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**AN INVESTIGATION INTO THE USE OF CONCRETE BLOCK CONSTRUCTION IN LOW
COST HOUSING IN THE WESTERN CAPE**

by

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**A Thesis Presented in the Faculty of Engineering and the Built Environment, in partial
fulfilment of the requirements for the Degree of MASTER IN SCIENCE in Engineering.**

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This dissertation is dedicated to my dad, Joseph Paul Bredeveldt.

ABSTRACT

South Africa is possibly facing the biggest housing backlog in its history, and the backlog is growing annually. The ability and means to deliver must be improved, together with a compromise between the construction materials used and the occupants' preferences.

This study seeks to examine the use of concrete block construction for the wall superstructure of low cost housing in terms of affordability and acceptability by the end-users.

Three objectives of this research study, which are fundamental to the research, are identified, and these are reviewed. The first is the investigation of trends in the use of construction materials in the superstructure of low cost housing through a literature review. The second is the establishment of the current methods and materials that are being used for low cost housing construction in the Western Cape by means of a questionnaire survey. The final objective is to establish the end-user's satisfaction levels with regard to the use of concrete block construction by means of a questionnaire survey.

The data collected indicated respondents' perceptions and opinions, and was analysed using qualitative methodologies.

The primary conclusion to be drawn is that concrete block construction for low cost housing is the most affordable option because of its ease of construction, good quality and low construction costs due to the use of less material compared to conventional bricks. However, although the end-users are satisfied with concrete block houses because of their permanent status, they feel that the problems that do arise are due to poor workmanship and bad site supervision.

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted in partial fulfilment for the Degree of Masters of Science in Engineering at the University of Cape Town. It has not been submitted before for any degree or examination at any other university.

_____ day of _____ 2002.

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CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

Shelter constitutes a basic necessity and is a fundamental human right, especially given the impact on human health and the productivity and economy of people living in decent and safe housing (Goodman, 1979). To the individual, a house is probably the most important investment, especially in financial terms, because of the associated expenditure outlay (Morini, 1993). Access to housing is dependent on income, which, in turn, determines affordability. An individual's income is highly significant to South Africa's current housing problems. Previously, the housing problems in South Africa were aggravated by the fact that South Africa did not have a uniform, national housing policy, and the various housing departments applied different standards for the different population groups (Africa, 1993). These past policies have contributed to the current housing problems. In terms of affordability, the complexity of the South African situation is aptly displayed in the fact that affordability is reflected in income where more than 65 percent of the population earn less than R 1000 per month, seriously affecting the ability of certain groups to access decent housing (Steenkamp, 1993). Thus, South Africa faces a major challenge in furnishing its burgeoning population, which is expected to increase from 38.05 million in 1990 to 53.4 million in 2005 (Development Bank, 1992), with affordable low cost housing. However, more recently, and on a national basis, the 1995 White Paper gives the population for 1995 as 42.8 million with a projected growth rate of 2.27 % per annum between 1995 and the year 2000. The country was therefore predicted to have a population of 47.4 million at the turn of the century. In terms of number of households, this totalled 8.3 million in 1995 based on an average of 4.97 persons per family (White Paper, 1995).

A lack of housing in many parts of the world requires the development of new building concepts as well as durable and sustainable materials, which will need minimum

maintenance during the life of the structure. In this respect, the selection of materials, especially local materials, can be a catalyst in achieving affordability (Alum, 1993).

1.2 Background to the Problem

Countries in the developing world, especially those with limited resources, are continually faced with housing problems, manifested in acute housing shortages and resulting in spontaneous informal settlements and urban slums (Africa, 1993).

The provision of shelter for the poor is one of South Africa's major challenges, of critical proportions, for the future. This is aggravated by the fact that estimates of the housing need vary considerably because of differences in the assumptions upon which they are based (Badenhorst, 1993, citing Development Bank, 1991a).

1.2.1 Shortage of Low Cost Housing for Poorer Communities

With the inception of the new Democratic Government in 1994, both the Government and the private sector were committed in their efforts to meeting the housing needs of South Africa, which were then estimated at 270 000 formal housing units every year for the next ten years, in order to cover the existing backlog and meet the natural urban growth. In monetary terms, this rate of housing provision equates to approximately R5 billion per annum (Low and Kelly, 1993).

However, according to Jacobs and Seedat (1997), the estimated housing backlog in South Africa in 1997 was 1.5 million units. Furthermore, an additional 3.5 million housing units were to be provided over the next ten years to accommodate the natural population growth. The financial support required from the Government for this undertaking is estimated at R47.5 billion at current Rand value (Jacobs and Seedat, 1997).

Militating against the provision of housing is the reality that the national economy is limited with regard to speedily allowing for a radical redistribution of wealth. Neither will the demise of legal apartheid make substantial amounts of money available for, *inter alia*, housing delivery. Housing delivery has to compete for funding with, for example, education and public health (Badenhorst, 1993).

1.2.2 Affordability of Low Cost Housing

Although there is no fixed definition of affordable housing, it can be identified as part of the formal sector in which the structures comprise brick-and-mortar on a serviced site, or, where no superstructure is provided, individuals construct whatever shelter they can afford (Low and Kelly, 1993).

As a result, formal sector affordability is governed by factors such as product-price, gross income, and availability of subsidies and finance terms. Affordable housing, therefore, matches products and services to the individual pocket, with the object of providing acceptable accommodation to the poorer communities, within the financial limitations of the individuals and the country (Low and Kelly, 1993).

During the 1980's, South Africa witnessed a continuing increase in population especially in the poorer communities (Beaumont and Brown, 1993). More significant, however, is the changing structure of South Africa's urban areas. The effect of the increased movement of poorer people to urban areas and the marked deterioration in the availability of finance has forced a move towards more affordable solutions for housing. This move to more affordable housing had been further aggravated by previous policies in the 1980's, which restricted subsidies to R7 500 per site, regardless of site conditions, and the effects of inflation and taxation. Unfortunately, most engineers and administrators were trained and experienced only in first world standards and procedures. The consequence of lowering design standards in many instances has increased environmental degradation with unacceptable levels of erosion and pollution (Beaumont and Brown, 1993).

In this light, many countries, especially those regarded as developing countries, see affordable or low cost housing as possessing many negative connotations, perhaps linked to a historical association with unsafe, and sometimes uninhabitable dwellings. The overarching desire to reduce the overall cost per housing unit while increasing the number of units constructed within a given budget, contributes to the perpetuation of these perceptions. Making homes more affordable to individuals and/or families with moderate to lower incomes, has resulted in cost cutting measures that might compromise the structural stability of the housing unit. Less costly, and less durable, building materials have been used in this cost reduction effort, potentially endangering the inhabitants of the house. Where this has occurred, these structures have tended to deteriorate over time into run-down or possibly unsafe states (Haupt and Coble, 2001).

1.2.3 *Materials Currently used for Low Cost Housing*

As mentioned previously, many low-income families end up in self-built shacks in squatter areas and slums. According to Hamm (1994), these self-built shacks are unacceptable because they are structurally unstable, are not resistant to rain penetration and do not provide protection against fire and unlawful entry. In addition, they are unsuitable for long-term financial arrangements.

Initially, the structure of housing in urban South Africa comprised circular walls, with a stable timber frame, supporting the grass-thatched roof (Green, 1993, citing Slade, 1981), and this was defined as a rondavel. The walls comprised posts set along the circumference and saplings running in horizontal hoops enclosing an internal space between the posts. The cavity was filled with either rubble, stones, or packed earth and the wall then plastered with 'daga', a dampened cement and sand mixture. Often, uprights were included in the walls to help support the roof (Green, 1993).

More recently, according to Green (1993), low cost housing built in South Africa demonstrates the successful construction of adequate low cost housing, with respect to

design, construction and maintenance, within affordable financial requirements. The materials that were used for this low cost housing development included corrugated iron, thatch and flattened iron sheets, wood, cardboard and plastics. The walls were plastered wattle and daub or plastered wattle and daub in combination with corrugated iron and concrete blocks. The floors were mainly concrete or mud/manure mixtures.

Adobe

According to Dietz (1979), low cost housing developments using adobe as the construction material are still widespread, and it is, in many ways, both the easiest and the most difficult to employ. Adobe is widely used in its natural state and, to a much lesser but growing extent, is modified by the addition of various other materials, such as gravel, sand, silt, clay, colloids and organic matter (Stulz and Mukerji, 1993). In addition to the solid particles, soil also comprises air and water, without which the soil cannot be used for construction purposes. Stulz and Mukerji (1993) stated that the most widely known and practical construction methods of low cost housing using adobe are rammed earth in formwork; bricks moulded in raw earth and baked by the sun, and compressed earth blocks which are produced in presses.

Structural Timber

Materials made from wood, although found in virtually all parts of the world, also have limitations when used for construction purposes. In timber frame construction, the structural framework of the building is in timber, which supports different cladding systems for walls and roofs (Hamm, 1994). The most cost effective wall materials involve overlapping timber strips, which raises the question of durability, protection against fire, and strength against unlawful entry into the structure (Hamm, 1994). Although wood is versatile, relatively easy to fabricate, has high strength and toughness relative to its weight, supply is a major problem because of dwindling supplies (Dietz, 1979). Moreover, environmental concerns are forcing countries such as the United States of America, which has traditionally used wooden materials, to look

at other environmentally sustainable materials. For example, in the United States of America, forty-one trees are used for one average wood-framed house, with twenty-three trees for the floors and walls, thirteen for the roof, and five for the interior (www.wrmca.com/clever.htm).

Metals

According to Stulz and Mujerji (1993), metals are not generally considered appropriate materials for low cost housing in developing countries, as metals are expensive, in most cases imported, and very often require special tools and equipment (Dietz, 1979).

Concrete

Hamm (1994) stated that the most popular and cost effective construction methods for building low cost housing use concrete brick and block and burnt clay brick masonry. In the Witwatersrand area, the majority of the low cost houses are constructed with clinker concrete masonry units using single leaf external walls (Dietz, 1979).

1.2.4 High Maintenance of Current Low Cost Housing

Apart from the problems associated with low cost housing delivery systems, is the issue of maintaining the end product. The initial focus of reducing costs of construction by the use of cheaper and less durable construction materials, results in increased maintenance costs during the life of the dwelling. Maintenance practices in South Africa have been changing (Green, 1993), due to the decreasing availability of traditional materials and the adoption of newer construction methods.

Fewer rondavels are evident, while more multi-roomed, low cost houses are being constructed with expensive materials, such as concrete, steel and timber, leading to high maintenance costs (Green, 1993, Dietz, 1979).

According to Hamm (1994), defects, such as cracks in walls, leaking roofs and leaking walls, are a matter of concern as these defects, which eventually require maintenance, is one of the reasons why there is a breakdown of acceptance and confidence in low cost housing.

Traditional low cost housing is maintenance-intensive and 27% of the homeowners carry out repairs every day on floors, walls and roofs (Green, 1993). More than 80% of roofs on low cost housing are tiled, but the tiles are laid without a plastic protection sheet underneath and this results in dust and rain seeping through, which makes living uncomfortable for the owners. Floors are literally swept out of the house with time because the concrete mixtures are not of the required strength and the screed is applied too thinly. Instead of 15 cm wide external walls, some low cost houses have 11 cm wide exterior walls and these thin exterior walls eventually crack due to weakly constructed foundations (De Beer, 1993). Too narrow eaves and a lack of guttering increases the problems of erosion in wattle and daub houses, while plaster tends not to adhere well to mud blocks, and eventually falls off in large pieces (Green, 1993).

1.2.5 Compromise between Affordable and Acceptable Low Cost Housing

Issues such as population growth, quality of life, and standard of living need to be considered within the framework of affordable low cost housing. The reality is that durability and quality are constrained by the laws of nature, including thermodynamics, chemistry and time, and therefore can be seen to be a highly complex concept with a significant moral component. This moral component is based on the belief that the current generation should pass on its inheritance of natural wealth, not unchanged, but undiminished in potential, to support future generations (Kibert, 1998).

It is apparent then that there is a need for affordable housing which is durable, and therefore, the housing need in South Africa is fertile ground for the innovator, whether he or she is working in the financial, planning, design or construction fields. Ways of improving production volumes and reducing construction costs, while still delivering an acceptable product or

service, are constantly being sought through the development of unconventional construction techniques, better utilisation of available manpower and material resources, and the use of new, more cost-effective construction materials and products (Wallis, 1993).

It then follows that products and services for low cost housing should match the homeowner's pocket with the objective of providing acceptable and durable accommodation to the greatest number of people, while remaining within the financial capacity of individuals (Low and Kelly, 1993).

Housing problems can be solved in a practical way by formulating construction procedures that utilise local materials and skills. This approach avoids the depletion of scarce foreign exchange, which is often a common problem in developing countries. This is especially so where construction materials are combined in composites and assembled efficiently, reducing the number of components and parts that must be transported and assembled on site. If, for example, the roof and ceiling can be combined into one component, the amount of material and consequently the cost will be greatly reduced (Goodman, 1979).

1.3 Concrete as an Affordable and Acceptable Construction Material for Use in Low Cost Housing

Vijay, Chakrabarti and Goel (1997) encourage the use of concrete materials for low cost housing construction by providing alternatives to current components so as to achieve greater durability. Thus, an important step in low cost housing development should be the correct choice of construction materials.

1.3.1 History of Concrete

According to Stulz and Mukerji (1993), the essential ingredients of concrete are cement, aggregate and water. When mixed in carefully prescribed proportions, a workable mass of

concrete is produced, which can take the shape of any formwork into which the concrete is placed and allowed to harden.

Concrete has evolved to become the world's most common and important building material (Robinson, 1997). Its role in construction is so widespread that its importance is often overlooked.

The term concrete often evoked images of flat, grey expanses, and the "concrete jungle" conjures a picture of a community overrun by heavy construction (Robinson, 1997). Nevertheless, concrete has given the world countless well-designed and aesthetically pleasing structures. The versatility of concrete is unequalled by any other building material (Robinson, 1997, Stulz and Mukerji, 1993). It is non-combustible, withstands heat to a certain extent, provides protective barriers against radiation, and plays an essential role in protecting the coastlines.

This remarkably versatile building material is constantly being refined, and today concrete can be used to produce many types of textures or finishes (Robinson, 1997). Concrete can be used *in situ* or precast, is easily manufactured, and factory controllable. It may also be cast in a variety of attractive forms. As prominent below ground as it is above, concrete is also used for hidden services, in the form of culverts, sewers and drains. It is this versatility which has led to the promotion of the use of concrete and its development technologically. With the world becoming increasingly environmentally conscious, it is believed that concrete is the ultimate "green" building material (Robinson, 1997).

Moreover, concrete can be seen to be the basic building element for modern society. Every major construction project utilises concrete. Concrete has a superior lifespan compared to other products, such as adobe and timber, and its thermal mass plays a role in energy efficiency. Its light reflectiveness also helps conserve energy. From the homeowner to the largest urban areas, concrete plays a major role in protecting and maintaining our environment (www.wrmca.com/clever.htm).

It is apparent from the above literature that the factors that are of great import to the problem of housing provision are affordability and acceptability by the end-users. Therefore, the housing need in South Africa today can be seen as providing the urge for construction innovation, where the properties of concrete can be exploited. According to Wallis (1993), the utilisation of concrete can increase production volumes of housing and reduce construction costs, while still delivering an acceptable product or service. These are goals which are constantly being sought through the development of unconventional construction techniques, better utilisation of available manpower, and more cost-effective construction materials and products (Wallis, 1993). Therefore, the potential of concrete as a material for affordable and acceptable housing becomes apparent and needs closer scrutiny.

1.4 The Problem Statement

The problem to be researched may be stated as:

“End-users are dissatisfied with the current delivery of low cost housing in terms of materials and execution.”

1.5 Hypothesis

The hypotheses to be tested may be stated as:

Concrete block construction results in acceptable low cost housing for end-users in terms of materials and execution.

End-users prefer the use of concrete block construction over other construction materials.

1.6 Objectives of the Research

The objectives of this research project are to:

- Investigate trends in the use of construction materials in the superstructure of low cost housing through a literature review.
- Establish what current methods and materials are used for low cost housing construction in the Western Cape by means of a questionnaire survey.
- Establish the end-users satisfaction levels with regard to the use of concrete block construction by means of a questionnaire survey.

1.7 Research Methodology

To achieve the above objectives, the following research methodology will be employed:

- Undertake a literature review on the affordability and acceptability of current construction materials used for low cost housing.
- Assess the affordability and acceptability of current materials used for low cost housing construction through case studies, interviews and questionnaires, carried out locally, focussing on the Cape Flats.
- Examine the suitability, in terms of affordability and acceptability, of using concrete blocks rather than other construction materials, for low cost housing developments.
- Draw conclusions and formulate recommendations.

1.8 Limitations

This research project is subject to the following limitations:

- The research will be restricted to the Western Cape, and more specifically, to low cost housing developments on the Cape Flats.
- This study is limited to the construction materials used in the wall superstructure.
- The duration of the research will be from August 2000 to March 2002.

1.9 Structure of Thesis

Chapter 1 presents the background to the problem, the hypothesis, research objectives and the methodology employed.

Chapter 2 will present an analysis of the literature appropriate to affordability and acceptability of current construction materials used in low cost housing construction.

Chapter 3 will present an investigation of the research methods available for the collection of primary data, regarding the current status of affordability and acceptability of recently built low cost housing.

Chapter 4 will document the methodology employed in, and results emanating from, a questionnaire survey into the current practice of construction for low cost housing in the Western Cape, with regards to affordability and acceptability. This survey specifically focuses on the construction materials used for the wall superstructure of low cost housing. The major parties involved, namely, homeowners, materials suppliers and developers are surveyed.

Chapter 5 will present a case study of the current practice of construction of the wall superstructure for low cost housing. The results of the questionnaires and case study are presented with respect to affordability and acceptability.

Chapter 6 will conclude the results obtained in the research, together with recommendations for practice and areas of future research are suggested.

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CHAPTER 2

AFFORDABILITY AND ACCEPTABILITY OF CURRENT LOW COST HOUSING CONSTRUCTION MATERIALS

2.1 Introduction

It is apparent from Chapter One that the factors that are of great import to the problem of affordability are the population dynamics of South Africa, the high incidences of poverty as well as the high level of unemployment rates which contribute to the level of earning power, which is prevalent amongst the vast majority of the population.

Current South African housing policy is formulated around the supporter paradigm, where State assistance is given in the form of a capital subsidy grant to households who then control the process of housing provision in an incremental manner (Adebayo and Adebayo, 2000). However, issues such as affordability and acceptability, in improving housing for the lowest income groups, continue to be experienced.

Although South African housing policy (Africa, 1993), advocates for the use of local building materials and technologies, Adebayo and Adebayo (2000) contend that, in practice, local governments have continued to implement building codes and regulations, leading to a lack of uniform housing quality, and specifically in the use of materials.

In addition, McIntosh and Fourie (2000) state that South Africa is currently experiencing problems with the sustainable management of the built environment with respect to the inability of low income communities to afford a house. Sustainability is therefore critically linked to affordability, firstly, in relation to the capital costs of a development, and secondly, with respect to long term maintenance and cost recovery from the end users (McIntosh and Fourie, 2000). Present approaches tend to be focused on delivery rather than long-term durability. New approaches must be identified, which increase both the affordability, and therefore the quality, of future low cost housing developments (McIntosh and Fourie, 2000).

2.2 Affordability and Acceptability of Current Low Cost Housing

Bentil and Herbsman (1989) stated that the problem of inadequate shelter and unaffordable housing is a worldwide problem. According to Aboutorabi and Abdelhalim (2000), affordable housing is defined as the ability of households to pay the costs of housing without imposing constraints on living costs. Moreover, it is the ability of households to occupy housing that meets well-established norms of living standards, at a net rent which leaves the residents sufficient income to prevent the standard of living falling below the poverty standard. The inability of homeowners to meet initial costs and future repayments proves to be problematic in terms of cost recovery by the developer and affordability by the community.

Adebayo and Adebayo (2000) agree that constraints, such as employment levels, income generation and access to housing, in improving housing for the poorer communities continue to be experienced in the areas of affordable housing. In South Africa, the income of poor communities has continued to be too meagre or unstable to permit commitment of their scarce resources to housing (Adebayo and Adebayo, 2000). Therefore, improvement of housing conditions then becomes impossible, directly affecting the performance of housing policy (Adebayo and Adebayo, 2000).

McIntosh and Fourie (2000) argue that affordable housing is directly linked to the income profile of the users and to the amount of funding available. During the period between 1985 and 1995, South Africa experienced a negative growth rate in the Gross Domestic Product (GDP) per capita. In 1986, the GDP per capita was \$714 and this had reduced to \$665 by 1995 (McIntosh and Fourie, 2000, citing UNECA: 1997:13).

According to Bentil and Herbsman (1989), affordable housing should be a primary concern worldwide. The lack of adequate affordable housing has continued to be a serious problem for many years and, therefore, remains a key hurdle, preventing large-scale delivery of housing in South Africa (Adebayo and Adebayo, 2000). In housing projects, starter houses have remained as they were for more than five years (Smit, 1998). It would seem then that with a limited possibility of an increase in the subsidy amount, the goal of a permanent complete dwelling remains an elusive one. Furthermore, poor people who are eligible for the capital subsidy programme are also unable to afford the range of ongoing water, electricity and rate charges associated with formalised owner-occupation (Adebayo and Adebayo, 2000).

However, there is a contradiction in the current policy's market-orientated approach to low cost housing delivery, when unemployment and poverty abound in South Africa. Firstly, high priority should be given to employment and income generation needs of the poor, and the growing number of people without any source of income. Secondly, formal housing is not considered a priority by the poorer communities in comparison to the necessities of daily living (Adebayo and Adebayo, 2000).

According to Bentil and Herbsman (1989), the impediments to affordable housing may vary in different undeveloped countries, but the common impediments are identified as the lack of adequate transfer of modern technology and cost effective methods of construction, in addition to psychological resentments to the use of local indigenous materials and the high cost of imported materials.

McIntosh and Fourie (2000) state that construction procedures for low cost housing in South Africa have to alter in order to accommodate large sectors of the population who depend on non-formal systems of delivery. These systems are essentially self-managed, and generally fall outside the ambit of the government policy, planning and management systems. The extent of these systems, and their contribution to livelihoods and social order, are rarely acknowledged. More realistic building codes, shelter standards and the use of concrete building materials and technologies, have the potential to reduce the ultimate cost of housing and make housing more affordable to the poor (McIntosh and Fourie, 2000).

Furthermore, McIntosh and Fourie (2000) argue that South Africa's housing policy has been upgraded to a R16000 grant on freehold land, which is intended to cover both the survey and infrastructure costs. However, this grant will only cover site development and service connections or part of a top structure (McIntosh and Fourie, 2000). The pattern in applying the housing policy has been that State housing projects are not able to accommodate the very poor (McIntosh and Fourie, 2000). Moreover, households, which acquire houses at no cost to themselves, have difficulty in paying rates and service charges, and the very poor will usually find sanctuary in dense informal settlements on the outskirts of the city where cheap access to land and services can be secured (McIntosh and Fourie, 2000).

Therefore, current government policies do not accommodate the very poor in terms of affordable housing (McIntosh and Fourie, 2000). However, Aboutorabi and Abdelhalim (2000) contend that the study of housing

affordability could contribute to the acceptability by the end-users in developing countries, particularly in the townships of South Africa, by developing cheaper housing which is not of a lesser quality, and offering financial assistance.

Hegde (2001) agrees that the cost of housing needs to be reduced in order to make it affordable for the growing population. The inability to do so would create major socio-economic problems such as the mushrooming of the slum areas and the resulting burden on the society. The government's views on low cost housing consisted of badly constructed matchbox like houses, which looked more like army barracks than places of human dwellings (Hegde, 2001).

Furthermore, an investigation carried out by Hegde (2001) revealed that the housing costs consist of the cost of the land and its development, as well as the cost of construction. This construction cost consists mainly of the cost of materials and labour as illustrated in Table 2.1.

Table 2.1 Low Income Housing Costs

Construction Components	Materials (%)	Labour (%)	Total (%)
Foundations	9.5	3.0	12.5
Walls	17.5	5.0	22.5
Roofing	17.5	5.0	22.5
Doors and Windows	12.0	3.0	15.0
Flooring	8.0	2.0	10.0
Plumbing	8.0	2.0	10.0
Electrical Works	6.0	1.5	7.5
Total	78.5	21.5	100.0

(Source: Hegde (2001))

According to Hegde (2001), and as can be seen from Table 2.1, the majority of the building costs is taken up by the materials. Therefore, the construction of low cost houses, using more cost-effective materials, can conceivably reduce the costs of construction.

2.3 Construction Materials Used for Low Cost Housing in South Africa

Throughout the history of the human race, the selection and construction of shelter has been governed by the availability of materials and the need for protection from the elements and other threats whether they are from animals or other humans (Morris and Booyesen, 2000). Where the person requiring shelter has had a choice, aspects such as convenience, comfort and social customs have influenced those choices. The implementation of accessible and appropriate building materials and methods in the construction of low cost housing will develop and promote health and sustainability within the poorer communities (Morris and Booyesen, 2000).

Historically, disadvantaged communities have developed shelter on the basis of availability of materials, suitability of design and facility of construction. In addition, social customs have added complexity and interest, occasionally at the cost of practicality and comfort. This regional, ethnic, cultural diversity is well illustrated by Africa since the climate varies from desert to sub-tropical, from high plateaus to coastal plains. Therefore, according to Low and Kelly (1993), poorer communities would build dwellings consisting of materials which could be obtained relatively easily; for example, corrugated iron, plastic or timber.

However, Low and Kelly (1993) stated that these materials have disadvantages such as lack of permanence, difficulty with expanding and upgrading, low thermal and acoustic insulation, and low structural strength. Low and Kelly (1993) further asserted that studies have identified that construction techniques implementing these materials are not cost effective.

Cox (1984) argued that the problem is further aggravated by the fact that poor communities are excluded from participating in any of the formal mechanisms which exist to provide housing in both developed, and developing, countries. Construction techniques have to adapt in terms of design and production to promote economic growth (Cox, 1984), and the poorer communities must become an integral part of the productive sector of the economy.

Dholakia and Dave (1989) further asserted that between 60 and 70 percent of the overall cost in any construction project is comprised of the cost of materials and that the utilisation of commonly used materials,

such as bricks, stones, wood and mud, must depend on local availability. Furthermore, houses constructed from concrete would provide a more permanent and more acceptable home suitable for upgrading in the future. However, the various materials that are available are in abundance, and their judicious use should be dependent on their locality and climatic conditions of the area, thereby saving on costs of construction (Dholakia and Dave, 1989).

Cox (1984) stated that the majority of developing countries have not reached a level of self-sufficiency in the production of building materials, which an effective housing policy would warrant. This has led to building material shortages in the developing countries, resulting in dependency on imported materials. Since the housing construction industry of industrialised countries is one of the first sectors to be adversely affected by a recession or inflationary pressure, adverse impacts, such as the lack of supplies or cost increases in terms of materials, are inevitably transferred to those developing countries dependent on the importation of building materials.

Society assumes that lowering the cost of construction of a building is similar to lowering the quality of construction. However, Hegde (2001) argues that an affordable low cost house can be constructed by the optimum usage of labour and materials and not entail the lowering of quality.

Furthermore, according to Low and Kelly (1993), whatever construction materials are considered should fulfil the following criteria:

- (a) The cost of construction must be very competitive;
- (b) The method of construction must be such that existing skills are utilised and that new skills do not have to be acquired;
- (c) The skills must be simple enough to be transferable;
- (d) The method of construction must maximise the number of people employed per Rand spent. Wherever possible, local labour must be utilised;
- (e) The capacity to produce the various building units must presently exist in South Africa. South Africa cannot afford to import expensive capital equipment at this stage;
- (f) The structure and finishes must be acceptable to the prospective owners;

- (g) The structure must be such that additions and alterations can be easily effected to allow for upgrading;
- (h) Modular construction should be implemented wherever possible; and
- (i) Standards must be appropriate, providing durability, thermal and acoustic insulation and aesthetics. High standards lead to wastage of scarce resources. Low standards lead to frustration and lack of acceptability by homeowners.

(Source: Low and Kelly (1993))

2.3.1 Adobe

Adobe is the most readily available building material worldwide. Most soils are suitable for use as building materials, though in various cases, the addition or removal of certain constituents is required to improve the soil's quality. However, according to Stulz and Mukerji (1993), soil construction is found to a lesser extent in regions of extreme rainfall as soil has the disadvantage that it softens when wet, which causes earth structures to require maintenance, or face collapse (Morris and Booyesen, 2000). Therefore, according to Dietz (1979), natural earth, although its properties vary enormously, is not generally suitable for construction purposes.

However, Stulz and Mukerji (1993) stated that soils that do not possess the desired characteristics for a particular construction could be improved by adding one or more stabilisers, which would effectively increase the compressive strength and impact resistance, and also reduce its tendency to swell and shrink. Furthermore, the addition of stabilisers would reduce or completely exclude water absorption by sealing all voids and pores.

According to Stulz and Mukerji (1993), the most common naturally available stabilisers used in traditional low cost housing constructions are sand and clay, straw, plant fibres, plant juices, wood ashes, and animal excreta. The most common manufactured stabilisers are lime and pozzolans, portland cement, gypsum, bitumen, resins and molasses. With the addition of stabilisers to soil, the applications of the improved soil product are found in foundations, walls, floors and roofs. It follows from the facts given above that the choice

of the most suitable stabiliser will mainly depend on local availability and costs, but also to some extent on social acceptance.

According to Morris and Booyesen (2000), research into and recommendations on the use of earth for construction are not recent phenomena. In 1950 the National Building Research Institute of the CSIR published a lengthy report on 'The properties of compacted soil and soil-cement mixtures for use in building' (Morris and Booyesen, 2000). Currently, research into earth block construction is being undertaken at the University of the Free State, by the Peninsula Technikon and the Namibian Clay House Project, as well as by the Thlolego Project near Rustenburg and in internationally supported projects in KwaZulu-Natal and at East London.

Furthermore, according to Morris and Booyesen (2000), most of the people of southern Africa live at a relatively high altitude and fairly close to the Tropic of Capricorn and this imposes large diurnal temperature fluctuations such as differences between day and night temperatures which are often in excess of 20°C. Under such conditions the mass of earth walls and the thermal inertia effect they provide would seem to be ideal.

Abd-el-Hamid (1984) agreed that the situation regarding low cost housing, in terms of durability, dictates the need for the adoption of technology that is essentially socially and culturally acceptable. The compatibility of these prerequisites with the characteristic attributes of earth-sheltered housing is obvious. Our ancestors adopted simple, non-energy consuming techniques using earth as the basic construction materials for housing. Such building materials are ideal for a region such as the Western Cape, especially the Cape flats, where rainfall is low and the climate favours the use of heavyweight material, which has a good thermal performance and a high heat storage capacity.

At present, low cost housing using earth technology construction does not exist in the Western Cape, as earth technology is not an accredited form of construction, and contractors and developers are therefore sceptical about implementing earth as an acceptable construction material. Nevertheless, according to Morris and Booyesen (2000), the use of earth walls in South Africa has been well documented and there are many examples of relatively large and sophisticated buildings such as Thuyinhuis, the State President's

Office in Cape Town, and the farmhouse in Riebeeck Wes in which Jan Smuts was born, constructed of earth, that have lasted many years. However, earth technology has yet to be accepted as part of the National Building Regulations.

It must, however, be stressed that building with earth is not easy. It is indeed the lack of expertise that often brings about poor construction, which in turn gives soil construction its poor reputation (Morris and Booyen, 2000). However, with a sound background in earth technology, acceptable earth-built shelters are possible.

2.3.2 Structural Timber

Structural timber is a familiar building material found in many parts of the world. Timber is not only one of the oldest building materials, but has remained until today the most versatile and, in terms of comfort and health aspects, most acceptable construction material. Dietz (1979) asserted that timber is versatile and relatively easy to fabricate, has high strength and toughness relative to its weight, and this makes it an attractive construction material.

However, as an organic material, providing food for some types of organisms, and subject to oxidation and decay, structural timber can succumb to a number of destructive agencies (Dietz, 1979). In addition, while structural timber has favourable resource efficient construction attributes such as low external energy, traditional logging practice results in negative environmental effects, such as eroded soils, slowed regeneration, and introduction of toxic chemicals (O'Brien and Allen, 1994).

According to Stulz and Mukerji (1993), timber is suitable for construction in all climatic zones, and is unmatched by any other natural or manufactured building material in terms of versatility, thermal performance and provision of comfortable and healthy living conditions. Timber is compatible with traditional constructional skills and rarely requires sophisticated equipment. The production and processing of timber requires less energy than most other building materials. However, high costs and diminishing supplies of naturally resistant timber species, due to uncontrolled cutting and exports, results in serious environmental problems (O'Brien and Allen, 1994).

Stulz and Mukerji (1993) stated that, although only a small proportion of the timber harvested is used for construction purposes, the universal concern about the rapid depletion of forests, especially the excessive felling of large old trees, which take hundreds of years to replace, and the great environmental, climatic and economic disasters that follow deforestation, has led to a great deal of research into alternative materials and rationalised timber utilisation.

According to Hamm (1994), a typical timber frame low cost house consists of a structural framework in timber, which supports different cladding systems for the walls and roof. The most cost-effective wall materials involve overlapping timber strips, which raises the question of durability, protection against fire and strength against unlawful entry into the dwelling.

Formal low cost housing using mainly timber is not evident in the Western Cape. However, timber can be used successfully in construction if certain precautions are adhered to, such as using well seasoned wood, good workmanship, avoidance of ground contact, protection against dampness by means of moisture barriers and provision of joints designed to accommodate thermal and moisture movement (Stulz and Mukerji, 1993).

2.3.3 Metals

According to Stulz and Mukerji (1993), metals are not generally considered appropriate materials for low cost housing constructions in developing countries such as South Africa, as they are usually expensive, in most cases imported, and very often require special tools and equipment.

However, according to Hutton and Van Niekerk (1993), Dorbyl Limited developed a unique innovative and affordable steel housing product, which consisted of a 100% steel one-room dwelling. The walls and roof were constructed from high tensile steel, manufactured by Iscor according to the American Standard ASTM 446. This allowed for a relatively lightweight product with good strength characteristics. The roof is simply bolted onto a rail fixed to the walls. Steel sheets for the walls were produced by Iscor on continuous hot dipped zinc coating lines to the requirements of the South African specification SABS 934:1969 (as amended 1983). The sheets were then profiled to the Kliplok design. Kliplok is an Australian-developed

positive locking roofing and cladding profile. A pre-fitted steel door with a lock as well as one small window, pre-fitted with glass, was included in the package. The only tools needed were two flat spanners and a ladder. The product was appropriately named "Zinki" in reference to the name "Zinc Sheets" commonly in use for conventional corrugated galvanised sheets. However, possible homeowners perceived 100% steel housing and steel framed housing as unconventional and preferred to live in traditional houses constructed using blocks and bricks.

2.3.4 Concrete

According to Dietz (1979), concrete refers to a composite of mineral particles, namely, aggregate, combined with a paste of water and a cementing material, most commonly portland cement, which changes or cures from a soft and plastic state into a hard and rigid mass. Stulz and Mukerji (1993) agreed that the essential ingredients of concrete are cement, aggregate and water. As previously stated, when mixed in carefully prescribed proportions, a workable mass is produced, which can take the shape of any formwork into which the concrete mass is placed and allowed to harden. In addition, concrete has inherent strength, volume stability, thermal insulation, and durability. Moreover, a durable material like concrete usually has a long service life and minimal maintenance (O'Brien and Allen, 1994).

Stulz and Mukerji (1993) stated that concrete could take any shape and achieve compressive strengths exceeding 60 N/mm^2 . In addition, the embodied energy requirement to produce one kilogram of plain concrete is the lowest of the manufactured materials. The high thermal capacity and high reflectivity, due to light colour, are especially favourable for construction in hot dry areas, such as the Western Cape. Properly executed concrete is extremely durable, maintenance-free, resistant to moisture penetration, chemical action, fire, insects, and fungal attack (Stulz and Mukerji, 1993).

Because of concrete's versatility, it has many applications in low cost housing developments. According to Stulz and Mukerji (1993), concrete can be used in the construction of pipes, gutters, toilet bowls and washbasins. Concrete can also be used for walls and roofs, or complete structures, either in situ or in the form of precast elements. Furniture, such as cupboards, tables, beds, and various items for children's playgrounds could also be constructed using concrete.

Petersen (1994) claimed that the versatility of concrete makes it particularly suited to community-based manufacture of building and construction products. The local communities could manufacture precast concrete products such as bricks, building blocks and door and window frames.

Moreover, the last century has witnessed an unprecedented development in construction techniques where concrete played the dominant role (Ngab, 2001). The success of concrete in the developed world is significant and there is a clear trend that such development will continue and shift to the developing world. Ngab (2001) states that concrete consumption worldwide is in the order of 10 billion tons per year, next only to the total consumption of water.

Fifield (1994) agreed that concrete offers solutions to affordability and acceptability issues. However, this will not be possible unless there is a greater understanding of concrete and its implementation (Shah, 1994).

Concrete Masonry (Concrete Block Construction)

According to Petersen (1994), a concrete masonry unit is a precast building element of rectangular shape, either solid or hollow, formed from a mixture of cement, aggregate and water. The units are made in a range of sizes, shapes, colours, textures and profiles and are designed to meet various requirements such as strength, thermal and acoustic insulation and fire resistance. Concrete masonry is used extensively in the construction industry, and concrete masonry structures will have adequate strength and stability for their purpose when designed and built under competent supervision according to the applicable standards, codes and regulations.

Concrete masonry was first introduced into South Africa in the 1950s, as a relatively poor quality, backyard product. Since then, the industry has seen significant growth and improvements, especially in the quality of concrete masonry units manufactured and the applications thereof. According to Hamm (1994), an additional improvement in concrete masonry construction is the interlocking, dry-stacking and soil-cement types of masonry units, which are specially developed, and which form a very small percentage of the total output of building blocks and bricks. Improved technologies have contributed towards the manufacture of better concrete. The improvement in quality was largely assisted by work undertaken by the Concrete

Masonry Association and Portland Cement Institute, and the publication and implementation of various standard specifications and codes of practice implemented through the SABS (Low and Kelly, 1993).

Hamm (1994) stated that concrete brick and block and burnt clay brick masonry construction is still the most popular and cost effective methods of construction used for low cost housing. In the Witwatersrand area the majority of the low cost house are built with clinker concrete masonry units using single leaf external walls. With a concrete tile roof, such a modest 48 m² home consumes approximately 3 tons of cement (Hamm, 1994).

According to Low and Kelly (1993), a proposed solution to the poor quality of low cost houses, through the implementation of concrete, is to utilise the "thermal mass" of the house itself. Thermal mass, as opposed to thermal insulation, is the ability of a relatively thick wall such as concrete masonry, to store heat accumulated by solar radiation, which then is released at a later time. With South Africa experiencing dry, relatively warm days followed by cold nights, this form of energy conservation is extremely practical (Low and Kelly, 1993). Furthermore, concrete masonry is suitable for housing in South Africa, due to its versatility as concrete blocks can be manufactured by both manual backyard operations and highly sophisticated, highly mechanised concrete plants producing thousands of masonry units per day (Low and Kelly, 1993).

Cost reduction can be achieved through wall thickness reduction (Low and Kelly, 1993). The required minimum wall thickness for external walls is 220 mm, namely two leaves, and 110 mm for internal walls. The Revised National Building Regulations (SABS 0164:2, 1992) allow 140 mm for the widths of external walling, namely, a single leaf, and 90 mm for internal walls. This not only results in a significant saving in material, both for the masonry units as well as the mortar, but the single skin construction results in significant reduction in labour costs. However, a move towards single leaf construction for external walls has brought about a number of technical problems which have to be solved, such as rain penetration of walls, restraining of roof trusses and installation of electrical services. Sealing around windows and binding internal walls to external walls also poses a problem (Low and Kelly, 1993).

Hamm (1994) agreed that the most appropriate and affordable construction method for low cost housing construction is still blocks and mortar, as it is faster and more efficient to build with than conventional bricks.

In addition, concrete blocks are highly durable and almost maintenance free. It has excellent natural acoustic and thermal properties, creating buildings that are cool in summer and warm in winter. Presently, the emphasis is on rationalised masonry construction because the materials must be used effectively and the building operations must be simplified.

Furthermore, Hamm (1994) stated that concrete masonry construction is labour intensive and the most common choice of builders. A simple 48 m² single leaf masonry low cost house, which excludes electricity and major services, can still be built by a local small contractor for less than R12 000. According to Hamm (1994), the most popular type of concrete masonry unit for low cost housing is the maxi brick or M290 brick for solid single leaf construction. The size of the solid unit is 290 mm x 140 mm x 90 mm. The external walls are 140 mm thick and the internal walls are 90 mm thick. Every third course of the external wall corresponds with every second course of the internal walls.

Hamm (1994) further stated that hollow concrete blocks are also used extensively for single leaf wall construction. The most common size of concrete block is 390 mm x 140 mm x 190 mm. Concrete face bricks and plaster bricks of size 220 mm x 106 mm x 72 mm are used extensively to replace burnt clay bricks in traditional construction methods.

Finally, Petersen (1994) cautioned that the quality of masonry work depends on the care taken in laying the units accurately to line and level, and on the neatness and uniformity of the joints. In this respect, concrete masonry has taken the lead as the most viable construction method for low cost housing.

Concrete Modular Construction

The concrete industry was one of the first to adapt to modular construction. Modular construction is an innovative way of supplying low cost housing to poorer communities (Low and Kelly, 1993). It involves the design and construction of the structure in such a way that the dimensions of all the units, namely, walls, doors, windows and other structural units are multiples of a fixed module.

Modular construction offers many advantages in the reduction of wastage of materials, time and cost of construction. However, for modular construction to be successful, all suppliers of building materials must adapt their units to modular dimensions. There will be a certain initial cost involved with setting up for the change over to modular construction, but the benefits are on-going because South Africa cannot afford to continue manufacturing mis-matching units (Low and Kelly, 1993).

No-fines Concrete

Hadjri and Scott (1993) identified no-fines concrete as an alternative material for the production of low cost houses. It is a mixture of coarse aggregate, cement and water, without the fine aggregate, generally known as sand. The preferred aggregate size is 20 mm.

No-fines concrete differs from normal concrete, in that the cement content is low, namely, one part to ten parts coarse aggregate. No-fines concrete is cellular in structure, having 30 percent voids; thus, there is no capillary suction of moisture, and no-fines concrete does not segregate. It compacts under its own weight without the need to vibrate or rod the material. Pressures on the shutters are only one half to one quarter that of normal concrete. The most significant difference is that no-fines concrete has a very low drying shrinkage, and this enables the box-like plan of a house, for the full height of the walls, to be poured in one operation without construction joints (Hadjri and Scott, 1993).

Hadjri and Scott (1993) explained that the method of construction using no-fines concrete follows a simple procedure. The two sets of shutters are set up 140 mm apart, for the full height of the house with the timber windows and the doorframes fixed in position. No-fines concrete is then poured, and the following morning, the shutters are stripped. Lintels and cills are not required. Internal partitions may be constructed of hollow blocks or other materials. Cutting of the no-fines concrete, which commonly occurs in other forms of construction, is unnecessary, and consequently there is no waste.

Based on studies carried out by Hadjri and Scott (1993), it was found that no-fines concrete offers advantages to low cost housing construction in developing countries. It requires low technology, creates employment for the semi-skilled and unskilled, and it makes use of indigenous materials. Construction takes

place on site using normal methods of concrete construction. Haulage of materials is considerably less than for other forms of construction. It is suited to large or small developments of 1 000 houses or as few as 25 houses, respectively.

Insulated Forming Systems

A method used for years in Europe, which is rapidly gaining acceptance in the Africa, is the use of insulating forming systems and ready-mixed concrete. Two categories of system are the most popular. Firstly, interlocking, hollow, polystyrene blocks are stacked to create the form for the concrete. Secondly, combinations of panels are utilised to form a system of ties to space them apart, which creates the stay-in-place formwork. With vertical and horizontal reinforcement in place, the concrete is then poured into the cavity in either system to form the wall (<http://www.wrmca.com/clever.htm>).

The advantages of these systems are that the forms are erected quickly with unskilled labour. They also result in flexibility with regard to design and appearance and the system is not reliant on suitable weather conditions. In addition, very little waste is created (<http://www.wrmca.com/clever.htm>).

Foamcrete

Foamcrete consists of a cement-based slurry that is aerated by adding a pre-foamed foaming agent in conjunction with polypropylene fibres (Weihart, 1996). Foamcrete is also known as cellular, aerated or foamed concrete but, as no aggregate is used, the material strictly speaking cannot be classified as concrete.

According to Kearsley and Mostert (1997), this lightweight building material can be used by rural communities for affordable and sustainable development of housing. In addition, these lightweight foamcrete building blocks may be used for wall panels, roofing sheets, footings and floor slabs. However, although foamcrete is a lightweight building material, it is relatively strong, has good thermal properties, and is non-combustible (Weihart, 1996).

Kearsley and Mostert (1997) stated that research on the properties of foamcrete has been conducted on an ongoing basis at the University of Pretoria for the past six years. Foamcrete with densities varying between 700 and 1 500 kg/m³ have been manufactured.

According to Weihart (1996), a prototype unit was constructed using pre-cast foamcrete building blocks, where each unit equated to sixteen standard bricks, weighing 10 kg. These blocks were dry-stacked and the wall was then wrapped in polypropylene netting, which acts as an anchor for any subsequent finishing layers. The netting was covered with a thinly sprayed layer of cement slurry.

This method of construction would speed up the delivery of housing, without the use of skilled labour, because it uses 'tilt-up' construction. Tilt-up construction is the process whereby the floor is cast and then the walls are cast flat on the floor, requiring no shutters. After gaining sufficient strength, the walls are lifted into position (Weihart, 1996). According to Kearsley and Mostert (1997), trial units have been built successfully, using both blocks and tilt-up panels.

2.4 Conclusions

In essence, affordability and acceptability of low cost housing calls for a holistic and integrated approach towards delivery of housing for the poorer communities. Past and present low cost housing construction approaches have not addressed the needs of the very poor in conjunction with the needs of the developers of low cost housing. The ongoing political pressure on the government to overcome the housing backlog has resulted in significant pressure on housing delivery organisations to rapidly deliver large numbers of houses at the lowest possible price. In terms of affordability, the lowest possible price usually results in the use of cheaper construction materials, where developers are given a budget within which they must produce a certain number of units, which in turn, determines the cost per unit. This usually results in the use of cheaper construction materials as material costs make up the bulk of the construction costs. This pressure has superseded quality and acceptability considerations, which in the long run may result in dwellings that are only marginal improvements on the existing shacks.

Finally, housing the poor in South Africa is a long-term programme whose success is dependent on a delivery system in which individuals must be able to participate. It is anticipated that a good record of economic growth will be able to place the poor on the road to affordability.

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CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Chapter Two reviewed the literature relating to affordability and acceptability of low cost housing in South Africa.

This chapter will propose a research design best suited to address the problem of affordability and acceptability of low cost housing by describing the development of the methods adopted to collect data and how they will be used to test the hypotheses.

The first section provides a summary of the various research methods that are available to the researcher, and subsequently provides a basis for formulating the research method chosen for this study.

The subsequent section discusses the reasoning behind the selection of these methods by comparing and contrasting the alternatives that were considered for key parts of the research design.

3.2 Research Design

The argument presented by Leedy (1993) concerning the choice of research method is used as a starting point, where consideration is given to the aspects of solving a problem, and of reaching an objective.

Research methodology is provided with a strong base from Best's (1981) argument that the aim of research must be to further one's understanding of relationships, events and processes. Leedy (1993) argues that the research methodology must help to explain what the

nature of the data is, and what method is used to process them to arrive at conclusions. Leedy (1993) further argues that a pragmatic presentation regarding the data may be perhaps most expeditiously handled if the following four principal questions with respect to research data are answered (Leedy, 1993:145):

- (i) *“What data do you need?”*
- (ii) *“Where are the data located?”*
- (iii) *“How do you intend to get the data?”*
- (iv) *“Precisely, and in detail, what do you intend to do with the data?”*

According to Fellows and Lui (1997), the information obtained while doing research depends on the pattern and techniques of searching. Research is therefore defined as the process of acquiring knowledge, and understanding its importance towards the study.

Furthermore, Mellville and Goddard (1996) described research as the process which reveals knowledge that previous researchers have not discovered. Research is therefore a never-ending process through discoveries and creations, which result in new discoveries and new creations.

Moreover, Fellows and Lui (1997) stated that research requires a systematic approach by the researcher, irrespective of what is investigated and the methods adopted. Careful and thorough planning are therefore essential, and especially where large amounts of data are collected, rigorous record keeping is vital in the study of theory and previous work, as well as in field work.

3.2.1 Quantitative Research

Leedy (1993) described quantitative research methodology as impersonally experimental. The attitude adopted by quantitative researchers is an either/or attitude, and variables are manipulated to control natural phenomena. Furthermore, quantitative research methodology

approaches incorporate sub-methodologies of experimental studies, quasi-experimental studies and statistical-analytical studies (Leedy, 1993). According to Fellows and Lui (1997), quantitative research relies solely on assumptions that are adapted from scientific techniques.

3.2.2 Qualitative Research

Qualitative studies are field focussed. The researcher is aided by the use of an observation, where it is not a matter of checking behaviours, but rather of perceiving their presence and interpreting their significance (Leedy, 1993).

Furthermore, in qualitative research studies, the use of expressive language and attention to particulars is paramount. Therefore, according to Leedy (1993), qualitative research is realistic due to its coherence, insight and instrumental utility.

Moreover, all qualitative studies must have distinct starting and ending points, as the study begins when the researcher has identified the problem and ends when the researcher draws conclusions and makes recommendations for future purposes (Fraenkel and Wallen, 1993).

3.3 Research Methods

Various research methods, such as experiments, surveys, questionnaires, case studies and interviews, exist for implementation by the researcher in the collection of primary data. According to Fellows and Lui (1997), these various methods of research allow for efficient management styles, team cohesion and communication, measured in terms of values of time, cost and quality, and ensure that the appropriate information is available for further study and documentation. However, the different research methods and styles are not mutually exclusive.

The different approaches focus on collection of data rather than on examination of theory and literature, as the collection of data impacts upon the analyses of the findings. The analysis is

an important aspect of any research study as the results, conclusions, values and validity of the study are dependent on the outcome of the analysis (Fellows and Lui, 1997).

Bell (1993) stated that research projects are usually carried out with insufficient regard to the array of approaches that are available to the researcher. Therefore, the research design methodology chosen is an important part of any research project, as it gives the overall framework for collecting and formulating the data needed for the research.

3.3.1 *Experimental Methods*

Leedy (1993) explained that the basic structure of experimental research is simple, as experimental research methods deal with the phenomenon of cause and effect. This phenomenon of cause and effect would be assessed within a closed system of controlled conditions, such as in a laboratory.

According to Fellows and Lui (1997), there are two scenarios involved in experimental research, and each situation is assessed individually and the results are then compared. Firstly, one of the situations is manipulated by introducing external factors to change it to an appropriate and logical result. Secondly, the two results are then compared again, and the results analysed. Finally, whatever change had occurred would then be known to have been caused by the introduction of external factors.

Leedy (1993) stated that experiments of a similar nature are carried out in a natural setting, such as in the field, or in an artificial setting, carried out under ideal conditions, such as in a laboratory. Leedy (1993) asserted that the researcher would therefore be able to create the exact conditions that would be required for a specific result, as well as have control over factors and be able to manipulate the results in a particular setting.

Nel, Radel and Loubser (1998) asserted that the researcher, through the experimental method, determines the influence that an independent variable, such as the cost of a house, has on the dependent variable, namely, the number of houses sold.

Advantages of the Experimental Method

Kinnear and Taylor (1983) stated that experimental research methods produce meaningful results. Emory and Cooper (1991) agreed that in the collection of primary data, which are data closest to the truth, the experiment is more successful than other methods in accomplishing goals, as the corruption of extraneous variables is easier to control, and the convenience factor and costs of experiments is superior to other methods.

Disadvantages of the Experimental Method

Kinnear and Taylor (1983) commented that the introduction of extraneous variables results in uncontrollable differential effects among treatment groups occurring in field experiments. Moreover, according to Emory and Cooper (1991), the laboratory environment is too contrived and requires future capital investments to improve the existing conditions. In addition, experimental studies are effectively applied to present problems and those in the immediate future. Studies of past situations are not feasible and intentions and predictions are difficult.

3.3.2 Analytical Surveys

According to Fellows and Lui (1997), analytical surveys operate on the basis of statistical sampling. Leedy (1993) stated that the analytical survey method uses numerical values for the interpretation of the primary data.

The principles of statistical sampling, when selecting a representative sample, are employed for economy and speed (Leedy, 1993). Samples are surveyed by means of questionnaires or

interviews. Analytical surveys vary from highly structured questionnaires to unstructured interviews.

Interviews

According to Best (1981), an interview is a conversation between two people. The interviewer initiates the interview for the specific purpose of obtaining information relevant to the researcher's field of study. The interviewer relies on the fact that people are able to offer accounts of their behaviour, practices and actions.

Furthermore, Best (1981) described the interview as a distinctive research technique, having three specific purposes. Firstly, it may be used as the principal means of gathering information, having direct bearing on the objectives of the research study. Secondly, it may be used to test the hypothesis, or to suggest new ones, or as an explanatory device to aid in the identification of variables and relationships. Finally, the interview may be used in conjunction with other methods in a research study.

According to Wimmer and Dominick (1994), a successful interview will uncover participants' perspectives on a particular issue. This could prove useful to the researcher as reasons to specific answers and backgrounds may surface. Moreover, an interview allows for the respondent's behaviour to be observed, and this could provide extensive insight into the opinions, motivations and feelings of the respondent. Interviews vary in their nature as they can either be structured, semi-structured or unstructured (Fellows and Lui, 1997).

Structured Interviews. In a structured interview, the interviewer administers a questionnaire by posing questions to an individual and recording the responses. The researcher seldom goes beyond the set parameters of the interview, with little scope for probing those responses by asking supplementary questions and to pursue new and interesting aspects (Fellows and Lui, 1997).

Erwee (1984) stated that, in structured interviews, questions are asked in exactly the same order with exactly the same wording every time. This standardisation is designed to control response bias by ensuring that the respondents are replying to exactly the same question.

Unstructured Interviews. According to Fellows and Lui (1997), in an unstructured interview, the interviewer introduces the topic briefly and dictates the background of the research. The interviewer then records the replies of the respondent, which can be anything the respondent wishes to say.

Erwee (1984) stated that the unstructured interview allows for extensive probing of the respondent in order to permit free speech and expression of detail and feelings.

Semi-Structured Interviews. Semi-structured interviews fill the spectrum between structured and semi-structured interviews. They vary in form quite widely, from a questionnaire-type interview with some probing, to a list of topic areas in which the respondents' answers are recorded (Fellows and Lui, 1997).

According to Bouchard (1969) and Green and Taber (1980), the primary disadvantage of interviews is the frequently-cited effect on participants of being observed in a laboratory setting rather than in their own environment.

Questionnaires

Leedy (1993) stated that the questionnaire is an instrument, which would enable the researcher to gather data beyond his physical reach, without seeing the source from which the data has originated. According to Plotnik (1993), a questionnaire is a method employed by the researcher, whereby selected individuals are administered a series of questions. The aim of these questions is to solicit a response pertaining to the particular field of investigation, and then to compare the findings based on individuals' behavioural characteristics, attitudes and opinions, for the purpose of the particular research study.

The questionnaire is, therefore, a totally impersonal probe. Because of this impersonality associated with questionnaires, a questionnaire needs to be governed by certain practical guidelines. Firstly, according to Allison *et al.* (1996), the language used must be unmistakably clear, because what may be clear to the researcher, may be meaningless to the person being questioned. Secondly, questionnaires should be designed to fulfil a specific research objective, as questions are often inexpertly written, and this results in a low response rate.

In addition, a questionnaire can be compared to a highly structured interview between the researcher and an individual. Plotnik (1993) stated that the only difference between a questionnaire and an interview is that the respondent replies to the questions in a verbal manner in an interview, whereas in a questionnaire, the answers are written down on the answer sheet.

Fellows and Lui (1997) stated that questionnaires occur in two primary formats, as either opened or closed questionnaires. Open questionnaires are designed to enable the respondent to answer the questions fully by answering in any manner of content and to the extent of the respondent. Closed questionnaires allow the researcher to limit the number of responses.

Best (1981) stated that questionnaires may be administered by post to respondents, or to groups and particular individuals personally by the researcher. Questionnaires may also be used in more localised and intimate settings.

Moreover, according to Best (1981), questionnaires should be clear and concise, unambiguous and easy for the respondent to answer. More specifically, questionnaires should not require extensive data gathering by the respondent to facilitate answering the questions.

Advantages of Questionnaires. Erwee (1984) identified the administrative simplicity and ease of data processing characteristics of questionnaires. The structured question format is

designed to control response bias and to increase the reliability of the data. Depending on the answer a respondent offers to a particular question, the interviewer would be able to branch to the next appropriate question. Much more control can be exercised over the context within which questions are asked and answers given, and the respondent would not be restricted in any manner when answering the questions (Fellows and Lui, 1997). The respondent would also be able to check information for its validity on the basis of non-verbal cues.

According to Fellows and Lui (1997), open questions are appropriate when the researcher has a limited knowledge of the particular subject. Furthermore, motives, expectations and true feelings surface when open-type questions are asked.

Fellows and Lui (1997) stated that closed questions are processed and administered easily because they have previously been formatted and coded. Closed questions asked are exact and to the point, and therefore the responses are clear, enabling the researcher to group and quantify responses of a similar nature.

Disadvantages of Questionnaires. Since the analyst is required to interpret the response and assign it to a predesignated category, there exists a potential for a problem of errors in interpretation (Erwee, 1984). Fellows and Lui (1997) claimed that closed questions force the respondent to make artificial choices because the questions are rigidly structured. Open questions are time consuming, and therefore limit the number of questions to be asked. Responses are often incomplete and therefore difficult to analyse.

Leedy (1993) contended that all questions should be designed to fulfil a specific research objective. Aimless, careless and imprecise expressions are the most common faults that occur when constructing a questionnaire and the reason why few questionnaires are returned to the researcher.

3.3.3 Descriptive Surveys

According to Leedy (1993), the descriptive survey method, also referred to as the normal survey method, is employed to process data that are received by the researcher through observations. These data are discreet in nature and different to historical data, which are readily available to the researcher by means of written records, which have been previously documented.

The sample population for the study should be clearly and carefully defined, and specifically limited in order to set parameters. Descriptive survey methods may include verbal interviews, written questionnaires and observations (Leedy, 1993).

Leedy (1993) stated that researchers do two things when employing the descriptive survey method. Firstly, the population sample, bounded by the research parameters, is observed and closely scrutinised. Secondly, a careful record of what is observed is made for the purpose of aggregate records for the researcher to refer to at a later date. In this sense, descriptive survey research involves, in common with historical research, the study of records.

Disadvantages of Descriptive Surveys

According to Fellows and Lui (1997), descriptive survey techniques are labour intensive for the researcher as well as for the respondent. An additional negative aspect is the low response rate, notably for postal questionnaires, with a response rate of between 25% and 35% (Fellows and Lui, 1997).

Furthermore, Leedy (1993) defined a descriptive survey as utilising observation techniques as the principle means of obtaining data. However, information collected in surveys by means of observation techniques primarily, is susceptible to distortion through the introduction of bias (Leedy, 1993).

3.3.4 Case Studies

According to Fellows and Lui (1997), case studies involve a variety of data collection techniques. Unlike questionnaires and interviews where a large number of cases are researched for statistical purposes, a case study is the particular occurrence of the topic or problem of the research study.

Leedy (1993) stated that interviews and questionnaires may accompany case studies in the collection of primary data, and facilitates generalisation of the findings of the research study.

Furthermore, Cohen and Manion (1989) mentioned that, unlike experiments, which manipulate variables to determine their significance, case studies represent samples of individuals. Therefore, a case study would then typically observe the characteristics of an individual's unit, such as a house, and the purpose of such an observation would be to probe and analyse intensively the multifarious phenomena that constitute the life cycle of the unit with a view to establishing generalisations about the wider population to which that unit belongs.

3.3.5 Triangulation

Triangulation is the use of three or more research methods, such as an experiment, a questionnaire and an interview, to investigate the same aspects of a project (Fellows and Lui, 1997). As a result, the responses and findings of questionnaires and interviews of a sample of respondents would prove effective in the validity of the findings from a particular case study.

Leedy (1993) stated that triangulation attempts to gather observations through the use of a variety of sampling strategies to ensure that a theory is tested in more than one way. According to Fellows and Lui (1997), triangulation is classified as theoretical, involving the use of terms of reference when analysing sets of data. Data triangulation gathers observations using different sampling strategies. Investigator triangulation involves the use of

observers, interviewers and analysts in a particular study. Methodological triangulation is the use of two or more methods of gathering data in a study of a particular area.

The use of the triangulation method can be very powerful to gain insights and results, which would assist the researcher in making inferences and in drawing conclusions.

3.3.6 Observation Methods

The observation method has been the prevailing method of inquiry as far back in time as the earliest history of scientific activity. According to Erwee (1984), the observation process involves the recording and recognising of the respondent's behaviour.

It is rare for a research design methodology to rely solely on the observational method. In practice, observational techniques are used in conjunction with other data collection processes. However, observation techniques continue to characterise most research.

Participant Observation Methods

According to Fellows and Lui (1997), the participant observation method is employed when the observer is physically engaged in the very activities that must be observed. The researcher is regarded as part of the group he is observing, unknowing to the other participants in the group.

Non-participant Observation Methods

The non-participant method requires that the observer be excluded as part of the group being observed, and that the observer's role is known to the members of the group (Fellows and Lui, 1997).

Advantages of the Observation Method

Fellows and Lui (1997) stated that observation techniques are more reliable than experiments and surveys, as the observation may take place over an extended period of time in natural environments. As a result, more intimate and informal relationships are developed with the subjects being observed.

Disadvantages of the Observation Method

According to Fellows and Lui (1997), bias may be introduced when the researcher is the sole observer. The researcher's own values, opinions and experiences may distort the outcome of the observation.

3.3.7 Historical Research Methods

Leedy (1993) stated that historical research methodology deals with currents and counter-currents of present and past events. Moreover, the historical method looks closely at the interpretation of the facts. Therefore, the historical researcher presents facts, supported by rational explanations, rather than what events took place. It then follows that the historical researcher concentrates mainly on documentary sources.

3.4 Sampling

According to Fellows and Lui (1997), testing a hypothesis involves sampling from the population by collecting data and executing analyses. The objective of sampling is therefore to provide a practical means of enabling the data collection and processing components of the research study to be carried out, while ensuring that the sample provides a good representation of the population. Unfortunately, without a survey of the population, the representativeness of any sample is uncertain. Measurements of characteristics of a sample are called statistics, while those of a population are called parameters.

Fellows and Lui (1997) asserted that an important aspect of sampling is the determination of the size of the sample to be studied. Moreover, Leedy (1993) stated that sample size depends on the degree to which the sample population approximates the qualities and characteristics of the general population.

Fellows and Lui (1997) stated that it is necessary to obtain data from only a portion of the total population with which the research study is concerned. That part or portion of the population is called the sample. Therefore, the context of the research study indicates the population concerned with the problem.

More specifically, the first step in sampling for any research study would be to define the population. If the population is sufficiently small, a full population may be researched. However, in the majority of research projects, a sample must be taken as representative of the population.

3.5 Bias in Research Design

Fellows and Lui (1997) stated that systematic error or bias occurs in the collection of primary data, when the errors assume a regular pattern of under- or over-measurement, by a proportion or an amount. According to Leedy (1993:213), bias is defined as:

"any influence, condition, or set of conditions that singly or together distort the data from what may have been obtained under the conditions of pure chance"

Leedy (1993) asserted that bias is any influence that may have disturbed the randomness by which the choice of a sample population has been selected. All researchers must therefore be alert for the presence of bias. Bias is, however, inherent in all research.

According to Leedy (1993), bias is frequently minute and imperceptible as it infiltrates the research process. Even the most sensitive and careful researcher may easily overlook any

form of bias. Bias attacks the integrity of the facts, and it can have a particularly negative impact when it enters surreptitiously into the research system and goes undetected.

3.6 Justification for Chosen Research Methodology in this Study

The objective of qualitative research is to gain and develop understanding, discover meaning and explain phenomena, in addition to the collection of information and data. Therefore, qualitative research will enable the researcher to develop a coherent and comprehensive view of insights into affordability and acceptability of low cost housing with regard to the use of concrete block construction from the perspective of the respondents. In this light, the case study and the questionnaire survey approach, forming part of the qualitative research method, will be implemented in this research study. More specifically, the questionnaire survey method will provide a tool to gather data over and beyond the physical reach of the researcher. Furthermore, particular facets of the topic of this research study will be demonstrated through the use of a case study, which would then offer substantive support to alternative interpretations. Moreover, qualitative research methodology investigates peoples' beliefs, opinions, understanding and personal views of a particular subject being researched. This will give the researcher insight into the feelings of the end-users. The information gathered in a qualitative approach may be unstructured, but it will supply the researcher with detailed information which will enrich the content and the scope of the field of study.

3.6.1 Research Participant Identification/Selection Process

In an exercise of this nature, the sampling method employed becomes an important issue because of the fact that only part of the total population sample can be covered (Leedy, 1993). Due to the time factor, practicality, and cost, only a sample of the total population is possible. However, it is important that the sample size reasonably represents the total population with respect to the number of stakeholders in the Western Cape.

In addition, it is important to realise that the results obtained from the respondents in the various fields of construction for low cost housing for this survey may not necessarily represent the views or practices of everyone in the field of low cost housing construction. The accuracy of the sample depends upon the degree to which the respondents answered the questions. According to Landeau (1991), the minimum size of a sample is a compromise between the need for a representative size (as high as possible) and the collection and computation time (as short as possible).

To validate the problem under investigation and test the hypotheses, it was necessary to identify and select a sample of low cost housing developments, material suppliers, and low cost housing developers.

Consequent to a request for information on identifying low cost housing developments to be surveyed, Bob Louw from INCA responded telephonically. He is one of the leading experts involved in the development of concrete technology. The ensuing telephonic interview intended to identify appropriate low cost housing developments for the purpose of this particular research study. The outcome of this telephonic interview was that few low cost housing developments in the Western Cape use anything other than concrete blocks for the wall superstructure. Therefore, the findings from either 10 or 2 low cost housing developments in the Western Cape will produce similar results. This has led to the choice of only two particular low cost housing developments, namely, Bellville South and Wesbank, from project registers at developers' offices. In addition, the limited time frame inhibited a survey of a larger sample. These two developments were chosen because, although similar in construction methods used, they are vastly different in terms of size and intensity of construction which would impact strongly on the qualitative data obtained. This factor will establish in definitive terms the extent to which the use of concrete-based materials are valid in the redressing of the problems of acceptability and affordability.

The areas, namely Bellville South and Wesbank, to be surveyed were mapped out before departure to the field. On the basis of the telephonic interview with Bob Louw, it was decided

that not more than 10 questionnaires were to be conducted in a low cost housing development because of time constraints and similarities of construction material used, and no repeat visits were to be made.

The sample of building material suppliers and developers was drawn from a database compiled by the Department of the Built Environment, Faculty of Engineering at the Peninsula Technikon. The database consisted of the contact details of 12 suppliers and 10 developers throughout the Western Cape. Since it was not financially feasible to include all 22 organisations in the sample, a sample size of 3 materials suppliers and 4 developers was decided to be adequate. While it was originally intended to make a random selection from the database, it was decided to only include the largest organizations that were listed in the database. This list comprising of 7 organisations made up the sample frame. Every organisation in the sampling frame had an equal chance of being selected.

3.6.2 Use of Questionnaires and the Case Study

With the decision to use questionnaires as one of the main sources of data to be collected, the merits and demerits of this method needed to be considered. As a research tool, a questionnaire is subject to various limitations from several sources, namely, social desirability, anonymity, and socio-economic and educational differentials. These limitations were considered during the questionnaire design. Therefore, respondents were not required to state their names, and they were assured that the results of the survey were going to be used in aggregate form. Questionnaires were designed to reflect appropriate levels of the respondent's understanding.

Very little response is expected from postal questionnaires, as enquiry revealed that affixed stamps are kept for private use, and that low income communities will not use their own funds to return a questionnaire. The questionnaires were therefore administered personally to a selected group residing in the area to be studied, as well as to material suppliers, designers and contractors of low cost housing.

Non-response to mailed questionnaires is a significant factor that seriously limits the generalization of findings from any study using the questionnaire as a primary data-gathering instrument. For the above reason, a face-to-face method was used. However, several problems were met with this method. In both low cost housing areas, visits could only be made during the morning and midday for security reasons. It was considered unsafe to visit these areas earlier than 09:00 when there are not many people about, and later than 18:00 when most people would have been indoors. This may have introduced some bias to the study given that only certain people in certain households and at certain times of the day could be questioned.

Furthermore, in a situation where other forms of communication such as telephones are limited or non-existent, a questionnaire survey remains the most effective method of data gathering. In order to address this problem, another method of data gathering was used, namely the case study, as a supplement.

In addition, the use of a case study will allow the researcher to focus on a specific issue, such as affordability, and identify interaction processes between the developers and the end-users as they occur. Moreover, qualitative approaches, such as case studies, will seek to gain insight and understanding of peoples perceptions as individuals or as a group, regarding issues of acceptability and affordability of concrete houses.

To eradicate any expected bias, questionnaires need to be well designed, planned and distributed within a short period of time. The questions will be arranged in a sequence to facilitate responses so as to minimise any bias. Furthermore, the response level of the questionnaires will not be less than those obtained from the case study, and in this way, any bias will be further reduced. The questionnaires will help to generate primary data in a format, which will be easy to process and analyse.

Finally, the results of the analysis of the case study and questionnaires will identify the future use of concrete in low cost housing construction as a means of providing affordable low cost housing which is acceptable to the end-users.

3.7 Conclusions

In this chapter, the research methodology, namely the case study and questionnaire survey, that were used to gather data regarding affordability in terms of developers' building cheaper houses which is affordable and acceptable to the end-users, were outlined. The administration of the questionnaires used to gather data regarding affordability and acceptability of low cost housing was described. Additionally, the sample selection and questionnaire administration processes were outlined.

In the next chapter the findings of the questionnaire survey are presented and analysed.

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CHAPTER 4

FINDINGS AND ANALYSIS OF THE QUESTIONNAIRE SURVEY

4.1 Introduction

Chapter Three reviewed different research methodologies in detail, with specific emphasis on characteristics, advantages and disadvantages. An appropriate method, namely a case study in conjunction with a questionnaire survey, was then chosen for the purpose of substantiating the problem as well as testing the hypotheses of this study, based on the effectiveness for this particular research.

This chapter describes the design of the questionnaire survey instrument developed to collect primary data and how it was used to substantiate the problem as well as test the hypotheses. It is therefore the aim of this section of the project to carry out a questionnaire survey to establish the opinions and views of the various stakeholders with regards to affordability and acceptability of concrete low cost housing. In addition, photographic evidence has been used to highlight the types of low cost houses being built.

From the foregoing arguments it is intended that this study should attempt to provide a basis on which others can build by understanding affordability in terms of the costs incurred by the developers, as well as affordability in terms of purchasing power of the end-users of low cost housing.

4.2 Questionnaire Design

One of the primary concerns in a questionnaire design is the degree of structure imposed on the interviewee's responses. Therefore, open-ended questions were used.

4.2.1 Open-ended Questions

Respondents were given an opportunity to provide their own answers to questions. Firstly, these questions were included because the author did not anticipate replies from respondents on certain issues, such as income levels. Secondly, these questions were included in order to provide insights, side comments, and explanations in order to develop a 'feel' for the research findings on various aspects of the study.

4.2.2 Questionnaire Length

According to Leedy (1993), shorter questionnaires are usually completed more often than longer ones. Within the context of what the questionnaires were designed to establish, this factor was considered in establishing the final draft of the questionnaires.

4.2.3 Questions

Since the delivery of affordable and acceptable low cost housing is directly related to the business future of construction firms and developers, in terms of procuring more projects, and hence business survival, controversial questions, namely questions asking respondents to reveal confidential details of their business, were avoided.

Homeowners. In order to evaluate homeowners responses on particular issues which were established from the literature review (Chapter 2) in terms of their preferences and affordability regarding concrete block construction used for low cost housing, a questionnaire was designed (see Appendix I).

Table 4.1 shows the main question areas for homeowners. Each question was structured to attract responses on factors, which were considered to identify their preference to materials usage and establish whether the current methods of construction are affordable and acceptable.

Materials Suppliers. A questionnaire (see Appendix II) was designed to establish materials usage for low cost housing. Table 4.2 shows the material suppliers' main question areas.

Developers. Based on the standards prescribed by the National Home Builders Registration Council, whereby low cost housing should be constructed using 140mm concrete blocks of 3.5 MPa for the wall structure, it was necessary to design a questionnaire (see Appendix III) for randomly selected Developers of low cost housing. Table 4.3 shows the main question areas of this questionnaire.

Table 4.1 Homeowners Questionnaire Survey Synopsis

Question Areas	Number of Questions
Preferences (e.g., type of construction material)	1
Knowledge of construction	1
Satisfaction levels	1
Major quality problems	3
Construction materials and methods	4

Table 4.2 Material Suppliers' Questionnaire Survey Synopsis

Question Areas	Number of Questions
Experience of respondent in current responsibility	1
Construction materials and methods	3
Affordability	1
Acceptability	1
Major quality problems	1

Table 4.3 Developers' Questionnaire Survey Synopsis

Question Areas	Number of Questions
Experience of respondents in current responsibility	2
Construction materials and methods	3
Affordability	2
Sustainability	1
Major quality problems	3

4.2.4 Anonymity

Persons are more likely to respond to a questionnaire where their anonymity is maintained or guaranteed. A statement was included as the first section of each questionnaire guaranteeing the anonymity of respondents.

4.2.5 Variables Measured

The variables measured were those that describe the physical structure of low cost houses. While these variables, for example, wall structure, as an indicator of housing delivery and conditions, affordability and acceptability, are consistent with previous studies, they have been conditioned to apply to the housing condition in South Africa, especially the Western Cape.

Moreover, homeowners' ability to make rational decisions about construction materials and technology cannot be measured accurately. Consequently, the variables measured were those earmarked to highlight affordability and acceptability of low cost housing and the extent and impact of these conditions on concrete block construction.

4.3 Findings of the Questionnaire Surveys

For the exact wording of the questions, reference should be made to the appropriate questionnaire in **Appendices I – III**. Questions, referred to below, are specific to a particular group of respondents (e.g., Developers, question number 1).

Thus, the following response rates refer to individual response rates, which were received for different questions. In general, the percentages associated with various forms of opinion are given. Hence, unless otherwise stated, where the term 'respondents' is used, it refers to item respondents as opposed to the overall response rate of the survey.

4.3.1 Response Rates

All the respondents replied immediately upon personally receiving the respective questionnaires which were hand delivered by the researcher. Thus an overall response rate of 100 % was achieved for the questionnaire survey. This is depicted in Table 4.4.

Table 4.4 Response Rates

Description	Total Actual Sample	Total Responses
Homeowners	20	20
Material Suppliers	3	3
Developers	4	4
Total	27	27

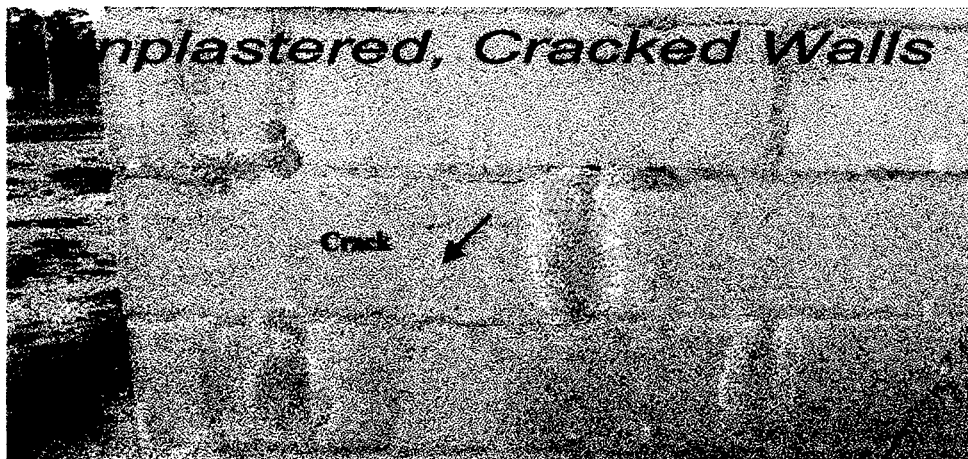
4.3.2 Photographic Survey

Photographic evidence was used to highlight the types of low cost housing which exist for the purpose of this research project. The photographs were taken to depict the construction material used for the wall superstructure of current low cost housing.

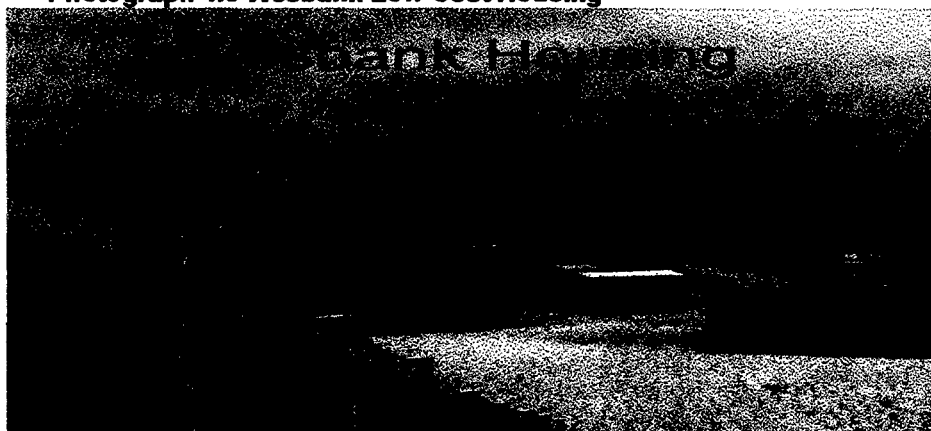
Photograph 4.1 Low Cost housing in Bellville-South



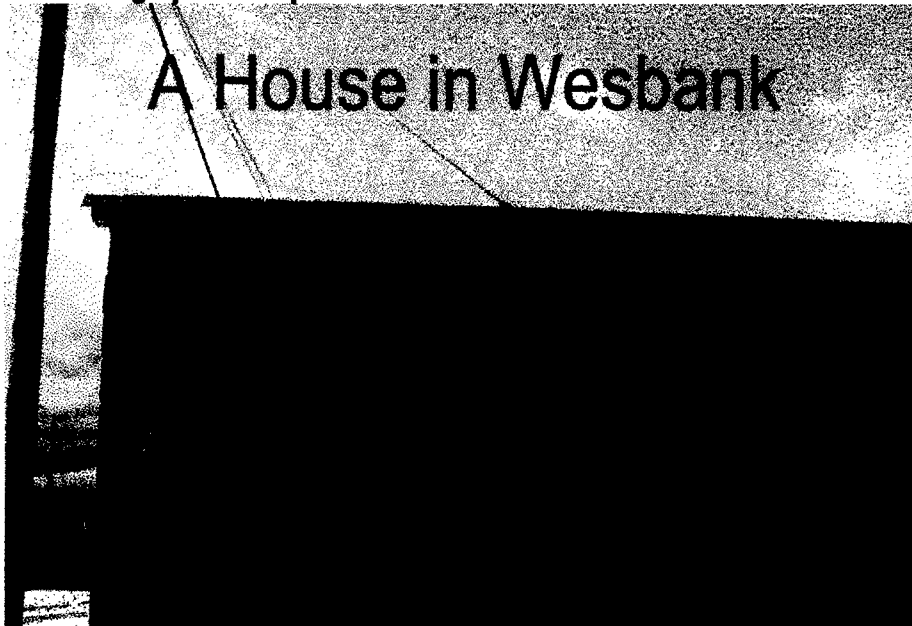
Photograph 4.2 Wall Structure



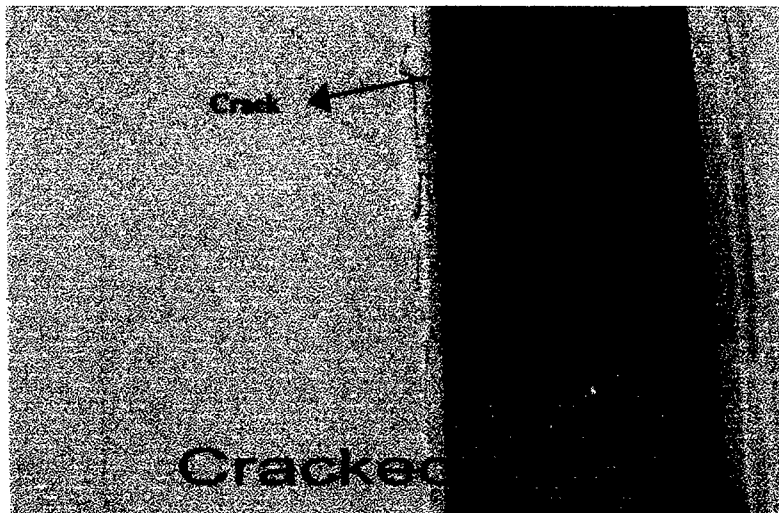
Photograph 4.3 Wesbank Low Cost Housing



Photograph 4.4 Unplastered Wall Structure



Photograph 4.5 Unplastered, Cracked Wall Structure



Generally, the photographs show evidence of concrete block construction. The particular problems observed in these houses include cracked wall structures. The foundations were generally found to be exposed.

As the dampproof course is laid between the foundation and the brickwork, this should prevent rising damp. Cracks and damp were, however, visible in almost every household, internally and externally. The cracks appear to be the normal cracks which are expected in any masonry work of this nature.

4.3.3 Homeowners Responses to the Questionnaire Survey

See Table 4.1 for the details relating to the questionnaire survey synopsis of the homeowners' questionnaire. The total number of homeowners questioned was 20. Ten homeowners were visited in the morning, and the other ten were visited in the afternoon. Eighteen of the respondents were women.

Question 1: *Where have you resided previously and in what type of structure? (E.g. Timber, corrugated iron)*

Sixteen of the respondents had previously lived in informal settlements before acquiring a formal low cost house. These sixteen respondents reported that their houses in the informal settlements were constructed from materials such as wood, corrugated iron, asbestos sheeting and even plastic sheeting, that is anything that provided shelter against harsh weather conditions and offered protection. These sixteen respondents stated that concrete block houses are a major improvement on their previous houses, but they feel that improvements to their existing house structures are possible. They also reported that they felt safer in a concrete block house. The physical characteristics of informal houses, based on information obtained from the respondents, are presented in Table 4.5.

Table 4.5 Physical Characteristics of the Wall Structure of Informal Houses

Construction Material	Frequency
Concrete Blocks	4
Asbestos	1
Corrugated Iron	7
Wood	6
Plastic Sheeting	2
Total Number of Respondents	20

The 4 respondents, who reported that they did not reside in an informal settlement but in concrete block houses before acquiring their present house, were not the owners of those houses. In most cases these respondents rented or stayed with family or friends.

Evidently, 5% of respondents in the survey had resided in asbestos houses, 35% were of iron sheets, 30% were wood built houses, and 10% of plastic sheeting. This is indicative of the need for affordable, yet acceptable low cost housing, for example, concrete block construction.

The present housing conditions, as perceived by homeowners, vary. Generally, most of the respondents find their houses unsatisfactory in terms of space and privacy. They are, however, in favour of concrete block construction being used for their houses. Table 4.6 shows that 5% of the homeowners agree to be living in houses that are in a 'good' condition. Thirty percent find their houses in an 'average' condition, 50% live in houses that are considered 'unsatisfactory', while 15% considered their houses to be in a 'bad' condition. These responses were based on the respondents' feelings due to inadequate space and lack of privacy in their houses. They are also unhappy about the lack of a back or front yard due to the houses being very close to each other. It is significant that more than 50% of the respondents were unhappy with respect to the spatial arrangements of their houses, but were satisfied with regards to the actual structure.

Table 4.6 Housing Conditions

Number of Homeowners	Housing Conditions
1	Good
6	Average
10	Unsatisfactory
3	Bad

Question 2: *When did you purchase your present house?*

Question 2 sought to determine the age of the dwelling in order to assess how soon after acquiring the houses, the respondents became aware of any problems. Six of the 10 residents questioned from one of the low cost housing schemes stated that they had purchased their new homes two years ago. The remaining 4 respondents are renting. All of the houses are already in desperate need of repairs and maintenance in terms of roof sheets and window and door frames. The damaged roof sheets and broken window and door frames appear to be due to vandalism more than structural reasons. The cracks in the walls were observed to be hairline cracks but the actual walls appeared to be structurally sound.

Eight of the other ten residents residing in another low cost housing scheme reported that they had purchased their new homes three years ago. Two respondents are tenants. The same problems were observed as in the previous 10 residents questioned.

Question 3: *Have you experienced any serious technical problems with the quality of your house? (E.g. Wall failure, major cracks and leaks)*

To establish what homeowners considered being major problems concerning quality, respondents were asked to list the major quality problems. The results of the questionnaire survey are shown in Table 4.7.

Table 4.7 Major Quality Problems

Problem	Percentage
Cracking of wall structures	100%
Damp	85%
Thinness of wall structures	60%
Loose and broken fixtures	35%

Two problems are considered to be dominant among all the respondents questioned. These are cracking of walls and the appearance of damp due to exposed foundations or lack of dampproof courses, and the fact that there are openings at the intersection between the roof and the walls. Both these problems became evident very soon after the respondents moved into their homes. The cracks are fine mortar cracks which are to be expected in any masonry construction. The damp appears to be emanating from the ground in some cases and from the roof structure in other cases.

Eighteen of the residents reported that the wall cracks are due to the poor quality of construction materials used, and that the appearance of damp is to be expected because the walls are not plastered. Another problem that 12 of the respondents noted was that the walls are too thin as in most cases the external walls were observed to be only one layer thick.

Question 4: *How long after purchasing the house did any technical problems arise?*

All the respondents reported that the above technical problems became evident within the first three months of purchasing their new homes.

Question 5: *What is your knowledge of building houses?*

An attempt was made to establish the respondents' knowledge of house construction. The respondents all reported that they had no formal or technical knowledge regarding building houses, but that they would still like to choose the shape or design of their house, as well as the materials used to construct their houses. They felt that this was a way of personalising their homes, as they did not like the way that everyone's house looked the same.

Question 6: *Did you have a choice in the type of material used to build the wall structure?*

An attempt was made to establish the type of construction material respondents preferred for their homes. All the respondents preferred concrete block houses. They stated that concrete is solid and permanent. The respondents reported that concrete is an extremely strong and durable material, and that the poor quality of their houses was due to bad workmanship by the contractors who are only concerned with speedily delivery of houses, with no concern for the families who would live in them eventually.

Question 7: *If yes, why did you choose this particular type of building material?*

None of the homeowners had a choice in the type of construction material used to construct their homes. The respondents did, however, report that they would most likely choose concrete block construction after the researcher informed them about other methods of construction using clay bricks, timber, steel or adobe.

Question 8: *If no, do you know what type of building material was used to construct your house?*

All the respondents reported that their walls were constructed using concrete blocks.

Question 9: *Are you satisfied with the construction material that was used to construct the wall structure?*

All the respondents reported that they were satisfied with the construction materials used for their homes. They were, however, concerned with the workmanship of the wall structure.

Question 10: *Do developers provide affordable quality low cost housing?*

Twelve of the respondents reported that developers provide affordable low cost houses, but of a poor quality. These 12 homeowners defined affordability as being able to afford their monthly bond installment on their new house as well as being able to provide food and education for their families. However, the poor quality of their homes resulted in additional costs over the life cycle of the house.

The remaining 8 respondents reported that their houses are not affordable as their income is too meagre for bond repayment, service charges, as well as daily living expenses. These respondents are on the verge of losing their homes.

4.3.4 Summary of the Findings from the Homeowners' Questionnaire Survey

It is apparent from the findings from the Homeowners' questionnaire survey that the end-users are satisfied with the construction material used for the wall structure of their current houses. They are, however, dissatisfied with the workmanship of the construction, as they feel that the problems, such as cracking and damp, are due to hurried and incomplete construction. The end-users are aware that the wall structures are not plastered, but only bagged. Even without any formal or technical knowledge of building houses, they state that they should be involved in the planning and construction stages of their new homes with regards to funding and appearance in order to make these homes more affordable and acceptable. Without any technical knowledge of

concrete technology, the respondents felt that concrete blocks were the most acceptable form of construction material available for the wall structures because of its strength and durability.

4.3.5 Materials Suppliers' Responses to the Questionnaire Survey

This questionnaire survey was administered to 3 Materials suppliers' in the Western Cape.

Question 1: *What is your length of experience (in years) as a supplier of construction materials?*

The respondents have construction experience of between ten and twenty years. From this, it can be deduced that material suppliers appear to be highly experienced in the construction business.

Question 2: *Do you supply construction materials for low cost housing?*

This question sought to determine whether the materials suppliers' supplied material for low cost housing construction. All the respondents questioned reported that they supplied concrete blocks, timber for trusses and window frames and many other materials required for the construction processes of housing in general.

Question 3: *If yes, what types of construction materials do you supply and what is the most common type?*

The majority of materials suppliers reported that they supplied contractors with concrete blocks for wall construction, timber for roof trusses, door and window frames, as well as asbestos and metal sheeting for roofs of low cost housing. One material supplier, who only specialised in concrete, supplied concrete lintels, vents and trestles for low cost housing. Their general

response was that concrete blocks are the most commonly used construction material for wall construction in low cost housing because they are cheap and easy to build with.

Question 4: *Please indicate the technical problems related to low cost housing built with concrete blocks.*

Materials suppliers reported that the technical problems concerning quality are associated with the poor manufacture of concrete blocks rather than poor workmanship on site. This contrasts with the responses received from the homeowners, who stated that poor workmanship was the cause of their dissatisfaction.

Another serious problem as perceived by the material suppliers, which is evident in most wall structures of low cost housing, is cracking of walls. The materials suppliers reported that this was due to the concrete foundations not being cured for the correct period of time. The foundation is cast and the wall structure is started the very next day because the contractors are only concerned with the number of houses to be built and not concerned with the quality of the houses they produce. This speedy delivery and insufficient curing time usually gives rise to rising damp in the wall structure. Another interesting factor, which also gives rise to damp, is the fact that these walls are not plastered, but only bagged.

Question 5: *Are concrete blocks readily available as construction materials?*

All the materials suppliers agreed that concrete blocks are readily available as construction materials. Materials suppliers reported that concrete blocks have been in use for forty years, and will continue to be readily available in the future.

Question 6: *Is concrete block construction the cheapest method of construction available for low cost housing?*

All the materials suppliers reported that concrete block construction is the most affordable form of low cost housing construction because of the ease of construction as well as saving on construction time because the concrete block is a large unit. This is due to the fact that concrete blocks are larger than conventional bricks and therefore requires less labour as the labour rates in the Western Cape are higher than in any other province in South Africa. Concrete block construction is an established form of construction and does not require additional or new training. In addition, because concrete block units are larger than bricks, fewer units are required.

Question 7: *Is concrete block construction an acceptable option for the end-users of low cost housing?*

Respondents reported that concrete blocks are acceptable to the end-users, provided the manufacturing process can be monitored more effectively so as to ensure that the standards, as set out in SABS 1215 and SABS 0400, are adhered to. The respondents stated that houses built forty years ago are still structurally sound, and therefore concrete blocks will still be used for construction purposes in the future.

4.3.6 Summary of the Findings from the Materials Suppliers Questionnaire Survey

It is apparent from the findings from the Materials Suppliers questionnaire survey that the most commonly used construction material for the wall structures of low cost housing, and housing in general, is concrete blocks. However, the materials suppliers feel that the manufacturers of concrete blocks are not producing good quality blocks, which are resulting in problems such as cracking and the appearance of damp. Materials suppliers stated that concrete block construction is an affordable option for low cost housing because the unit is bigger than the conventional brick, and therefore less units are required to build a house. Using less units would then result in more houses being built.

4.3.7 Developers' Responses to the Questionnaire Survey

This questionnaire survey was administered to 3 Materials suppliers' in the Western Cape.

Question 1: *What is your length of experience (in years) in building low cost housing?*

The respondents' construction experience ranged from 5 to 20 years.

Question 2: *What types of low cost houses have you built?*

The respondents have designed and built low cost housing units ranging from 20 m² with no internal walls to 50 m² units comprising a kitchen, bathroom, living room and a bedroom.

Question 3: *What construction material was used for the wall structure?*

All the developers reported that they constructed walls of concrete blocks. One developer reported that his company uses a concrete block cavity wall for the external walls and a single concrete block wall internally, depending on the cost that was allowed for each house in a particular development.

Question 4: *What is your knowledge of concrete as a construction material?*

All the respondents stated that concrete blocks are always their first choice as a construction material because of their durability in low cost housing construction. Concrete block construction allows the contractors to use less material, because they are hollow, as well as unskilled labour.

Question 5: *Is concrete block construction the most affordable method with which to build low cost houses?*

The respondents all stated that concrete blocks are affordable in terms of fewer blocks being required per house. The time taken to build with blocks is therefore shorter than building with bricks which are smaller in size than the concrete block. No expenditure is required for training of labour. Concrete block houses can be maintenance free because of their proven durability as can be seen in houses which had been built thirty and forty years ago.

Question 6: *Is concrete block construction an acceptable method of construction for low cost housing in terms of the end-users needs?*

Sixty-six percent of the developers questioned agreed that if the concrete blocks were manufactured according to the standards, the end product would be everlasting and cheaper in terms of maintenance costs. These developers stated that manufacturers are producing poor quality concrete blocks to save on costs, and that houses built with these blocks would need maintenance work.

However, one developer in particular reported that well-known manufacturers of concrete blocks produced good quality blocks.

Question 7: *Does your company make use of any alternative methods of construction using concrete for low cost housing? (E.g.: No-fines concrete, foamcrete)*

None of the respondents who were questioned used any alternative methods of construction. The main reason was that homeowners prefer a solid house made with some form of blockwork. Developers cannot afford the expense and time needed for experimenting with new construction methods as the demand for the delivery of low cost housing is just too great. Low-income communities are even more wary of houses built with alternative materials and methods, as they want houses that look and 'feel' the same as other houses.

Question 8: *Would you implement alternative methods of concrete construction if they were cheaper and more durable than concrete block construction?*

None of the developers was prepared to spend time and money investigating alternative methods. However, they are prepared to implement alternative materials and methods of construction if they prove to be more cost-effective than the conventional concrete block construction.

Question 9: *Has your company had any comebacks from dissatisfied homeowners who have concrete block low cost housing?*

Respondents reported low incidences of dissatisfied homeowners and that technical problems are rare.

Question 10: *What were the reasons for their dissatisfaction?*

According to the respondents, if problems arise, it is usually not structural or technical. In most cases the common problems experienced are cracked roof tiles, normal soil settlement, swelling of doors and blistering of paintwork.

Question 11: *What was done to rectify the problem?*

According to the respondents, the problems are rectified individually and as soon as possible.

4.3.8 Summary of the Findings from the Developers Questionnaire Survey

It is apparent from the findings from the Developers questionnaire survey that the most commonly used construction material for the wall structures of low cost housing, and housing in general, is

concrete blocks. However, the developers agree with the materials suppliers that the manufacturers of concrete blocks are not producing good quality blocks, which are resulting in problems such as cracking and the appearance of damp. Developers of low cost housing stated that concrete block construction is an affordable option for low cost housing because the unit is bigger than the conventional brick, and therefore less units are required to build a house. Using less units would then result in more houses being built. In addition, the end-users are satisfied with concrete block houses.

4.4 Discussion of Results

It is evident that homeowners prefer concrete block construction as it gives the appearance of a 'conventional' house. Homeowners are aware that concrete is a durable building material which offers protection against harsh weather conditions as well guarding their valuables and keeping them safe. Furthermore, homeowners maintain that the problems associated with their houses are due to bad workmanship rather than the actual construction material, unless poor quality concrete blocks have been used. Moreover, the homeowners reported their dissatisfaction with the similarity of low cost houses in the same development in terms of shape, finishes and colour. Very importantly, low-income communities are not prepared to sacrifice quality for affordability, as they know that it will cost them even more in the long term due to repairs and maintenance.

It would have been futile asking for the income levels of these households, as this would have inferred that it was their choice to live in such unacceptable conditions. It was noted that households' assets were limited to the barest necessities, highlighting the futility of asking questions about income levels. However, it was noted that household possessions tend to be greater in better houses. These infer that households living in cement and concrete block houses command higher income levels and are able to acquire more assets. Alternatively, it could be that households in houses built from less durable materials might delay consumption of conspicuous assets for security reasons.

It appears from the analysis of the results, however, that certain developers could be using concrete blocks manufactured by backyard operators, resulting in maintenance and repairs to the low cost houses built with these blocks. Therefore, developers and contractors should use concrete blocks manufactured by well-known and reputable manufacturers. In addition, according to one developer, concrete blocks are not tested on site.

The developers stated that the main reason for the similarity in houses built in the same scheme was due to the limited expenditure that is allocated to each unit in a low cost housing development, which in turn restricts any innovations in the design of the low cost house. This also verifies that homeowners do not have choices in the design and construction of their homes. Moreover, this depicts that low-income communities do not choose to live in such unacceptable conditions.

Material suppliers questioned appeared to be highly experienced individuals within their areas of expertise. Material suppliers stated that concrete blocks are cheap compared to bricks and will always be readily available, provided that the manufacturers maintain the required standards for the concrete blocks. Alternative methods of construction for low cost housing would require the additional expenditure of labour and training costs, as concrete block construction is a well-known form of construction used by all contractors.

The developers agree that concrete is a readily available construction material and still has many uses in the future of construction. The ingredients of concrete, such as, sand, cement, stone and water, are in abundance, and they do not see a shortage in the foreseeable future.

Concrete blocks must be manufactured according to the South African Bureau of Standards, codes SABS 1215 and SABS 0400. These standards set specifications for the materials used to manufacture the concrete blocks. The required strength for a 140 mm concrete block is 3.5 MPa, but this is the least important factor which should be considered. The strength of concrete blocks

is considered only when handling the blocks on site. The important properties of these concrete blocks are their finished texture and appearance. This is a result of low cost houses not being plastered, or even bagged, as the cost of plastering and bagging is too expensive.

The material suppliers agreed with the developers that the contractors of low cost housing prefer concrete blocks, as the concrete blocks are cheaper and faster to build with than smaller bricks. This is due to the concrete blocks being hollow, which results in less material being used to manufacture the blocks. The concrete block is also much bigger than the brick, and this means that fewer blocks than bricks are required to build a low cost house. It is then evident that a saving in material costs of low cost housing, results in a saving in the total cost of the house.

Further questions relating to the affordability of low cost housing were generally supportive of concrete block construction. Developers would, nevertheless be willing to use alternative methods of construction, provided that the new method is acceptable to the low-income communities and is more affordable than concrete block construction.

The material suppliers questioned all agreed with the homeowners as to the technical problems concerning quality, such as cracking and damp, associated with low cost housing. They also stated that the problems experienced by homeowners after moving into their homes are a result of hurried construction, where the concrete foundation is not given enough time to harden sufficiently and cure. As a result, cracks and settlement occur due to poor workmanship and not poor quality of construction materials and methods employed.

Therefore, one of the major reasons for maintenance with respect to the durability of the low cost houses built using concrete block construction identified in this survey stemmed from poor construction and site practices. The material suppliers and homeowners agreed that quality of site work was inadequate and was probably the major cause of maintenance being required.

The developers, however, disagree. The cracks are surface cracks, which generally occur in any form of masonry construction. All low cost housing has dampproof coursing installed, but no waterproofing. It must be noted that concrete is a porous material, which does allow moisture and gases to migrate through the material.

The majority of the material suppliers questioned are aware of new and alternative methods of construction using concrete, but stated that contractors are not using these methods for fear of failure and unacceptability to the end users. However, material suppliers do admit that limited knowledge exists on alternative methods of low cost housing construction and would encourage its use if more information were made available.

The developers, however, stated that no alternative method of construction for low cost housing is as effective and efficient as concrete block construction. This is due to, as stated previously, the ease of construction, no training being required, less concrete block units being required than bricks, and concrete's durability and proven performance in the construction industry. According to the general information discussed in Chapter one and Chapter two, this is true. Finally, it appears that all low cost houses in the Western Cape are currently being constructed using concrete block construction.

4.5 Conclusions

The purpose of this chapter has been to document the results and analysis of a questionnaire survey into the current practice of concrete block construction for low cost housing in the Western Cape, with respect to affordability and acceptability by the end-users.

The analysis above highlights the effectiveness of concrete block construction for low cost housing in terms of :

- (a) The attributes of concrete block construction, namely, affordability, speedy delivery and acceptance by the low-income communities.
- (b) The attributes named above, which are important to the housing needs of South Africa, and more specifically the Western Cape, because of the high employment rate and the growing population.
- (c) Contractors producing more units due to the ease of construction and durability of concrete blocks.
- (d) Concrete blocks being larger than conventional bricks which results in the use of less materials for the wall superstructure, and in turn, this results in a reduction of the cost of the house.

Finally, the findings in this chapter validate the analysis presented in Chapter 2, where the provision of low cost housing was shown to be a major problem, as well as highlighting the economic characteristics of households.

In conclusion, it has been established that concrete block construction is being used extensively for low cost housing in the Western Cape.

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CHAPTER 5

FINDINGS AND ANALYSIS OF THE CASE STUDY

5.1 Introduction

This chapter reports the results of a case study undertaken in order to supplement the findings of the questionnaire survey reported in Chapter 4.

5.2 Use of a Case Study

Consequent to a request for information on identifying a low cost housing development to be surveyed for the purpose of the case study, Professor Mark Alexander, head of the department of Civil Engineering, Faculty of Engineering and the Built Environment, University of Cape Town, responded in an interview. The ensuing interview intended to identify an appropriate low cost housing development for the purpose of this particular case study. The outcome of this interview was that a low cost housing development was completed in the Westlake area, near Muizenberg on the Cape Flats, where the end-users were involved in the design and construction phases of the project. This factor will establish in definitive terms the extent to which the end-users are satisfied with the final product, as well as determine the affordability in terms of purchasing power of the end-users.

In the questionnaire survey, fairly current construction was targeted in order to comparatively analyse the factors of concrete in terms of acceptability and affordability. Westlake housing development was chosen, as it would show, in real terms, the effects of the deployment of the same construction method, namely, concrete block construction. This rationale will afford the possibility of establishing the longer term benefits, or otherwise, of concrete as an acceptable and affordable construction material. This, according to Tipple (1994), is a suitable method of investigating problems within low cost housing.

The case study carried out entailed a site visit to the Westlake low cost housing development, where the author observed various aspects pertaining to the construction materials used, as well as establishing the end-users perceptions regarding the affordability and acceptability of their current homes.

The observation method was also used in gathering information through the case study. The author observed various construction materials and methods that were used. The merits of this method are that it does not rely on the respondents' willingness to provide the desired data. Secondly, the potential bias caused by the questionnaire survey is reduced or eliminated.

5.3 Findings of the Case Study

The case study is described and analysed, covering the main issues affecting affordability and acceptability with regards to concrete block construction which were established in Chapter Two and incorporated in the hypothesis.

5.3.1 Project Description

The Westlake housing project involves a public ownership and a private partnership between the former South Peninsula Municipality and a joint venture between Cavcor and Rabie Property Developers. This joint venture was initiated in 1997. The partnership involved the construction of a low cost housing development, together with a light industrial complex for the local community of an informal settlement.

The former South Peninsula Municipality provided the funding of approximately R 1.1 billion which was required for the development. Cavcor and Rabie Property Developers were responsible for the development of 100 hectares of land situated in the Westlake area. The actual development was then contracted to Power Developments who specialise in low cost housing developments. The development was expected to accommodate 700 informal

settlement inhabitants, as well as create jobs for these eventual residents of the Westlake housing project.

The main objective of the partnership was to create a holistic and community-centered consultative approach in order to implement a development plan for Westlake, which would benefit all the residents of the entire Westlake area.

Due to the labour-intensive nature of the project, labour was recruited from the local community. The community was therefore trained in the basic skills that would enable them to build their own homes.

5.3.2 Homeowners' Comments

The ten homeowners questioned, all of them female, reported that their houses were built with concrete blocks. All of the respondents find their houses satisfactory. They would not opt for concrete inside their home for uses other than the wall structure, foundations and floors, because they want the same finishes as other houses. The major technical problems that have occurred, or are currently occurring, are dampness around the window openings and blistering of the paintwork. The residents of Westlake have noted no major structural defects.

The author observed fine cracks on the external walls of most houses. They appear to be emanating from the lintels situated above the window and door openings, and then follow the joints between the concrete blocks. The external walls have not been plastered, and the author observed that the walls have been bagged. In all other respects, the houses appear to be structurally sound.

The residents of Westlake are proud owners, and this is largely due to the fact that many of them participated in the building of their homes.

5.3.3 Developers' Comments

One of the developers (Rabie Property Developers) was asked about the construction materials and methods used in the Westlake housing project. They referred the author to the company that was responsible for the construction, namely Power Developments, who were also responsible for the actual design and construction of the Westlake housing project. Power Developments informed the author that they build low cost housing using concrete block construction because it is the cheapest method. More units can be constructed with concrete blocks than with bricks. The representative stated that the concrete blocks used by their company are of the highest quality.

The representative was not too eager to discuss alternative methods of construction using concrete as he stated that he is not qualified to give details about new methods that are being developed. He was aware of other alternative methods of construction that had been used before, such as asbestos sheeting and precast concrete panels, but stated that concrete block construction is far superior to those methods in terms of affordability, durability and acceptability by the homeowners. Many of those houses do not exist anymore, whereas houses built with concrete blocks more than ten years ago are still standing. The representative added that concrete would always be readily available because the ingredients of concrete are natural resources.

When asked to explain the reason(s) behind choosing concrete block construction among other options, the representative stated that although the range of construction methods is increasing for low cost housing, the Western Cape public building sector does not have any formal approach of choosing between these methods. According to the representative, this could be due to the limited literature regarding these alternative methods of construction.

The representative believed that designers and contractors of low cost housing would use alternative methods if they prove a more affordable option to concrete block construction since the material costs make up the bulk of the construction costs in low cost housing.

5.4 Conclusions

The purpose of this chapter has been to document the results and analysis of a case study into the current practice of concrete block construction for low cost housing in the Western Cape, with respect to affordability and acceptability by the end-users.

In conclusion, it has been established that:

- (a) Concrete block construction is being used extensively for low cost housing in the Western Cape.
- (b) Concrete block construction is the preferred method of construction for low cost housing by the contractors and the end-users with regards to affordability and acceptability.
- (c) Concrete block construction is the cheapest method of construction.
- (d) Houses built using concrete blocks are durable.

5.5 Chapter References

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CHAPTER 6

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

6.1 Introduction

This thesis examines the appropriateness of concrete block construction for low cost housing with regard to affordability, in terms of delivery by the contractors and purchasing power of the end-users, as well as acceptability of concrete block construction by the end-users.

The objectives of this study are to:

- (a) Investigate trends in the use of construction materials in the superstructure of low cost housing through a literature review.
- (b) Establish what current methods and materials are used for low cost housing construction in the Western Cape by means of a questionnaire survey.
- (c) Establish the end-users satisfaction levels with regard to the use of concrete block construction by means of a questionnaire survey.

6.2 Summary of Findings

In Chapter One the purpose of this research study is discussed, and the subject of concrete block construction as an affordable and acceptable method of construction for low cost housing introduced. The current status of affordability and acceptability of low cost housing is identified. It is concluded that current low cost housing is still unaffordable to the poorer communities. In addition, the end-users of low cost housing are dissatisfied with their houses. More specifically, the need for affordable low cost housing in South Africa is identified

because of the high unemployment rate and the growing population. Concrete block construction, as an affordable and acceptable method of construction, is advocated.

Chapter Two provides an overview of the current types of construction materials used for low cost housing in South Africa. It is shown that the needs of the very poor in conjunction with the needs of the contractors of low cost housing have not been addressed in terms of affordability and acceptability. The ongoing political pressure on the government to overcome the housing backlog has resulted in significant pressure on housing delivery organizations to rapidly deliver large numbers of houses at the lowest possible price. In terms of affordability, the lowest possible price usually results in the use of cheaper construction materials, where contractors are given a predetermined budget within which they must produce a certain number of units, which in turn, determines the cost per unit. This usually results in the use of cheaper construction materials as material costs make up the bulk of construction costs. It is concluded that this pressure has superseded quality and acceptability considerations, which in the long term may result in dwellings that are only marginal improvements on the existing shacks.

Chapter Three describes the research methodology best suited to address the problem of affordability and acceptability of low cost housing. The case study and questionnaire survey method were chosen to gather data regarding affordability in terms of contractors' building cheaper houses which is affordable and acceptable to the end-users.

Chapter Four documents the results and analysis of the questionnaire survey to developers, contractors, material suppliers and end-users of low cost housing. Affordability, from the viewpoint of the contractors, is examined in terms of the construction materials used for the wall superstructure, which makes up the bulk of the costs of any house. It is concluded that the cost of a low cost housing unit in a development is determined as a result of a predetermined budget, or by the number of units required within this budget. This cost does not take into account the earning power of the end-users of low cost housing. The end result is that the end-users cannot always afford the houses. In addition, it is concluded that

concrete block construction is the cheapest form of construction for low cost housing due to its ease of construction, durability and low cost.

The findings and analysis of the case study are described in Chapter Five. It is concluded that concrete block construction is being used extensively for low cost housing in the Western Cape. Concrete block construction is the preferred method of construction for low cost housing by the contractors and the end-users with regards to affordability and acceptability.

A summary of the findings of the study relative to the attainment of each objective is provided below.

6.2.1 Trends in the Use of Construction Materials in the Superstructure of Low Cost Housing

The literature on the use of construction materials in the wall superstructure of low cost housing was reviewed. It is apparent that the most commonly used construction material for the wall structures of low cost housing is concrete blocks. However, manufacturers of concrete blocks are not always producing good quality blocks, which are resulting in problems such as cracking and the appearance of damp. Developers of low cost housing stated that concrete block construction is an affordable option for low cost housing because the unit is bigger than the conventional brick, and therefore less units are required to build a house. Using less units would then result in more houses being built. Thus, Objective One was attained.

6.2.2 Current Methods and Materials Used for Low Cost Housing Construction in the Western Cape

It is evident that the most commonly used construction material for the wall structures of low cost housing is concrete blocks. However, the materials suppliers feel that the manufacturers of concrete blocks are not producing good quality blocks, which are resulting in problems

such as cracking and the appearance of damp. Materials suppliers stated that concrete block construction is an affordable option for low cost housing because the unit is bigger than the conventional brick, and therefore less units are required to build a house. Thus, Objective Two was attained.

6.2.3 End-users Satisfaction Levels with regard to the Use of Concrete Block Construction

It is apparent that the end-users are generally satisfied with the construction materials used for the wall structure of their current houses. They are, however, dissatisfied with the workmanship of the construction, as they feel that the problems, such as cracking and damp, are due to hurried and incomplete construction. The end-users are aware that the wall structures are not plastered, but only bagged. Even without any formal or technical knowledge of building houses, they state that they should be involved in the planning and construction stages of their new homes with regard to funding and appearance in order to make these homes more affordable and acceptable. Without any technical knowledge of concrete technology, the respondents felt that concrete blocks were the most acceptable form of construction material available for the wall structures because of its strength and durability. Thus, Objective Three was attained.

The above leads to the problem statement:

“End-users are dissatisfied with the current delivery of low cost housing in terms of materials and execution.”

The study set out to determine the satisfaction levels of the end-users with regard to the construction materials used for the wall superstructure. The study showed that the end-users are generally satisfied with concrete block construction. However, the feelings of dissatisfaction arise as a result of the ongoing costs associated with maintaining the end-product. The delivery of low cost housing is driven by the need to house as many of the

poorer communities as speedily as possible. This usually results in poor workmanship and dissatisfied end-users.

The construction of low cost housing should be seen as an all-inclusive approach with regard to the developers, end-users and the construction process. Accordingly, concrete block construction is the preferred choice of construction method by the developers as well as the end-users because of its potential quality and durability, assuming proper construction methods are used.

6.3 Conclusions

This study set out to determine whether concrete block construction would be accepted as an affordable approach to low cost housing construction. The study showed that the defining characteristics of concrete block construction include its ease of construction, affordability, durability, speedy delivery and acceptance. Concrete block construction is driven by the need to make low cost housing construction more cost effective, while producing more units. Finally, the study showed that the end-users are generally satisfied with concrete block construction, provided the workmanship is improved.

In summary, the principal conclusions drawn from this study are:

- (a) The most commonly used type of construction material for the wall superstructure is concrete blocks.

- (b) Affordability and acceptability of low cost housing calls for a holistic and integrated approach by the contractors and end-users, towards the delivery of housing, considering not only the parts, but emphasising their relationship to each other and importantly the sum total of the parts.

- (c) The ongoing political pressure on the government to overcome the housing backlog has resulted in a significant pressure on the housing delivery organisations to quickly deliver large quantities of houses at the lowest possible price. This pressure has superseded quality and durability considerations, which in the long run have resulted in dwellings that are only marginal improvements from the existing shacks.
- (d) The use of concrete blocks is generally perceived to result in a good quality house and the common technical problems with masonry work, which do occur, such as incorrectly fixed damp proof courses around windows, poorly fixed flashings and wide cracks, are due to poor workmanship and bad site supervision.
- (e) The current practice of low cost housing construction using concrete blocks in the Western Cape demonstrates affordability due to the ease of construction, less units being required per house, and by keeping the total cost of the house down because less material is used to manufacture a hollow concrete block than a solid brick.
- (f) Housing the poor in South Africa is a long-term programme whose success is dependent on a delivery system in which individuals must be able to participate. It is anticipated that a good record of economic growth will be able to place the poor on the road to affordability. In addition, the built environment created should be a matter of concern if an acceptable and responsive built environment is to be created.
- (g) The permanent status associated with concrete block construction invites a sense of security and encourages the need for investing in permanent structures. Therefore, concrete block construction is acceptable by the poorer communities. The affordability and acceptability of concrete block construction for low cost housing as an effective solution depends heavily on the involvement of the end-users.
- (h) The current practice of concrete block construction for low cost housing demonstrates affordability in terms of more units being produced at a faster rate. This is due to the

concrete blocks being bigger than the conventional bricks, as well as being hollow. This, in turn, results in less material being used to manufacture the concrete blocks, as well as reducing the cost of the house as the material cost make up the bulk of the total cost of a single house.

- (i) The end-users approve of concrete block construction, but their perceptions are that developers and contractors seem to emphasise the time and cost aspects while neglecting the quality of construction.

The study showed that concrete blocks are the preferred choice of construction material for the wall superstructure by both the contractors of low cost housing as well as the end-users. The end-users would support its further implementation.

The hypotheses formulated to test the problem statement were stated as:

Concrete block construction results in acceptable low cost housing for end-users in terms of materials and execution.

Regarding Hypothesis One, this hypothesis can be accepted provided proper construction methods and good quality concrete blocks are used.

End-users prefer the use of concrete block construction over other construction materials.

Regarding Hypothesis Two, the results of the survey suggests that this hypothesis can be accepted.

The validation of the problem statement, in combination with the findings and analysis of the results, shows that the hypotheses were proven.

6.4 Recommendations for Future Research

As a result of the findings and conclusions, the following recommendations are made:

- (a) In order to establish the basic principles of affordability regarding low cost housing construction, the South African building sector should investigate in detail, and by means of a cost analysis, the costs incurred by the builders of low cost housing and compare these findings with the purchasing power of the end-users with regards to buying a house. As a starting point a literature survey should be carried out and be made available to developers and designers of low cost housing. This should be followed by intensive validation and checking exercises in order to establish the most appropriate construction costs in terms of affordability and acceptability by the end-users.
- (b) Whilst this research study has concentrated on concrete block construction for low cost housing, it is clear that a similar research study should be carried out focussing on alternative methods of construction for low cost housing. The current research study has demonstrated that poor workmanship and inadequate site supervision during the construction phase leads to a lack of quality in the final end product, hence it will be useful to address quality management problems.
- (c) It is also recommended that work be done in establishing a formal standards document, which could be used for any low cost housing development. This means that it will be possible to have a contract document which could specify factors relating to affordability and acceptability of any low cost housing project undertaken.
- (d) Some of the data generated by this research study has shown that most developers, designers and contractors of low cost housing are not innovative with regards to current developments in new construction methods. As a means of exposing them to various developments in alternative methods of construction, continuous professional

development seminars should be conducted to report on new and innovative methods of construction for low cost housing as this could pave the way for more affordable and acceptable construction procedures for low cost housing, as well as encouraging the implementation of these new methods.

Thus, the purpose of this chapter has been to document a summary of the findings reported regarding the use of concrete blocks in the practice of low cost housing construction. This has resulted in the development of a set of salient points regarding the construction materials and methods used for low cost housing.

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APPENDIX I

QUESTIONNAIRE TO HOMEOWNERS

Dear Sir/Madam

This questionnaire is designed in such a way that you can make suggestions, thereby making invaluable contributions to this work. All answers will be treated in absolute confidence and used only for academic purposes. You are however, free to skip any questions. Complete anonymity is assured. Your co-operation is appreciated.

Thank you.

1. Where have you resided previously and in what type of structure? (E.g.: timber, corrugated iron)

.....

2. When did you purchase your present house?

.....

3. Have you experienced any serious technical problems with the quality of your house? (E.g.: wall failure, major cracks and leaks)

.....

4. How long after purchasing the house did any technical problems arise?

.....

5. What is your knowledge of building houses?

.....

6. Did you have a choice in the type of material used to build the wall structure?

.....

7. If yes, why did you choose this particular type of building material?

.....

8. If no, do you know what type of building material was used to construct your house?

.....

9. Are you satisfied with the construction material that was used to construct the wall structure?

.....

10. Do developers provide affordable quality low cost housing?

.....

APPENDIX II

QUESTIONNAIRE TO MATERIALS SUPPLIERS'

Dear Sir/Madam

This questionnaire is designed in such a way that you can make suggestions, thereby making invaluable contributions to this work. All answers will be treated in absolute confidence and used only for academic purposes. You are however, free to skip any questions. Complete anonymity is assured. Your co-operation is appreciated.

Thank you.

1. What is your length of experience (in years) as a supplier of construction materials?

.....

2. Do you supply construction materials for low cost housing?

.....

3. If yes, what types of construction materials do you supply and what is the most common type?

.....

4. Please indicate the technical problems related to low cost housing built with concrete blocks.

.....

5. Are concrete blocks readily available as construction materials?

.....

6. Is concrete block construction the cheapest method of construction available for low cost housing?

.....

7. Is concrete block construction an acceptable option for the end-users of low cost housing?

.....

APPENDIX III

QUESTIONNAIRE FOR DEVELOPERS' OF LOW COST HOUSING

Dear Sir/Madam

This questionnaire is designed in such a way that you can make suggestions, thereby making invaluable contributions to this work. All answers will be treated in absolute confidence and used only for academic purposes. You are however, free to skip any questions. Complete anonymity is assured. Your co-operation is appreciated.

Thank you.

1. What is your length of experience (in years) in building low cost housing?
.....
2. What types of low cost houses have you built?
.....
3. What construction material was used for the wall structure?
.....
4. What is your knowledge of concrete as a construction material?
.....
5. Is concrete block construction the most affordable method with which to build low cost houses?
.....
6. Is concrete block construction an acceptable method of construction for low cost housing in terms of the end-users needs?
.....
7. Does your company make use of any alternative methods of construction using concrete for low cost housing? (E.g.: No-fines concrete, foamcrete)
.....
8. Would you implement alternative methods of concrete construction if it were cheaper and more durable than concrete block construction?
.....

9. Has your company had any comebacks from dissatisfied homeowners who have concrete block low cost housing?

.....

10. What were the reasons for their dissatisfaction?

.....

11. What was done to rectify the problem?

.....

APPENDIX IV

QUESTION GUIDELINES FOR THE CASE STUDY

- 1. Open Ended Question on the Following Should be Asked:**
 - 1.1 Comment on the research hypothesis.
 - 1.2 Comment on the construction material and method used as well as why this is chosen.
 - 1.3 Comment on the suitability of concrete block construction for low cost housing.
 - 1.4 Comment on alternative forms of construction using concrete for low cost housing.
 - 1.5 Comment on the affordability and sustainability of concrete block construction compared to available or existing alternate methods of construction using concrete.