

CHAPTER 5

WILL THIS CONSTRUCTION METHOD BE ACCEPTED INTO THE SOUTH AFRICAN MARKET?

5.1 Introduction

In the previous chapters different wall construction methods were discussed, the first was the traditional brick and mortar method, the second was the polyblocks system and the third a framed system comprising of OSB boards, gypsum boards, nutec panels, and fibre glass wool (Think Pink). These different wall construction systems all have different advantages and different disadvantages. The question that now needs to be answered is are these methods suited to be used in RDP housing schemes, and will the general public accept these methods and will they be happy to live in houses that are constructed with the different wall construction methods.

It is generally said that people are scared of change, that they do not accept change easily. Moving away from construction methods that the general public are familiar with, to new not so well known methods might cause a problem. A survey was conducted under members of the general public to see if these types of wall construction methods would be accepted by the general public, and if they think that these alternative wall construction methods can be used in RDP houses.

Another problem that can affect the implementation of these wall construction methods in RDP houses is that the South African Government has standard specifications according to which RDP houses must be built. In these specifications it is stated which type of concrete, bricks, cement, toilets, wash basin, roof sheeting etc. must be used in the construction of RDP houses. RDP houses are also built according to a standard set of plans. (Addendum A – plan of RDP house)

This complicates the matter of using alternative wall construction methods in RDP houses. Before an RDP house can be constructed with an alternative construction method approval is needed from the local government.

Interviews were conducted with two separate contractors that have experience in the construction of RDP houses. Each was handed a questionnaire that they needed to complete to determine what their thoughts are on alternative construction methods, if they would use methods like these to construct RDP houses, and if these methods are suitable and feasible substitutes for the traditional brick and masonry method.

5.2 Questionnaire to general public:

A questionnaire was handed out to members of the general public about the alternative construction methods. A booklet explaining how the different alternative wall construction methods work and how the methods are constructed was handed out along with the questionnaire. The questionnaire was distributed under the public at their place of work and at places of public gathering for example at a shopping centre. They were asked to read the booklet and to complete the questionnaire.

In the questionnaire to the general public that consisted from Twenty five participants in was determined that eighty percent (80%) of the participants have seen one of the construction methods before in their lives. After reading a booklet that was handed to the participant together with the questionnaire only thirty percent stated that they did not understand how the alternative construction methods worked, and how the walls are constructed.

When asked if they think that these types of wall construction methods could be used in the building of RDP houses only fifty percent (50%) answered “yes”. Forty three percent (43%) of the participants think that these alternative wall construction methods would be accepted as a construction method for low rise buildings in the construction industry.

Fifty six percent (56%) of the participants said they would consider buying or living in a house that was constructed with these alternative construction methods if they had the opportunity to do so.

5.3 Interviews with contractors.

Contractors interviewed: Chris Marree - Lona Building Projects

Andre Raath – Midnight Star Trading

In the interviews both contractors stated that they have seen the framed wall structure before, neither have seen the Polyblock system before. Chris Marree was a bit more sceptical towards the use of these alternative construction methods than Mr. Andre Raath. Both of them think that these alternative wall construction methods can work well in RDP houses if the method is properly researched and artisan and labour are properly trained in the method of construction.

One of the biggest problems facing the implementation of these wall systems is that there are almost no skilled artisans who has worked or knows how to work with these systems.

Mr. Andre Raath was very interested in the wall construction methods; he said he would definitely look into these methods if the methods were approved by government to be used in the construction of RDP houses. He said if using one of the methods could save him time or money without jeopardising quality, there would be no reason why he would not implement it in his business.

A basic RDP house constructed in Limpopo consists of two rooms, an open plan kitchen and living area. The basic size of an RDP house is 45 m² and the approximate value is R 70 000.

Constructing more of these RDP houses in a shorter period of time means greater profit margins and greater turnover for the contractor. It takes the contractors normally between a week and two weeks to construct a house of this size.

Both of the alternative wall construction methods are labour intensive and this falls well into the government plans to make projects as labour intensive as possible. Using these alternative wall construction methods can create a lot of new jobs; it is not only artisan and labour that need to be educated in the construction method but also the inspector that inspects the RDP houses.

The material that is necessary to construct the alternative wall construction methods might be problem since the suppliers of these materials are not as readily available as the suppliers who supply bricks and cement.

Before any of the alternative wall construction methods can be implemented in RDP houses the biggest problem remains to get the government approval for the use of these methods. The government needs to be educated in the construction method, the advantages it holds and qualities and properties the wall system has.

5.4 Test of Hypothesis

5.4.1 Sub-problem 4

Are these systems appropriate for the South African market, will it be accepted?

5.4.2 Hypothesis

It is viable and feasible to implement these wall systems into low cost housing and that they will be accepted in the South African market.

5.4.3 Comments

The results obtained from a questionnaire handed out to a few members of the public cannot guarantee that these alternative wall construction methods will be accepted in the South African market, and that these systems are appropriate for the South African market the sample only gives an indication of the general public feeling towards these alternative wall construction methods. Although the general public has very mixed feelings towards the alternative wall construction methods, research from the sample has proven that if the public is informed and educated in the construction methods that they do tend to accept the alternative construction methods. In chapter two, chapter three and chapter four researches showed that the construction of the Polyblock system and a framed wall system is just as easy as the traditional brick and mortar method, the cost to construct a wall is similar and the thermal performance, fire rating, insulation and acoustics etc. is better than the traditional brick and mortar method.

There are not many reasons why these methods are not suited to the South African market, and there are not many reasons why these wall construction methods can not serve as a substitute for the traditional brick and mortar method. Own research has shown that if the general public is educated in the construction method and is informed of the advantages and disadvantages of these wall construction methods that their feeling is generally positive to the wall construction methods and that they approve of houses constructed with these wall construction methods.

It can be concluded from the research that was done that people are scared to accept something that they are not informed about or are not educated in. It is important to take into consideration that only a small sample of the opinions and feelings of the general public was taken into consideration when the researched was done. In the questionnaires that were completed it showed that when people were educated in how the construction method worked and the advantages of these alternative construction methods that they are inclined to accept the methods, therefore the hypothesis was partially solved in that these alternative wall construction methods, are accepted and that they can be implemented in RDP houses.

CHAPTER 6

SUMMARY 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 alternative wall construction methods that can be used to construct RDP houses instead of the traditional brick and mortar method, to speed up production of RDP houses, to save time and money and to deliver a product of high quality.

6.2 Summary

The construction method makes use of polystyrene formwork, steel, concrete, galvanised steel, Gypsum plaster board, Aerolite, Nutec panels and OSB boards. The processes are simple, quick and efficient. Erection of an RDP house is completed after about 3-5 days, depending on the size of the unit.

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. The Polyblock method and the framed wall method are preferred by contractors who have worked with these wall construction methods.

Times are changing and the methods that are being used are outdated. Our aim in the country must be to improve the quality of life for all the people of this country, and by improving homes, skills and providing better job opportunities we can make this a reality.

6.3 Conclusion

The Polyblock system, and the framed wall system can become more competitive in South Africa. The fact that there are already various contractors making use of these new techniques, makes it clear that this new construction methods work and that there is a demand for it in South Africa.

In the study only a few of aspects were investigated, and the results were in favour of Polyblock system and the framed wall system. These alternative wall construction methods can serve as suitable alternatives to the brick and mortar method when RDP houses are constructed.

In this thesis alternative wall construction methods were discussed. The methods were compared to the traditional brick and mortar method that is generally used as the wall construction method in South Africa. The comparisons were done to see which of these methods performed better in certain areas and to see if these methods could be implemented in RDP building schemes. Emphasis was placed on the different methods of construction of these walls, the cost implications to construct these walls, the different properties of these walls and the general acceptance of these different wall construction methods by the South African public.

The method of construction comparison between the alternative wall construction methods and the traditional brick and mortar method was solved in that the alternative wall construction method is just as easy as brick and mortar methods to erect and in some cases might be even quicker.

The comparison between the costs of the different construction methods showed that both the Polyblock wall construction method and the framed wall construction method are more expensive to construct than the traditional brick and mortar method. Therefore this sub problem was not solved.

The Polyblock system and the framed wall system compared well to the masonry and brick method when it comes to fire ratings, insulation, acoustic properties. In some cases the alternative wall construction methods outperformed the brick and masonry method, and in

other cases it did not perform as well, this sub problem was in therefore this instance partly solved.

The traditional masonry and brick method is widely accepted by the South African public and government as the way to construct walls, in the surveys and the comparisons done to see if the alternative wall construction methods would be accepted by the general public, it was found that if the public understood how the method of construction, and they understood the properties of these walls, that the alternative wall construction methods would be accepted by the general public. It therefore leaves us with the problem that awareness needs to be created under the public on how these wall construction methods work and their different advantages and disadvantages. The majority of the public indicated that they in fact think that these wall construction methods can work in RDP houses and that they would live in houses constructed with these methods if they had the opportunity to do so.

As the research proves these alternative wall construction methods, the Polyblocks system and framed wall system can indeed be a worthy substitute for the traditional brick and masonry wall construction method in RDP houses. The Polyblock wall system and the framed wall system will work well in RDP houses; the systems can save a lot of time and money without giving to much away in ease of construction and physical properties and performance to the brick and masonry method.

The main problem of this thesis; a look at alternative wall construction systems and the appropriateness of these wall systems in RDP housing are solved in that the framed wall system and Polyblock will be worthy substitutes for the brick and masonry wall construction method.

REFERENCES

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Bibliography

- Barnard, J. Day, P., De Clercq, H., Hamm, P. & Somerville, L. 2008, *Training Course: SASFA Code for Light Steel Frame Building*, Johannesburg: IZASA.
- Barnard, J. and De Clercq, H. 2007, *SASFA Code for low rise Light Steel Frame Buildings*, Midrand.
- Cole, R.J. and Kernan, P.C., 1996, *Life-Cycle Energy Use in Office Buildings*, Building and Environment, Vol. 31, Toronto.
- Mckeever, DB and Phelps, RB 1994, Wood products used in new single-family house construction 1950-1992, Forest products Journal, retrieved on 24th April 2009.

Internet

Automa Building Products Polyblock leaflet in. (Detailed Description of alternative building methods from a different suppliers) 2009. Available online at www.abpbuildingproducts.co.za
Accessed on 4 May 2009

Automa Building Products Training Manual in appendix below. (Detailed Description of alternative building methods from a different suppliers) 2009. Available online at www.abpbuildingproducts.co.za Accessed on 4 May 2009

Cape Town property. 2008. Available online at www.capetownpropertyforsale.co.za.
Accessed on 05April 2009

Energy Conservation. 2005. Available online at <http://energy.uiowa.edu/ectips.htm>.
Accessed on 08April 2009

Innovation and experience. 1996. Available online at www.canadianarchitect.com. Accessed
on 08 April 2009

South African Light Steel Frame Building Association. 2003. Available online at www.sasfa.co.za: Accessed 05April 2009

Sustainable Homes. 1996. Available online at <http://www.sustainablehomes.co.uk>. Accessed
on 15July 2009

www.abpbuildingproducts.co.za Access: 4 May 2009

www.aerolite.co.za Access: 22 April 2009

[www.cbpguide.com /manual 5, fire resistance levels for clay brick walls](http://www.cbpguide.com/manual_5_fire_resistance_levels_for_clay_brick_walls) Access: 4 May 2009

www.everite.co.za Access: 22 April 2009

www.framerite.com Access: 7 May 2009

[www.isootherm.co.za/ gallery](http://www.isootherm.co.za/gallery) Access: 4 May 2009

www.masonrymagazine.com/products/benefits Access: 7 May 2009

www.nutec.co.za Access: 23 Junie 2009

www.osdguide.com Access: 7 May 2009

www.pgbison.co.za Access: 7 May 2009

www.siphomesystems.com/sip_structural_insulated_panels_pg102.html Access: 16 Junie 2009

www.steelfd.co.za/gallery Access: 7 May 2009

[www.steelframehouses.co.za/product info/steelframe](http://www.steelframehouses.co.za/product_info/steelframe) Access: 7 May 2009

www.yourhome.co.za Access: 23 Junie 2009

Interviews

Marree, C. 2009. Personal Interview conducted in July 2009

Raath, A. 2009. Personal Interview conducted in July 2009

ANNEXURE A:

Annexure A:

Open Ended Questionnaire – Framed wall construction system and Polyblock wall construction system as alternative building method:

- A. Have you heard of, or seen this type of construction before?**

- B. Do you understand how the methods of construction?**

- C. Would you live in a house built with these construction methods if you had the opportunity to do so?**

- D. Do you think this type of construction can be used in RDP houses?**

- E. Do you think this type of construction will be accepted by the general public?**

- F. Would you consider buying a house constructed with these construction methods?**