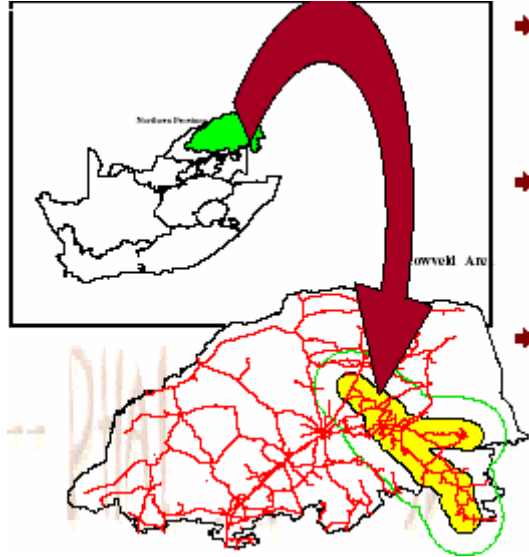


WATERBERG DISTRICT MUNICIPALITY



FEASIBILITY STUDY REPORT

TO CREATE BUSINESS OPPORTUNITIES
THAT CAN USE ASH AS AN INPUT MATERIAL

REF NO: WDM/2006/DUE 24

BY

MAQHAWE TECHNICAL & FINANCIAL SERVICES cc

Reg. No. 2005/171753/23

CONTACT DETAILS

LEFADI MAKIBINYANE
28 PONGOLA STREET
WIERDA PARK
CENTURION
0149

P.O. BOX 55275, WIERDA PARK, CENTURION, 0149

TEL: 012 653 0061

CELL: 082 707 3695

E-MAIL: Lefadi@webmail.co.za

**FOR THE WATERBERG DISTRICT MUNICIPALITY
LIMPOPO PROVINCE
SOUTH AFRICA**

Mr. Matome Magoba

Waterberg District Municipality Building

14th June 2006

Harry Gwala Street

Modimolle

0510

Subject: Final Report on the Feasibility study to create business opportunities that can use ash as an input material.

The interim report was submitted on the 22nd May 2006 with an invoice for the 40% of the contract value. We are now submitting the Final Feasibility Study Report together with the invoice for the balance of 60% of the contract price. We also request a meeting where this Final Report shall be discussed with the Waterberg District Municipality officials. In this meeting we shall also introduce the company that shall take forward the identified business opportunity for the utilization of ash into the implementation phase.

We commit ourselves as Maqhawe Technical & Financial Services to remain of service to the Waterberg District Municipality, not only with regard to this highly viable ash project, but also in many other intended projects that you continue to pursue as a caring District Municipality.

This final report is a continuation of the interim report and it concludes by bringing forward the Business Opportunity identified in the innovative product, PowerCem Fly Ash Premix that accordingly will be produced by making use of its constituent input materials in proportional ratios of 1% PowerCem, 40% Cement and 59% Fly Ash.

It was Maqhawe's intention to maintain the integrity of service delivery by converging this research study part of the Feasibility Study into a viable business opportunity that shall go a long way into addressing the local economic development challenges in the Waterberg District Municipality. It is our believe that this challenging quest has been successfully achieved in the identification of the company, Flyash Technologies (Pty) Ltd owned by the Dutch-based company, MEGATech Engineering Consultancy B.V. to ultimately bring the ash project into implementation.

We hope that this first ever work or engagement with the Waterberg District Municipality has earned us a track record that will enhance your favorable consideration of Maqhawe Technical & Financial Services in future similar work that you may require to be undertaken by consulting firms.

Please feel free to contact us in case you need any further clarification in this regard.

Yours Faithfully,

Lefadi Makibinyane
Managing Member
Maqhawe Technical & Financial Services cc
Tel: +27 12 394 3533
Fax: +27 12 394 4533
Cell: +27 82 707 3695
E-mail: lefadi@webmail.co.za

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1. EXECUTIVE SUMMARY

The Waterberg District Municipality retained Maqhawe Technical & Financial Services to compile a Feasibility Study that would identify business opportunities for ash as an input material. This report focuses on this particular assignment and attempts to converge the broad uses of ash into a specific viable business opportunity option. The report shall first give the broad understanding and applications of ash and the driving forces around the use of ash as the input material and shall also give a closer view of the cement and concrete industry in South Africa. It should be mentioned at this point that further to our interim report submitted at the end of May 2006, Maqhawe Technical & Financial Services successfully identified the most amazing Business Opportunity for the uses of fly ash produced by Matimba Power Station, by finding the International Technology provider in the name of Mega-Tech Engineering Consultancy B.V. from the Netherlands and through their South African registered company, Flyash Engineering (Pty) Limited. Maqhawe Technical & Financial Services could not have predicted such a closure to this wonderful study initiated by the Waterberg District Municipality's management.

This report is meant to provide more information to the Waterberg District Municipality on the fly ash utilizations and shall conclude by giving the salient points of the technological innovation developed by MEGA-Tech Engineering Consultancy B.V. and their Business Plan and shall thereby enable them to establish the rational decision on going forward with the implementation of this viable business opportunity for the use of ash as an input material.

The location of the fly ash resource in Lephalale far away from the vibrant construction industry had always been sited as a deterrent for any viable use of fly ash of Matimba Power Station, but this factual study have provided "out of the box" thinking to enable a potential business opportunity to be developed. It is worth noting that Flyash Engineering (Pty) Ltd have been working on the compatibility of the uses of this innovative product called PowerCem Fly ash Premix for the last three years and thorough tests through the Council for Science and Industrial Research (CSIR) and SABS have been conducted and approved.

Fly ash Engineering shall therefore go ahead and implement this ground-breaking technology in South Africa at a Capital Expenditure Costs of *R2.7 billion* in building seven ash beneficiation plants in seven areas located near the Eskom Power Stations. In so doing, *14,000 jobs* will be created in South Africa. If we proportionate these figures it implies that the investment that shall take place at Lephalale in Waterberg District Municipality shall amount to *R386 million* and create close to *2000 jobs*.

The report presents some concepts relating to the uses of ash in cement-bonded products, and describes various well-researched and piloted approaches to this subject. The need for an awareness of ash as a valuable resource is pointed out, and figures are given to indicate the inadequacy of present rates of utilization in relation to the high rates of accumulation.

There has been a detailed overview of the concrete and cement industry in South Africa as these areas represent the greatest opportunities for the utilization of ash and the leveraging of significant business opportunities for the intended local development purposes. MEGA-Tech Engineering B.V. have developed the ground-breaking product called PowerCem which can be blended with ash and cement at a ratio of 1% (PowerCem), 40% (Ordinary Portland Cement) and 59% (Flyash) to convert fly ash into a high grade cement binder and soil stabilizer that is used in civil works, concrete and road construction.

Maqhawe Technical & Financial Services as a concluding action to this Feasibility Study, shall take an honor to introduce the officials of MEGATech Engineering Consultant B.V. or should we say of the Flyash Engineering (Pty) Ltd to the Waterberg District Municipality during our wrap-up presentation before the end of June 2006. The major expectation from the Waterberg District Municipality going forward with the implementation of this Fly ash project would be that of a facilitator and we would recommend that Flyash Engineering (Pty) Ltd establish a Project Steering Committee that will consists of various stakeholders of including the Waterberg District Municipality.

2. INTRODUCTION

The Waterberg District Municipality retained Maqhawe Technical & Financial Services to compile a Feasibility Study that would identify business opportunities for fly ash as an input material. The Eskom Matimba Power Station in Lephalale in the Limpopo Province produces this fly ash.

Waterberg District Municipality is one of the six District Municipalities in the Limpopo Province that form a third tier of Government after the National and Provincial Government respectively; others being Eastern, Sekhukhune, Capricon, Vhembe and Mopani –District municipalities. Chapter 7 of the Constitution creates a framework for local governments, making them autonomous (independent) bodies and more independent of National and Provincial government than under the previous Constitution. For example, section 139 of the Constitution limits the powers that Provincial governments have to intervene in the affairs of Local government. So, the Local governments such as the Waterberg District Municipality are no longer directly accountable to Provincial government, and must take full responsibility for managing their own affairs and exercising their powers. Local governments are now accountable to their local communities more than ever before. Hence, Waterberg District Municipality, in their quest to improve the economic conditions of the local community identified amongst many a project to harness the fly ash produced by locally based Matimba Eskom Power Station to create the business opportunities that could assist to create jobs and alleviate regional poverty. The economic situation of the Waterberg District Municipality shall be discussed with the context of the Limpopo Provincial economy in the following section as part of the Feasibility Study report.

2.1. Economic Performance and Conditions

- I. The Limpopo Province is the second lowest province in terms of the contribution to the South African Gross Domestic Product (GDP);
- II. The provincial economy grew at an average rate of 3.6% between 1994 and 2000;
- III. In 2000 the province was estimated to have contributed about R32.3 billion, more than double its 1994 figure. This translates to about 4% of the country's GDP.
- IV. The main contributors to GDP for the province were services (28%), trade & catering (18%) and mining (19%);

- V. The main growth sectors between 1994 and 2000 were trade & catering (55%), financial services (39%), transport (29%), and water & electricity (15%);
- VI. Declining sectors for the same period were agriculture (-50%), manufacturing (-41%), construction (-17%), Government services (-8.7%) and mining (-5%).
- VII. Although Waterberg District was the largest contributor to GDP in 2000, it showed a modest decline of 7.2% over 1994 – 2000 with mining as its main source of growth (34.7%);
- VIII. The Capricon District showed a significant growth rate contribution (27.4%) from 1994 to 2000 with trade & catering as its main growth sector (56.3% contribution);
- IX. All Districts showed a marked increase in transport sector contribution except in the Vhembe District where it virtually collapsed.

2.2. Employment of the Limpopo Province

- I. The production structure is very labour intensive. However, unemployment is quite high (48% in 2000 overall) with Sekhukhune (68%) followed by Ester (55%), Vhembe (47%) Capricon (45%), Mopani (43%) and Waterberg (32%);
- II. The main creator of jobs, in terms of sectors, is trade & catering followed by services sector. Major sectors in employment creation are Electricity, Infrastructure (Construction) and mining;
- III. The province provides 8.2% employment opportunities in the primary sector and only 4.4% in the secondary sector.

2.3. Growth Prospects in the Province

- I. Manufacturing - There are opportunities in Manufacturing sector: Food processing, brick works, jewelry, tanning, furniture, industrial chemicals and light to medium engineering;
- II. Mining - Large mineral reserves in platinum group metals, iron ore, chromium, coal, diamonds, phosphates, copper and antimony;
- III. Tourism – Game farming, diverse terrains and extensive tourist infrastructure;
- IV. Agri-Industry – Abundant subtropical fruit, tea, coffee, vegetables, cotton and tobacco;
- V. Strategic Location in Relation to SADC – Link between South Africa Southern States and the rest of the African continent, Maputo Corridor.

2.4. Human Resources Assessment

- I. The Province account for 7.7% of the country's labour force (1.081 million jobs);
- II. From economically active population, only 42.6% participates in the labour market.
This is 14.6% lower than the National average of 57.3% and the lowest in the country.

3. FLY ASH PRODUCTION IN CONTEXT

Huge tonnages of coal are consumed annually in South Africa for the generation of energy by electric power stations. Eskom's coal-fired power stations consume approximately 92 million tons of coal per annum, producing 25 million tons of ash, to supply South Africa's electricity. Disposal of the many millions of tons of fly ash, produced as a byproduct of coal combustion, creates a problem. Nearly all the fly ash produced is slurried to form enormous, unsightly heaps of waste material. These dumps pose a potential environmental hazard, since elements such as Barium (Ba) and Boron (B) are readily leached from the ash by water and may thus enter terrestrial and aquatic environment.

Industrial utilization of fly ash comprises approximately 20% of the total coal ash produced in the USA and approaches 40 – 50% of the total produced in some of the major European countries. At present, only a very small proportion of the ash produced in South Africa is utilized in the concrete industry. It is, therefore, essential that environmentally acceptable uses of fly ash be increased in this country to prevent further accumulation of vast ash dumps, but more critically to accelerate economic growth of the local regions by leveraging potential business opportunities that can be realized through the utilization of fly ash.

Although the physical and chemical properties of fly ash are variable, it generally contains considerable amounts of plant-essential macro- and micronutrients, and can thus potentially be used as an amendment to improve soil fertility and increase plant growth and crop yield. A large number of studies have been conducted in North America, Europe and Australia to investigate the potential agronomic utilization of fly ash.

This study shall however focus on the business opportunities that would make a major proportional use of fly ash, thus as an input material to construction industry.

3.1. SIGNIFICANCE OF ASH DISPOSAL AND UTILIZATION

Energy considerations point to an increasing use of coal over the years and conservative speculation indicates that world coal production in the year 2010 may well exceed billion metric tons. The disposal of ash resulting from the combustion of such vast quantities of coal poses challenges that simply cannot be ignored and there is no doubt whatever that an effective strategy to combat this problem should be seen as an essential and urgent requirement in every country that burns coal for the generation of power or for other industrial purposes. This is a challenge that the Waterberg District Municipality is attempting to resolve by finding ways of beneficially disposing the Eskom Matimba Power Station coal through the creation of business opportunities that not only become profitable or viable but could also address economic development challenges of the area.

3.2. ASH DISPOSAL

The term “disposal” refers to the engineering and environmental problems resulting from the vast accumulations of ash, and involves factors such as desulphurization of flue gases, means of precipitation, handling and transportation of ash to suitable storage or backfill sites, etc.

These and other factors must all be controlled to maintain, as far as possible, an acceptable environment by avoiding pollution of air, water and land.

At the same time the conservation of natural resources must be carefully considered, taking into account the aesthetic quality of the countryside in regions of ash disposal and the impact of ash on the ecology of these regions. In considering these aspects, a fair balance must be found between environmental effects and economics of waste disposal.

Our belief is that the authorities concerned with these formidable responsibilities for ash disposal require the fullest possible assistance from those who are able to devise means of reducing the quantities of ash awaiting disposal. For this reason it warrants the concern with the need for greater utilization of ash than with the problems of disposal.

3.3. ASH UTILIZATION

Clearly, the environmental hazards inherent in the disposal of ash will be alleviated to a greater or lesser extent depending on how effectively we discover viable methods of utilizing the material industrially and commercially. It is imperative therefore that Maqhawe Technical Financial Services explore thoroughly all the current established methods of ash utilization and analyze them in terms of their full potential. Equally important is the need to seek innovative means of utilization.

Before examining further the potential for exploiting ash, it is necessary to be aware of the large range of ashes produced by the combustion of coal.

3.4. RANGE OF ASH TYPES AND QUALITIES

The residues arising from the firing of boilers with pulverized coal, which is consumed largely for the generation of electric power, consist mainly of fly ash which accounts for approximately 72 – 80% of the total, the remainder being bottom ash.

Since this Feasibility Study is concerned primarily with the use of fly ash as an input material in cement and concrete, it is important in this context to note that fly ashes, depending on their source, can vary widely in their physical, chemical and mineralogical properties.

In addition it is hardly surprising that changes in quality are to be expected from fly ashes taken from different precipitator fields. The significance of these variations is extended when it is realized that cement itself varies in its composition, so it is not surprising that combinations of different fly ashes and cements can exhibit different performance characteristics.

These references to the variations in fly ash are made not so much to sound an alarm as to emphasize the need for recognition that properties of the material from different sources can and do vary. However, variability of ash does not pose a serious problem in South Africa and it is relatively easy to select a suitable and reliable source from which a

consistent product can be obtained. The fly ash from Eskom Matimba Power Station bears a consistent quality because it draws its coal from one source.

Over 1 million tons (i.e. 4% of total ash production) are sold annually to the cement and concrete industry in South Africa. Finer than face powder, this versatile material, when used as a pozzolan in cement, has many advantages:

- Long term strength development,
- Decreased permeability,
- Reduced sulphate attack,
- Reduced efflorescence,
- Reduced shrinkage,
- Reduced heat of hydration,
- Reduced alkali-silica reactivity,
- Enhanced workability – concrete is easier to place;

Hidden benefits of the use of ash include:

- Avoidance of disposal costs,
- Creation of job opportunities,
- Reduction of the emission of greenhouse gases by partially replacing cement;

Fly ash has a remarkable versatility and other applications outside of construction (cement and concrete) field include:

- Combining with soil to improve soil quality and thus benefit agricultural output,
- Sewage treatment,
- Environmental rehabilitation of mine dumps and slimes dams by countering mine drainage,
- As a constituent of plastics and polymers,
- As a backfill in mining operations,
- As land fill,
- In road construction.

3.5. FLY ASH IN CEMENT-BONDED PRODUCTS

Fly ash has many uses and those of note are in concrete and cement-bonded products. In South Africa there is a worrying low utilization of ash as an input material and a comment on two important uses shall be highlighted:

3.5.1. Blended Cements

South Africa does use fly ash as a cement extender, but only in quantities that are not yet anywhere near the full potential. Geographic distribution of coal reserves is probably a strong reason for this low utilization. Because a large proportion of South Africa's coal reserves are situated in Mpumalanga Province, most of fly ash is produced in power stations concentrated in this area that happens to be far removed from major regions of construction activity. In spite of this problem, however, the merits of fly ash are such that there should still be more than adequate incentive to increasing its use in concrete.

Among the many benefits of fly ash in improving the engineering properties of concrete the more significant are:

- Reducing expansion of concrete caused by alkali-aggregate reaction,
- Reducing heat of hydration in mass concrete,
- Reducing sulphate attack in concrete,
- Enhancing long strength of concrete.

Apart from these technical advantages, there are other powerful incentives to increase the utilization of fly ash in cement and concrete. There is consciousness today of the very real need for conservation of energy, of material resources and of the environment. While the raw materials for making Portland cement are relatively abundant, one of the limiting features of future cement production will be the conservation of the energy resources. Major savings in energy can be achieved by the utilization of suitable industrial waste products such as fly ash and milled granulated blast furnace slag. Future developments in the cement and concrete industry will almost certainly include greater use of industrial

waste products not only as an important energy conservation measure but as a means of lowering production costs and reducing the capital content of future plant per ton of output.

3.5.2. Low-density Aggregate

High quality, low-density aggregates can be manufactured by pelletising and sintering fly ash, but South Africa is one of the few technically advanced countries in the world in which little or no low-density aggregate is used. In the U.K. and in the U.S.A. the annual use of such material is in the order of two million cubic meters, while in the former USSR the usage is about ten times that amount.

A major reason for the failure to exploit the technical and economic advantages of this material is conservatism in regard to an aggregate new to South Africa and for which no track record is available.

Another reason for the lack of initiative in this field is that South African climate, except in the warmer regions such as Durban, does not encourage the use of concrete offering the merits of low thermal conductivity.

In spite of these inhibiting factors there are a number of benefits to be considered in the use of low-density concrete. A few examples are:

- The mass of concrete structure is large in relation to the load it can carry, so that a small reduction in mass can bring real cost savings,
- Savings in transport cost and handling,
- Greater fire resistance, and fire damage is easier to repair.

An indirect benefit of some importance is that the exploitation of dense natural aggregates is usually accompanied by the use of environmental problems which are avoided by the use of artificial low-density aggregates. This point is of special significance in a number of areas of South Africa where the rock types available for processing natural aggregates are sub-standard and less suitable than many of those found in Europe. Availability of artificial aggregate would help in some measure to alleviate this problem.

The production of artificial aggregate has great potential and there is a promising future for its use in a numbers of fields. Its most substantial application however will almost certainly be in the production of load-bearing and non-load-bearing concrete building blocks.

3.6. LOW UTILIZATION OF ASH IN SOUTH AFRICA

At present the annual production of ash in South Africa is approximately 20 million tons of which about 80% is fly ash and the remainder bottom ash. Only about 4% of the total ash is profitably used. This extremely low utilization factor should be compared with the approximate figures of 18-20% in the USA, 55% in the UK, 65% in France and 80% in Germany.

It might be rewarding to reflect on some of the factors identified by this study contributing to the South African failure of making better use of this versatile and potentially valuable material. Among the most likely reasons for this are:

- As previously mentioned, the large distances separating our power stations from centers of industrial and construction activities is a strong deterrent to the use of fly ash;
- Transportation of ash presents problems due to the fineness and bulky nature of the material. It has been said that transportation is the Achilles heel of ash utilization. This factor, combined with the large distances involved, is a significant cause of low utilization;
- At present no standard specification of fly ash is available in South Africa, nor is the use of ash dealt with in current codes of practice for concrete construction work. British Standards for cement and concrete permit broad-based use of fly ash;
- Those responsible for ash production appear to have played little part in promoting its utilization. By contrast, the Central Electricity Generating Board in the UK has actively encouraged the use of ash;
- Ignorance of the benefits offered by fly ash probably contributes substantially to low utilization. In addition, innovative measures are often viewed with skepticism, and resistance to change is a powerful retarder.

3.7. INCREASING UTILIZATION

Many of the steps required to increase utilization are self-evident and follow naturally from the issues mentioned in the previous section. For instance, the lack of specifications for fly ash points to the need for rapid action in drawing up a national standard for this material. Similarly, ignorance of the benefits offered by fly ash indicates the need for a comprehensive education program coupled with effective dissemination of information.

Continuation of research is obviously necessary. The technology of fly ash is inseparable from its successful exploitation. Equally important, especially now, is a thorough and broad-based investigation into economic factors. The construction industry is extremely conservative and cost conscious, and tends to plan its activities in relation to traditional materials and basic costs without a full understanding of the long-term rewards and financial benefits of new materials. If the incentives were to be provided to specifiers, manufacturers and contractors they would be convinced of the commercial rewards that are to follow the introduction of fly ash.

While the engineers and scientists are carrying on with their research and studying the minutia of their test results, experts from other disciplines should be analyzing and quantifying the financial advantages of fly ash use. Even so, the evidence from the combined technical and financial surveys is not, in itself, enough. The knowledge gained by these experts must be effectively communicated to specifiers, engineers, architects, property developers, etc.

3.8. SPECIAL REPORT ON THE USE OF FLY ASH IN CONCRETE

Fly ash has emerged as an additive for concrete mix that helps improve the environment.

The production of Portland cement is responsible for some 7% of the world's production of carbon dioxide, a culprit in global warming. Experts estimate that each ton of cement produced contributes around one ton of carbon dioxide emissions in the atmosphere.

The reason is twofold. A major raw material in cement is limestone, the calcinations of which results huge releases of carbon dioxide. Cement clinker production uses a excessive amount of fossil fuels to make the other half of the damaging gas emissions.

When fly ash is used as an additive in concrete, it increases the durability and the life cycle of the product while requiring less cement and thus reducing the greenhouse gas emissions.

Fly ash comes from coal-fired electricity generating plants that grind coal to powder before burning it. The ash is the glassy mineral impurities left over after coal has been burned.

One ton of fly ash used instead of cement saves landfill space equivalent to what an average person produces in a little over a year. The reduction in carbon dioxide produced in cement manufacturing is equivalent to two months of emission from a car. The energy saved is enough to provide an average home with electricity for 24 days.

The use of fly ash in concrete is not new. The Romans first used volcanic ash in cements for construction of roads and aqueducts which have lasted for centuries. Today's coal fly ash closely resembles that volcanic ash. It is lighter in color than cement and consists of tiny glass spheres. Fly ash particles are smaller than Portland cement which allows them to flow more freely. While using less water it fills holes and blends easily with aggregates for more durability.

When water is added to Portland cement, it creates a strong binder which helps glue the aggregates together and create free lime. Fly ash reacts with lime (calcium hydroxide) to convert it into calcium silicate hydrate – the toughest and most durable paste in concrete. Fly ash additives serve to increase concrete performance cost-effectively, making a product that is more waterproof, more resistant to corrosive effects of the atmosphere, and longer lasting.

This section may indicate the pre-look of the focal point of this Feasibility Study and shall be firmed up as it converges towards an identification of a business opportunity for the Matimba Power Station ash at Lephalale in the Limpopo Province as per the mandate from the Waterberg District Municipality.

However, before the fly ash as an additive is fully explored the study shall first give an overview of the cement and concrete industry in South Africa and compares to the world trends.

4. AN OVERVIEW OF SOUTH AFRICA'S CEMENT AND CONCRETE INDUSTRIES

4.1. BACKGROUND

The purpose of this report is to provide an overview of the South African cement and concrete industries, including an analysis of its performance, key drivers, demand and supply conditions as well as prospects, and identify gaps and opportunities.

4.2. A BRIEF OVERVIEW OF THE CONSTRUCTION SECTOR

4.2.1 A GLOBAL PERSPECTIVE

The construction industry accounts for about 10% of the world economy with its size and importance varying from country to country. It accounts for about half of all fixed capital investment on average.

According to the Construction Industry Development Board ("SA Construction Industry Status Report 2004), approximately 70% of global construction investment is concentrated in the USA, Western Europe and Japan, while Africa accounts for only 1%. Per capita investment in construction in the developed world is approximately \$2 500 per annum compared to only \$46 per annum in Africa. The general level of gross fixed capital formation as a percentage of gross domestic product in developed countries is approximately 25%, while that of SA is still 16.5% (2004). This seems to indicate significant growth prospects for the sector in SA if domestic fixed investment is increased.

The construction industry has a significant multiplier effect on an economy as a whole. It is considered that one job in construction gives rise to two further jobs elsewhere in the construction sector and in other parts of the economy. On this basis it can be seen that as much as 20% of all employment may be linked to construction activities in some way. Furthermore, governments often use investment in construction as a tool for stabilising economies over the economic cycle. This is an important point, as a lack of stability in construction demand can be very damaging to employment as a whole and confidence in the sector in particular.

4.2.2. SOUTH AFRICA'S CONSTRUCTION SECTOR

South Africa's construction sector, with a contribution of approximately 2.4% to overall GDP in 2004, is one of the fastest growing sectors in the economy. The sector posted an average annual growth rate of 5.5% over the past five years, outstripping real economic growth of 3.4% p.a. for the economy at large. Construction is closely linked to the investment cycle, with both government and private sector capital spending impacting directly on the sector's performance.

The construction sector may be sub-divided into two broad categories, namely: the building construction industry with a market size (turnover) of R75 billion in 2004; and the civil engineering or infrastructure industry with a total market value of R48 billion for the same year.

4.2.2.1. Macro-economic overview

The South African construction sector's contribution to gross domestic product peaked in the mid-1970s around the 5.2% level. The sector's contribution to GDP subsequently declined to an average of 3.5% in the 1980s and to 3.1% in the 1990s, whilst reporting an average annual contribution of 2.4% of GDP over the period 2000 to 2004. The growth at its peak was driven by high levels of government capital expenditure on infrastructure and mining, strong commercial property demand (underpinned by a strong growth in manufacturing) as well as a booming residential property market (spurred by the low interest rate environment). Although the sector currently accounts for only about 2.4% of GDP, it has a strong growth push because of its extensive linkages with various other sectors of the economy.

Figure 1:



The sector, which from the late 1980s experienced a declining trend, started to show some signs of a recovery in 2002. The upswing in the residential property market, public infrastructure projects as well as increased civil construction activity contributed to this turnaround.

4.2.2.2. Key drivers

A number of factors have supported the excellent performance of the construction sector in recent years. These include:

- The rapid increase in fixed investment;
- The housing boom that has been experienced over the past three to four years;
- Rising consumer and business confidence, which have benefited from the favourable domestic economic environment in light of the lowest interest rates in more than two decades as well as benign inflation;

A general belief that interest rates will not rise substantially in the short to medium term;

- Rising disposable incomes, pushed up by consecutive income tax cuts;
- Expansions of the wealth and income base;
- Increased participation of foreigners in the domestic property market;
- Increased popularity of property as an investment asset, both through listed property instruments and for rental purposes; and
- The growing black middle class.

4.2.2.3. Outlook

Despite the excellent performance of the construction sector in recent times, increasing levels of tender competition in the non-residential sub-sector and civil engineering have left gross and operating margins depressed over the last 5 years, although these are still in line with global counterparts.

A recovery in the non-residential building and civil engineering works is not expected in the **short-term** due to the slow growth in commercial and rental occupancies as well as in the manufacturing sector, which is one of the major drivers of the industry. However, strong demand for retail commercial property should provide some support for this segment.

In the **medium- to longer-term**, however, infrastructure spending by government and state owned enterprises (SOEs) will provide a boost to the sector's cyclical upturn, with the benefits expected to accrue from 2006 onwards. Government's anticipated increased investment in social infrastructure includes spending on projects such as low-cost housing, clinics and schools. The capex programmes of SOEs, particularly Eskom and Transnet, as well as the Gautrain Project and the anticipated investment activity in the build up to the Soccer World Cup in 2010, will certainly provide an enormous stimulus to the construction industry. Furthermore, a relatively low interest rate environment, income growth and redistribution should sustain significant levels of activity in the residential buildings sector.

The outlook for the construction sector is therefore upbeat in the medium- to longer-term. Considering the above mentioned anticipated developments, the sector is likely to enjoy a period of robust growth over the next five years. Sectoral growth is expected to exceed overall GDP growth, which is forecast to average 4% during the same period. Gross fixed capital formation is forecast to expand at a rapid average rate of about 9% per annum, with the fixed investment/GDP ratio increasing from its current level of 16.5% (2004) to roughly 21% by 2009

4.3. THE CEMENT INDUSTRY

4.3.1 DESCRIPTION OF THE CEMENT SUB-SECTOR

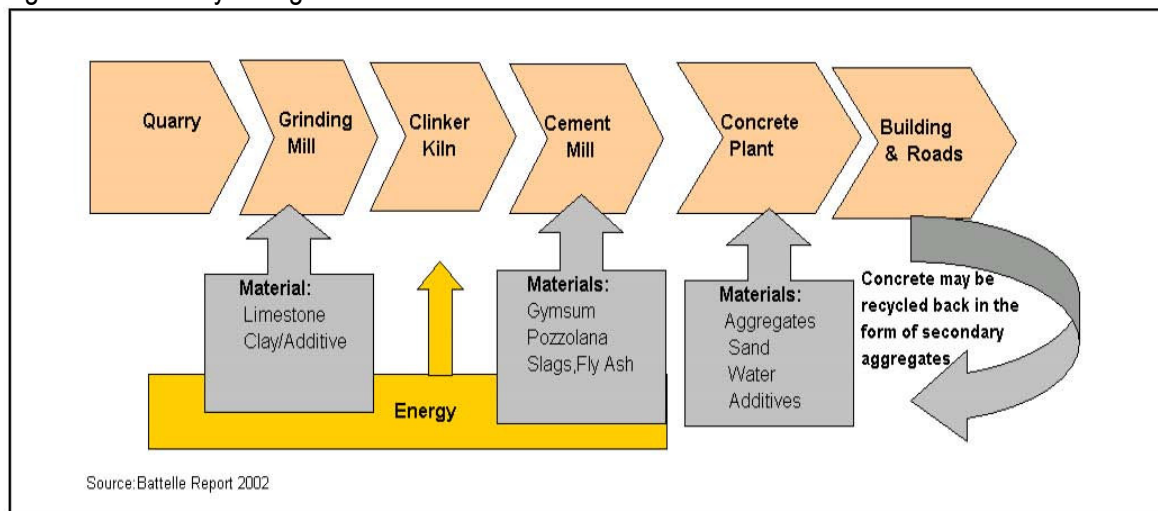
According to the Standard Industrial Classification (SIC), the cement sub-sector is classified as SIC 3693, and forms part of the non-metallic mineral products sector.

4.3.1.1 Cement versus concrete

Cement is defined as an hydraulic binder, i.e. a finely ground inorganic material which, when mixed with water, forms a paste that sets and hardens by means of hydration reaction and processes. It is referred to as a powder that serves as the binding element in concrete and mortar. It is therefore important not to make the common mistake of considering cement and concrete as being synonymous. Cement is produced by sintering about 78% of limestone with a mixture of various compounds or rock containing alumina, silica and iron dioxide.

Concrete is manufactured by mixing cement with sand, small rocks (called aggregates) and water (refer to Annexure 3 for detail on the manufacturing process).

Figure 2: Summary - Stages in the manufacture of cement and concrete



4.3.1.2 Cement plant size and location

Portland cement plants producing an average of 2 to 5 million tons annually, exhibit the following characteristics:

- Most cement plants are located near limestone quarries in order to minimise transportation costs;
- Installation of a cement plant requires an amount of R1.5 billion and 3 to 5 years to be fully operational;

- Cement plants require high levels of capital investment, with the ratio of capital investment per worker being amongst the highest of all industries;
- The nature of Portland cement manufacture requires some 80 separate and continuous operations, as well as the use of large-scale heavy machinery and equipment;
- Cement production consumes large amounts of heat and energy. Large volumes of fossil fuels (in solid and liquid form) are required to maintain high combustion levels of kiln. For every 100 tons of clinker produced, approximately 15 to 16 tons of coal have to be burnt; and
- Cement producers have to comply with the European standards for cementitious products.

4.3.2 OVERVIEW OF THE GLOBAL CEMENT INDUSTRY

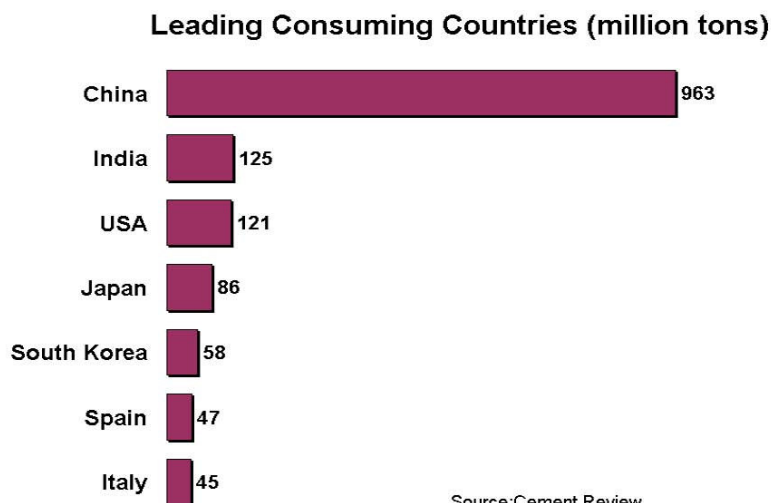
Global cement consumption recorded an historical peak of 2.16 billion tons in 2004, representing an annual increase of 8.9% on the previous year's figure.

4.3.2.1 Top consuming countries

Cement consumption tends to vary across countries and time, with countries that experience robust economic growth being most likely to record high rates of growth in demand for cement as building construction and infrastructure development flourishes.

China is the global leader in terms of consumption, consuming 963 million tons of cement in 2004, or 8.6% more than the previous year, and has also been a major exporter due to increased capacity. India and the USA follow with annual consumption levels just above 120 million tons, whilst Spain and Italy are currently the dominant consuming countries within the European Union.

Figure 3:

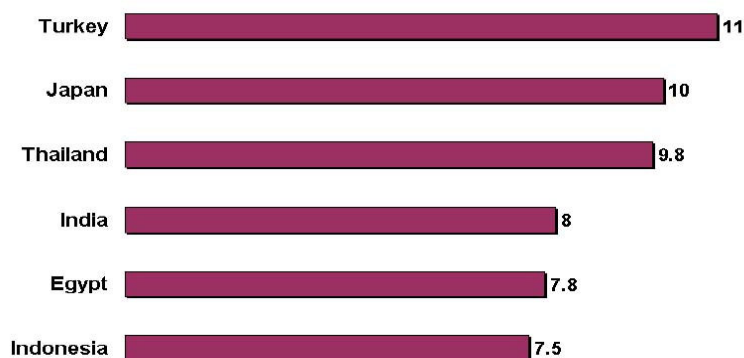


Source: Cement Review

4.3.2.2 Top exporting countries

Turkey has been a major exporter over the last three years, leading the list of exporting countries in 2004. It exported about 11 million tons last year (comprising 9 million tons of cement and 2 million tons of clinker), with Italy and the United States being major customers of Turkish cement while Spain is the major buyer of Turkish clinker.

Japan became the second largest cement exporter in 2004, followed by Thailand, which exports mainly to Vietnam and Bangladesh. Egypt exports largely to other African countries, the Middle East and the USA.



Source: Cement Review

Figure 4: Leading exporting countries (million tons)

4.3.2.3 Top importing countries

The United States' dependence on imported cement made it the leading importing country in 2004. The USA imported about 26.6 million tons in 2004, an increase of 2 million over the previous year's figure. Third in line, Bangladesh imported 6.4 million tons of cement from other Asia countries (i.e. Japan, Philippines and Thailand) to meet its domestic demand. Nigeria was the top African importer at 6.2 million tons of cement.

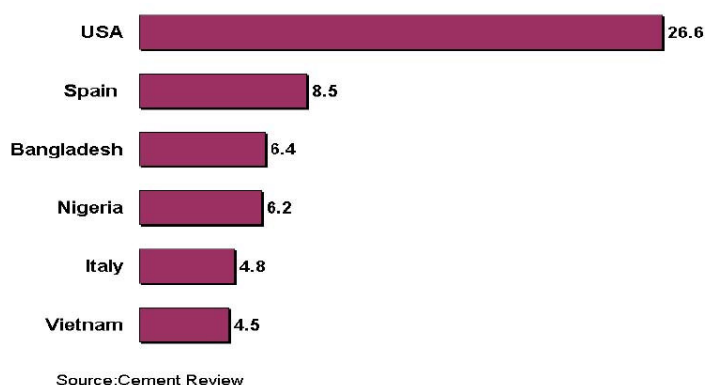


Figure 5: Leading importing countries

4.3.2.4 Industry concentration and globalisation

The global cement industry is becoming increasingly concentrated as acquisitions, mergers and joint ventures occur on a regular basis. Major world players include Lafarge, Holcim, Cemex, Heidelberg and Italcementi.

Table 1 below illustrates that countries such as Greece, South Africa and the UK exhibit highly levels of concentration, with the “concentration ratio” indicating the degree to which the top five companies dominate cement production capacity within a region or country

Table 1: Concentration and foreign ownership ratio

Concentration and Foreign Ownership Ratio in Selected Countries.		
Country	Estimated concentration Ratio	Estimated Foreign Ownership
Brazil	80%	27%
China	3%	1%
Egypt	63%	45%
Germany	58%	52%
Greece	100%	61%
India	42%	3%
Mexico	95%	0%
Russia	10%	0%
South Africa	100%	57%
Thailand	93%	12%
United Kingdom	99%	77%
United States	49%	89%

Source: Battelle Report 2002

As also indicated in the above table, high foreign ownership in countries such as the United States, the United Kingdom, Greece, Germany and South Africa illustrates the impact of globalisation on the cement industry. Through the investment of global cement companies,

there has been a notable improvement in quality control and safety implementation at cement plants and depots.

4.3.2.5 Global cement pricing

In 2004, strong price increases were announced in the United States, the United Kingdom and Germany. Further price increases are expected in the near future due to:

- The sharp rise in fuel and freight prices;
- Higher electricity costs; and
- The impact of new EU legislation on CO₂ emissions in a number of countries.

The price in India is expected to increase by 5% to 10% in 2005, with India's cement producers having benefited from the 15% surge in export volumes to the Middle East, particularly the Gulf countries.

Figure 6: Global cement prices.



4.3.3 OVERVIEW OF SOUTH AFRICA'S CEMENT INDUSTRY

The evolution of South Africa's cement industry reflects the country's changing economic environment and levels of investment activity over time. Averaging 1.5% per annum over the period 1980 to 2000, the annual rate of increase in demand for cement fell short of the average overall GDP growth rate of 1.9% over this period. This poor performance was more significant during the period 1989 to 1999 due to a general slump in local building demand and infrastructural investment.

Since 2001, however, growth in cement sales accelerated to between 4% and 16%. Exceptional growth was recorded in 2004, as sales volumes exceeded 12 million tons. The value of the annual production is estimated at between R3.3 and R4 billion.

4.3.3.1 Major players

South Africa's cement industry is dominated by the following four companies (refer to Annexure D for more details):

- Pretoria Portland Cement;
- Holcim;
- Lafarge SA (formerly Blue Circle); and
- Natal Portland Cement (NPC) – Cimpor

The structure of the industry basically remained unchanged from 1988 onwards, until the following mergers and acquisitions were effected in 2002:

- NPC was sold to Cimentos de Portugal (Cimpor);
- Blue Circle's production, blending and distribution facilities were taken over by Lafarge International; and
- Holcim's 54% acquisition of Alpha.

Cement capacity ('000 tonnes) in South africa	2004 cement capacity	2004 domestic production	Utilisation (%)	Estimated market share in South Africa (%)
PPC	5500	4229	77	35
Holcim	3920	3245	83	27
Lafarge	3000	2609	87	22
NPC- Cimpor	1010	952	97	9
Other blenders	750	700	93	6
Total	14200	11673	82	100

Source: UBS

Table 2: Major players' capacity utilisation and market share

4.3.2 Cement industry capacity

The average capacity utilisation of all the major players exceeds the 80% mark. Consequently, and in light of demand growth, Natal Portland Cement (NPC)-Cimpor in Natal, Pretoria Portland Cement (PPC) as well as Holcim have announced expansion plans:

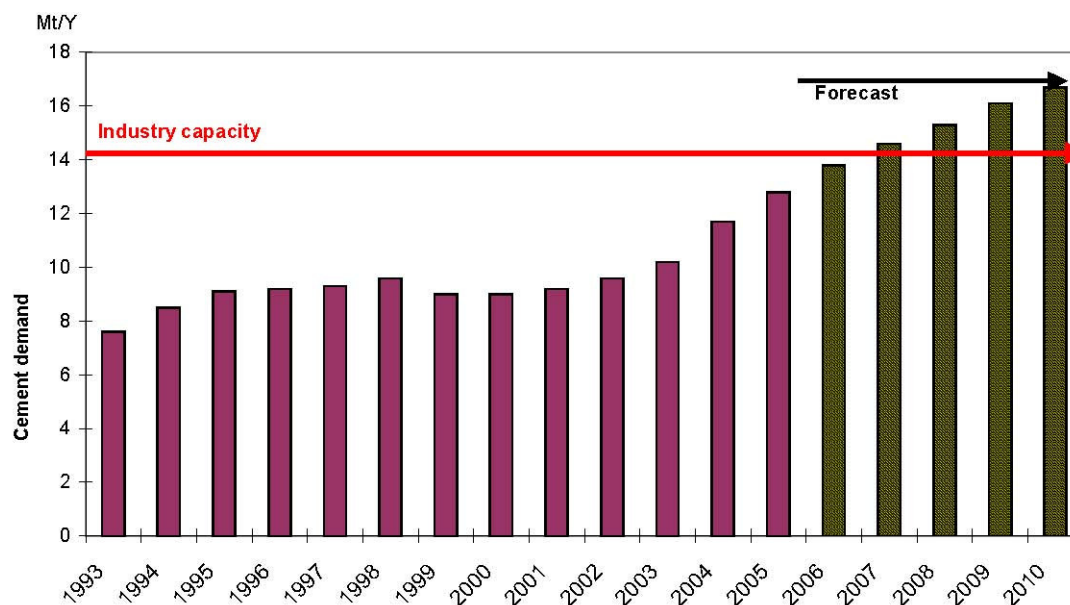
- NPC-Cimpor is planning to expand its Simuma kiln, which is expected to increase its capacity by 60% or 600 000 tons from January 2006;
- PPC expects to complete the de-mothballing of its Jupiter plant in 2006 and the installation of a new kiln line and associated infrastructure at Dwaalstroom factory at a cost of R1.36 billion; and
- Holcim has a kiln filter upgrade project planned for 2005, which will result in a small increase in capacity.

Considering the PPC and NPC announcements, their relative market shares are expected to increase over the next few years.

Of concern, however, is the fact that the major players are anticipated to approach their capacity limits over the next 12 to 36 months. Hence, the potential for shortages from 2007 onwards is looming unless cement production capacity is increased. The true maximum economic capacity utilisation of the industry is estimated at 90% to allow for shut-down during maintenance and other possible supply interruptions. Since capacity utilisation of all major players has exceeded 80%, it implies that supply is not likely to accommodate growing demand as it takes at least 2 to 3 years for a cement plant to reach full production.

The South African cement industry thus urgently needs to increase its production capacity to accommodate the growing demand for cement over the next five years. The following graph shows that production capacity from 2007 onwards will be insufficient unless the domestic industry's production capacity is increased.

Figure 7: Cement demand versus current production capacity



Source: Engineering News

4.3.3 The cement industry's facilities

The South African cement industry is comprised of a large network of producing, blending, milling and distribution units. The table below outlines the industry's facilities.

Table 3: The cement industry's facilities

Production Units		Milling/Blending units		Distribution Depots	
Slurry	- North West	Polokwane	- Limpopo	Lichtenburg	- North West
Lichtenburg	- North West	Mokopane	- Limpopo	Waltloo (Pretoria)	- Gauteng
Dudfield	- North West	Roodepoort	- Gauteng	Industria (Johannesburg)	- Gauteng
Dwaalboom	- North West	Brakpan	- Gauteng	Jupiter	- Gauteng
Hercules	- Gauteng	Kaalfontein	- Gauteng	Queenstown	- Eastern Cape
Ulco	- Northern Cape	Nelspruit	- Mpumalanga	East London	- Eastern Cape
Simuma	- KwaZulu-Natal	Middleburg	- Mpumalanga	George	- Western Cape
Port Elizabeth	- Eastern Cape	Newcastle	- KwaZulu-Natal	Montaque Gardens	- Western Cape
De Hoek	- Western Cape	Richards Bay	- KwaZulu-Natal	Maseru	- Lesotho
Riebeeck	- Western Cape	Bloemfontein	- Free State	Windhoek	- Namibia
		Durban	- KwaZulu-Natal	Tsumeb	- Namibia
		Matsapha	- Swaziland		
		Gaborne	- Botswana		

Source: Cement and Concrete Institute

4.3.4 Employment

Hard data on employment trends in the cement and concrete industry is not available. Nevertheless, due to its automated production processes, the cement industry is one of the least labour-intensive industries in the country and is estimated to employ over 7 000 people, both in processing and distribution.

Employment levels are projected to increase as major players expand production capacity to accommodate local demand. For example, PPC has recently indicated that its less capital-intensive Jupiter component, which is due for completion in 2006, will employ an additional 42 people.

4.3.5 Recent trends

The following are some of the recent trends evident in the cement industry:

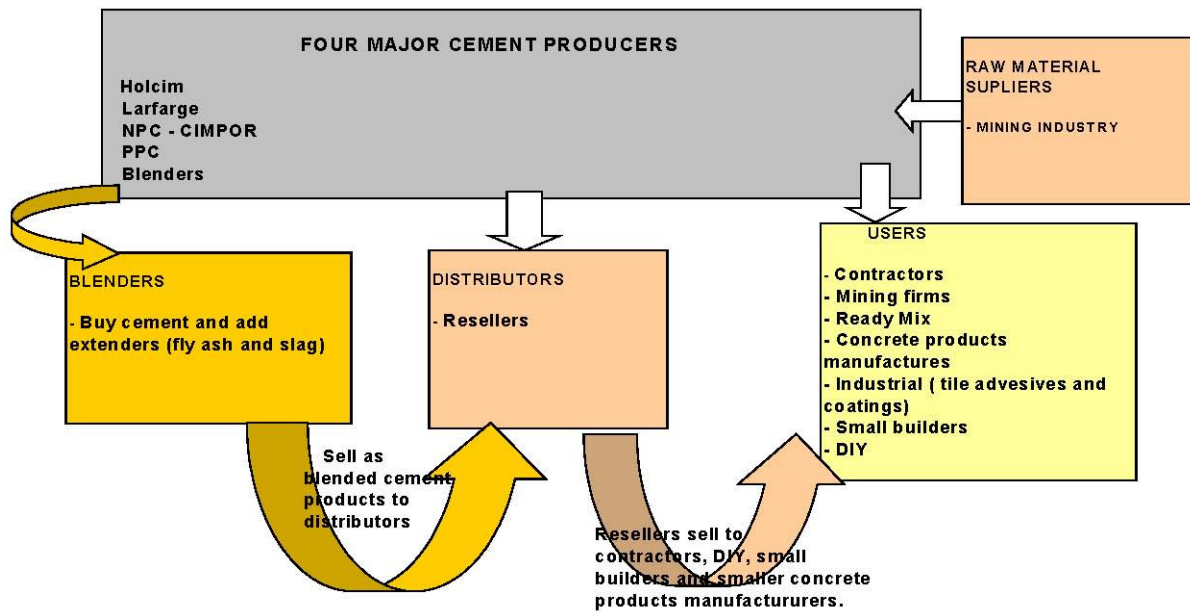
- Concrete is gaining acceptance as a “green” material as environment-friendly standards are increasing in importance worldwide, the reason being that less energy is needed to produce concrete than is the case with other building materials;
- Local producers are considering the use of combustible waste materials (such as paint solvents) as a fuel alternative to coal. These combustible waste materials are known for their contribution to the environment and reduction of emissions and landfills;
- Steel is replacing concrete beams and plastic piping is being preferred to the more expensive concrete alternatives; and
- There is a shift from manufacturing of CEM IIB cements to CEM V cement, the reason being that cement clinker producers are moving towards reducing the level of “greenhouse” gas emissions per ton during the manufacturing process.

4.3.5 Supply chain of cementitious products

Blenders are independent cement producers who purchase cement from clinker producers, then modify and extend for resale as a blended cementitious product. It is important to note that added volume of extended cement is not included in total cement demand, as data from blenders is not recorded.

The extended cement is then distributed through wholesale and/or retail trade “**resellers**” e.g. Ferreira’s, Mica, Cashbuild etc. The resellers will subsequently sell to small- and medium-sized builders, emerging contractors and DIY users.

Buyers such as the “**ready-mixed concrete producers**” are also significant purchasers of cement. The ready-mixed products are, amongst others, produced by Alpha and Lafarge. These products are more expensive but convenient, particularly when building sites are placed in dense locations or limited space.



Source: Concrete and Cement Institute

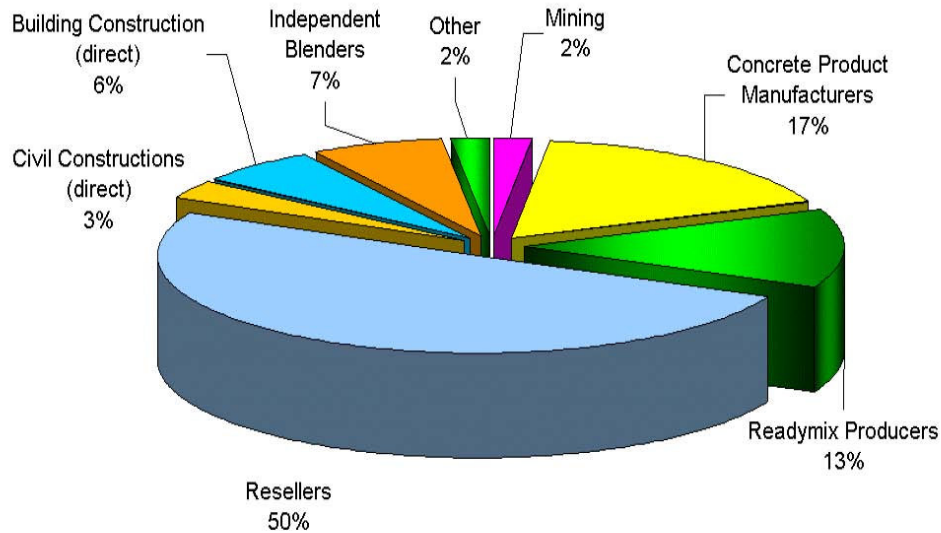
Figure 8: Supply of cementitious material

4.3.6 Sources of demand for cement

It is estimated that 50% of demand is driven by the residential building market, followed by non-residential building (30%) and construction works (20%). A drop in interest rates is a main driver of increased activity in the housing market. There has been significant growth in the informal building sector in the rural and semi-urban areas. It is estimated that the informal sector is responsible for over 20% of cement sales.

Growth in cement demand from **resellers** exceeded 16% in 2004, compared to 6.2% in 2003. The following shows that resellers are the largest buyers (50%) of cementitious products, followed by **concrete products manufactures** (17%) and **ready-mix producers** (13%). Cement demand from ready-mix concrete producers has been significant, posting 21.4% growth in 2004 compared to 5.6% in 2003.

Figure 9: Demand for cement by category of buyer

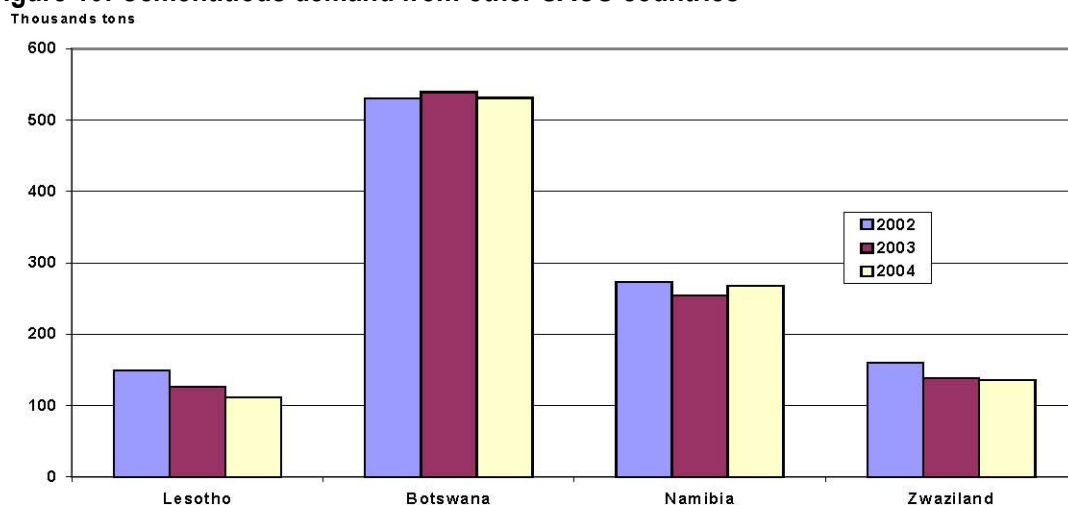


Source: Cement & Concrete Institute

4.3.7. Cementitious demand from the SACU region

According to the Concrete and Cement Institute, the volume of cement sales to other countries within the Southern African Customs Union (SACU) increased to 11.7 million tons in 2004, compared to 10.1 million tons in 2003. As illustrated in Figure 10, out of the four SACU states, only Namibia recorded positive growth, with its cement purchases from South Africa increasing by 5.1%. Cement purchases by Botswana declined by 1.5%, Swaziland's dropped by 1.7%, and Lesotho's cement purchases from South Africa fell by 11.6%.

Figure 10: Cementitious demand from other SACU countries



Source: Cement & Concrete Institute

4.3.8 Cementitious demand from South Africa's provinces

The following figure depicts growing demand for cement emanating from all provinces, in line with the building activity boom evident throughout South Africa. Gauteng obviously claimed the largest share of demand at 36% in 2004, followed by KwaZulu-Natal (15.1%) and the Western Cape (12.7%). In 2004, there was significant growth in demand for cement from the Eastern Cape (28%), Western Cape (25%), Gauteng (19%) and Mpumalanga (19%). Growth in demand from the Eastern Cape continues to accelerate due largely to infrastructural developments at Coega.

Figure 11: Cementitious demand from South Africa's provinces

As shown in Figure 12 below, Gauteng's per-capita consumption has risen to 422 kg/per person/year – that is, 17% lower than the EU average, but 2.7% higher than Turkey's per capita consumption, 11% higher than Egypt's, and 43% higher than Mexico's. The Western Cape province has also seen its per capita consumption of cement increase to 292 kg/per person/per year – basically similar to Mexico's average.

Figure 12: Per-capita cement consumption: Gauteng and Western Cape vs select countries



Source: Engineering News

Gauteng is expected to sustain high growth rates in per capita consumption due to its growing population and planned capital projects such as Gautrain, which is expected to consume about 270 000 tons of cement over its construction phase.

4.3.9 Sales of cementitious binders by product type

Cement sales grew by 15.5% to 11,7 million tons in 2004. Since the introduction of one CEM V cement manufacturer in 2003, there has been a shift in bulk sales from CEM IIB cements to CEM V and CEM III type cement (refer to Annexure A for brief descriptions of the main types of cement).

The shift reveals that cement clinker producers are moving towards reducing the level of “greenhouse” gas emissions per ton during the manufacturing process. The process of reducing the level of CO₂ emissions is achieved by manufacturing cement blended with fly ash, limestone or slag.

Table 4: Cement sales by product type

Product Types	2002 (tons)	2003 (tons)	2004 (tons)	%change 04 vs. 03
CEM I	2,146,053	2,198,581	2,965,651	22.6
CEM IIA	3,605,715	4,341,624	5,315,878	22.4
CEM IIB	2,278,044	1,735,430	1,071,178	-383
CEM III/CEM V	494,416	697,796	1,214,726	741
Masonry MC12.5	456	0	0	0
Masonry MC 22.5x	0	0	0	0
GGBS (Slag)*	501,777	585,760	670,535	14.5
Fly Ash*	118,808	136,726	159,535	16.7
Other	478,419	467,252	608,500	30.2
Totals	9,623,688	10,163,169	11,736,000	15.5

Source: Cement and Concrete Institute

It is important to note that there are additional sales of CEM V cement which are sold and used in the South African market, but these emanate from the blending companies who are not members of the Concrete and Cement Institute and therefore do not participate in the data collection process.

The table above indicates that masonry cement is no longer produced locally as it has been found to be unsuitable for road construction in the long-term. According to statistics from the Concrete and Cement Institute, and as shown in the table, granulated blast furnace slag (GGBS) appears to have been preferred over fly-ash for blending purposes.

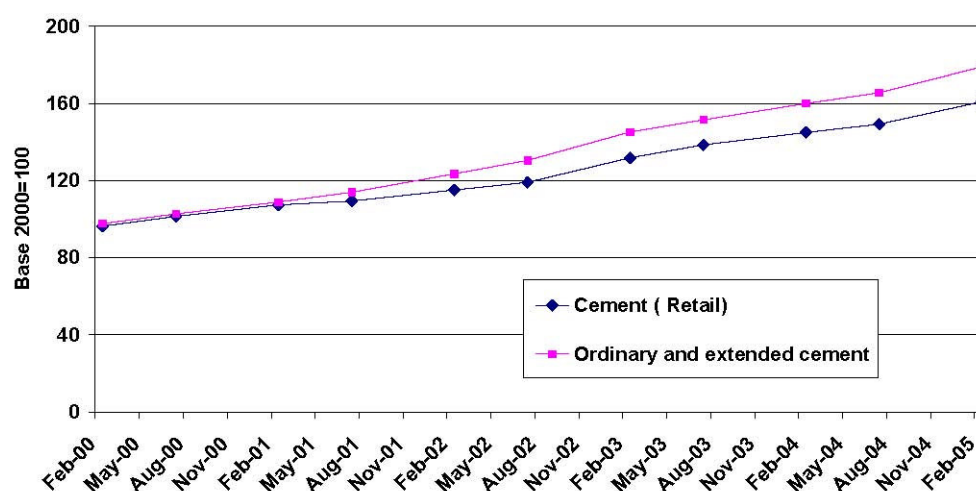
4.3.10 Pricing

The average price of cement has increased significantly since 1998. Retail prices currently range from R620 to R640 per ton, compared to some R300 per ton in 1998.

Cement price hikes have been largely driven by input cost increases (i.e. imported capital equipment and the use of more expensive road transport instead of inefficient rail transport). The average price increase in 2004, according to the Bureau of Economic Research, was 10.9%, which was high in international terms.

However, the new capacity expansion by major players is anticipated to weaken the industry's pricing power. The new capacity expansion is likely to reduce the cement industry's capacity utilisation to 68% by year 2008.

Figure 13: Producer Price Index – Cement (Retail) Ordinary and Extended Cement



Source: StatsSA

With the declining capacity utilisation, relatively high US dollar prices and increasing customer resistance, the pricing power of manufacturers is anticipated to moderate towards the average rates of increase in CPI and PPI over the next few years.

Table 5: Forecast cement price increase

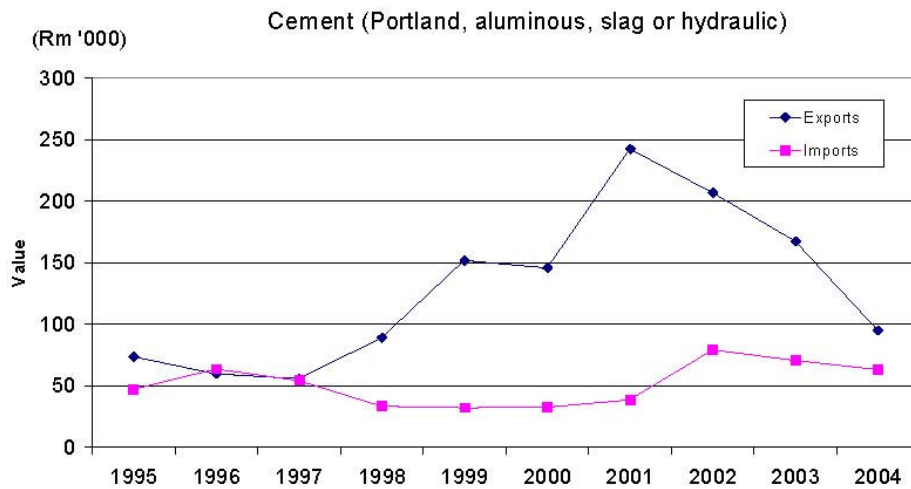
Forecast Cement Price Increases (%)				
	2004	2005Fs	2006Fs	2007Fs
PPI	2	6.1	5	5
CPI	5.3	6.4	5.5	5.5
Cement price increases	9.3	7.3	5.3	4.3

Source: UBS

4.3.11 Trade performance

The following chart shows that exports of South African cement have exceeded imports since 1997. A peak was reached in 2001 at R243 million in export earnings. However, the subsequent strengthening of the Rand had an adverse impact on export sales of South African cement, resulting in a sharp decline in excess of 40% since 2003. Nonetheless, the reduced export volumes were compensated by strong growth in the local market, which may lead to an increase in imports over the next few months as local producers run out of capacity.

Figure 14: Imports and exports of cement

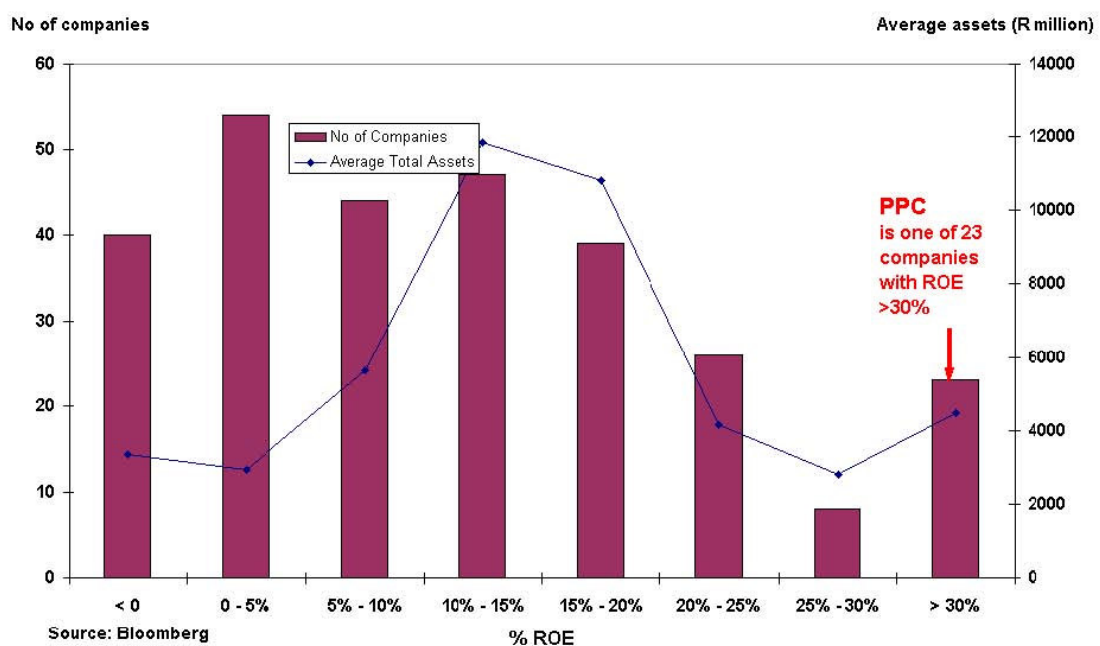


Source: Quantec

4.3.12 Financial returns of listed companies

Financial data provided herein pertains to international listed companies since PPC is the only South African cement company that is listed on the JSE. As shown below, on a global basis only 12% of the total number of internationally listed cement companies achieved over 30% return on equity (ROE) in 2004/2005. With an ROE currently above 35% and an asset base of R3.56 billion, PPC is in line with other international top performing companies.

Figure 15: Financial returns of internationally listed companies in the cement industry



5. THE CONCRETE INDUSTRY

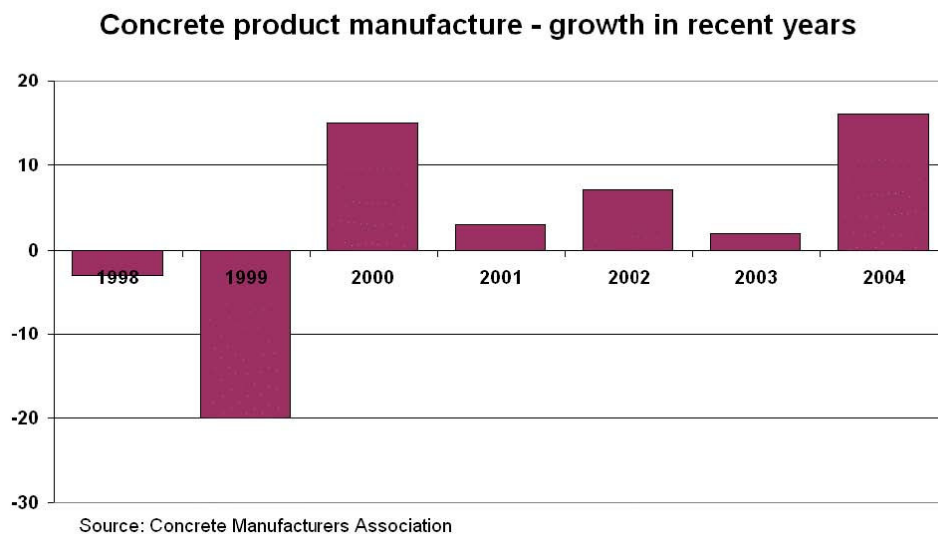
Concrete is a composite building material made from the combination of aggregate and cement binder. The most common concrete is Portland cement concrete, which consists of mineral aggregate (generally gravel and sand), Portland cement and water. Concrete is widely used for sidewalks, building structures, bases for gates/fences/poles and block walls.

5.1 THE CONCRETE PRODUCTS MARKET

South Africa's manufacturers of concrete products are major users of cement and account for about 17% of the country's cement consumption. Given the booming phase being experienced by the construction industry, the demand for a variety of concrete products such as roof tiles, floor tiles, garden walls, pavers, lamp-posts, slabs, cement bricks and pre-cast walls is on the rise, whilst demand for infrastructural materials such as concrete pipes, poles and manholes is growing steadily.

According to the Concrete Manufacturers Association, the demand for pre-cast concrete products grew by 17% in 2004 and the sector has also benefited significantly from growth in the use of roof tiles and paving tiles in township areas.

Figure 16:



Major challenges faced by the concrete manufacturing industry include shortages of raw material (such as clinker or pure cement), the scarcity of good quality materials other than cement (e.g. shortage of sand in the Western Cape), the high costs of imported raw materials, as well as stringent SABS standards imposed on imported material.

5.2 BRIEF OVERVIEW OF SELECTED CONCRETE PRODUCTS

Out of curiosity and to give a deeper level of information, this section of the feasibility study report focuses particularly on the following concrete products:

- Foamed concrete (also known as cellular, lightweight or gas concrete);
- Pre-stressed beams;
- Concrete lintels; and

- Chemical additives (used in the production of concrete).

Since published data on these concrete products is not available due to confidentiality issues, the following analysis is based on information gathered through interviews with the Cement and Concrete Institute (CNI) and the Concrete Manufacturers Association (CMA), whilst additional information on major players was obtained from the Ezeedex electronic database (refer to Annexure C).

5.2.1 Foamed concrete

Foamed concrete, which is also known as a lightweight, is a type of porous concrete that is produced through the mechanical mixing of foam with a concrete mixture. Foamed concrete has several advantages, including:

- Being an ageless and everlasting material;
- Preventing loss of heat in winter, while controlling humidity in summer;
- Being easy to process and trim;
- Flexibility in the sense of it being possible to produce in various shapes; and
- Weighing 10% to 87% less than standard heavy concrete, which makes it more convenient to transport.

In terms of the local supply market, foamed concrete is produced by a handful of ready-mixed concrete manufacturers. Although foamed concrete is commonly used in the mining industry, South Africa's market is not well established or may even be considered non-existent, with a couple of the reasons cited including a lack of marketing and the low survival rate of its manufacturers. A major shortfall of manufacturing foamed concrete is its high input costs, which are more than three times the input costs of ordinary heavy concrete.

5.2.2 Pre-stressed concrete beams

Pre-stressed beams are reinforced concrete beams in which reinforcement is incorporated in the form of rods, steel bars or fibres in order to strengthen the brittle concrete. The term "pre-stressed" refers to a technique embedding steel in concrete shapes so that the end result will meet design specifications for strength and rigidity. Pre-stressed concrete beams vary in uses, sizes and shapes. For example, concrete lintels (see 4.2.3 below) are a form of pre-stressed concrete beams.

Information gathered from the CMA and CCI highlighted the following with regard to pre-stressed beams:

- There is a growing demand for concrete beams, particularly in the building and civil construction industry;
- Pre-stressed beams are usually manufactured on the construction site due to their weight, size and transportation costs;
- The manufacture of beams requires highly specialised technology coupled with engineering expertise; and

- Pressed beams compete with structural steel beams, with steel beams being cost-effective in terms of production and accounting for about 50% of the market share of beams.

5.2.3 Concrete lintels

Lintels are made of high-strength concrete and wires of special steel. The effectiveness of lintels relies on the properties of the interaction between the concrete and the wires. Horizontal lintels form the upper part of a window or door frame and support part of the structure above it.

The following are some of the characteristics of concrete lintels:

- Lintels are commonly used in the building of residential dwellings and may be purchased from merchants of building materials;
- Although it is cost-effective to produce lintels, a large-sized plant is required;
- The production process is capital-intensive and requires sophisticated and automated machinery and equipment; and
- The production of quality concrete lintels is a major concern, as highly skilled personnel is necessary for their design.

5.2.4 Cement and concrete additives or “add mixture”

Additives are organic or non-organic materials in the form of solids or fluids that are added to the concrete to give it certain characteristics. In normal use, additives make up less than 5% of cement weight. The most commonly used types of additive are:

- *Accelerators*: to speed up hydration (strengthening) of the concrete;
- *Retarders*: to slow down the hydration of concrete;
- *Air-entrainers*: to add and distribute air to the concrete; and
- *Plasticisers*: to increase the workability of concrete.

According to the Freedonia Group, world demand for cement and concrete additives is projected to rise by 6.8% per year to US\$6.7 billion by 2008. The industry is expected to benefit from an improving construction outlook which, in turn, will boost demand in the global cement and additives market. It is estimated that about 95% of global demand for cement and concrete additives is concentrated in North America, Western Europe and the Asia-Pacific region.

The South African market for chemical additives or “add mixtures” is relatively small and dependent on imports. However, there is potential for growth in the use of chemical additives as the demand for concrete products is growing. Ready-mix concrete manufacturers, who enjoyed a growth of 29% in 2004, are expected to increase their consumption of chemical additives. The use of other forms of “add mixtures” such as pigments, which are used for colouring concrete products, is also showing signs of growth. Again, skills shortages remain a challenge as the applications and uses of chemical additives require specialised expertise and technology.

6. DEVELOPMENTAL IMPACT OF THE CEMENT AND CONCRETE INDUSTRIES

6.1. EMPLOYMENT

The cement and concrete industries are amongst the least labour-intensive of South Africa's industries. As indicated earlier in the report, modern cement plants are highly automated and in some cases fewer than 300 people may be employed in a large-sized cement plant. However, there is an indication that these industries have a significant multiplier effect – that is, the creation of direct and indirect employment for people who work in the supply chain, such as suppliers, transporters and other roles.

The multiplier effect is more notable in sub-sectors such as the manufacture of concrete products. This implies that less workforce is required in the production process while more employment is required in the distribution and application process of, for example, floor or concrete block paving, concrete roof tiling, etc.

6.2. BLACK ECONOMIC EMPOWERMENT

The cement and concrete industries are characterised by poor progress with regard to participation in BEE initiatives, which mainly occurs through the acquisition of stakes and the procurement of services.

To date, only two major BEE transactions were concluded:

- NAWA (National African Woman's Alliance) has bought a stake of 26% from an NPC-owned aggregate quarrying company, South Coast Stone Crushers; and
- Nozala Investments, a black empowerment women's investment holding company bought 25% shareholding in Afripak, a packaging subsidiary of Pretoria Portland Cement.

Participation in BEE is expected to change as the Department of Public Works is in the process of concluding a "Construction Charter" and more industry players are embracing the "Mining Charter" and Broad-Based BEE strategies.

6.3. TOWNSHIP AND RURAL DEVELOPMENT

As part of their Corporate Social Investment (CSI), most of the major industry players have realised the importance of skills and entrepreneur development amongst historically disadvantaged communities. For example:

Natal Portland Cement recently identified about 110 small businesses with the aim of training and developing them into viable and sustainable enterprises within the Durban region. NPC is involved in providing training courses for blockyard operators and other cement and concrete users in a sustainable business and skills outreach programme; and

PPC has sponsored and supported community projects, including brick making, women's housing projects, training of BEE cement merchants attached to the Nqgura (Coega) project, as well as sponsoring training programmes for emerging contractors.

The role of the cement and concrete industries in the development of rural communities may be considered insignificant, with the exception of their relationship to the mining of raw input materials. The cement and concrete manufacturing processes use limestone, clay or shale which are extracted directly from mining operations. Most of the lime quarries are located in rural areas and, as a result, provide employment for rural communities. PPC has shown commitment in reserving jobs through its process of rehabilitating its mines (limestone and clay or shale mines).

7. THE CEMENT AND CONCRETE INDUSTRY – SWOT ANALYSIS

<u>STRENGTHS</u> • Low energy costs. • Access to mineral deposits. • Job losses not expected in the next five years. • South Africa is well positioned in the manufacture of finished concrete products.	<u>OPPORTUNITIES</u> • Growing demand and investment in the residential and non-residential building market. • Cement demand from capital projects, e.g. Coega project and SOE capex programme. • Infrastructure developments leading up to the 2010 Soccer World Cup. • Expanded Public Works programme e.g. growing demand in social housing.
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<u>WEAKNESSES</u> • Lack of innovation in the use or application of cement and concrete. • Uneconomical transport infrastructure. • Barriers to entry in the cement industry due to the capital-intensive nature of the industry and very high establishment costs. • Skills shortages in the manufacturing of various types of concrete products.	<u>THREATS</u> • Anticipated shortages of cement considering the high level of demand. • Surge in building costs and house prices. • Sustainability of the industry after 2010. • Potential bubble in the housing market. • Shortages of raw materials, e.g. major players such as NPC have started to import clinker from Brazil. • HIV/AIDS.
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8. COMPETITIVE PLATFORM

Key:

+ Positive,

0 Neutral,

- Negative

Demand conditions

- Increasing demand from the construction industry (+)
- Looming cement shortages (-)
- Long-term demand after 2010 Soccer World Cup, e.g. demand for social housing (+)
- Strong currency affecting exports (-)

Government

- SABS standards governing the manufacturing of cement (+)
- Environmental legislation (0)
- Lack of monitoring mechanisms in the application of products (-)
- Delays in delivery of low cost housing (-)

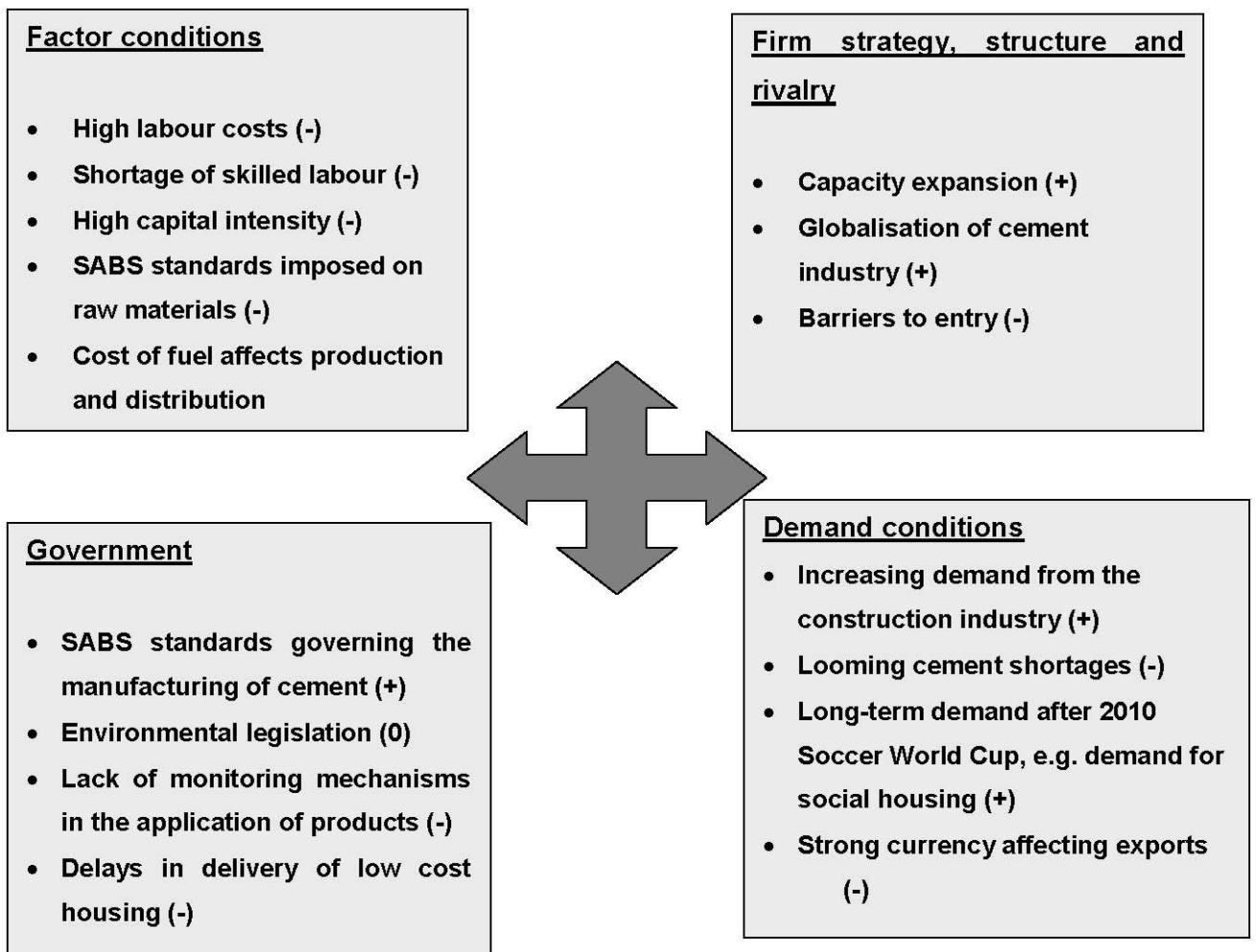
Firm strategy, structure and rivalry

- Capacity expansion (+)

- Globalisation of cement industry (+)
- Barriers to entry (-)

Factor conditions

- High labour costs (-)
 - Shortage of skilled labour (-)
 - High capital intensity (-)
 - SABS standards imposed on raw materials (-)
 - Cost of fuel affects production and distribution
-
- Related supporting industries
 - Access to raw materials (lime quarries) (+)
 - Availability of chemical additives (-)
 - Supplier of pure cement to construction industry (+)
 - Cyclical nature of construction sector (-)



9. INDUSTRY OUTLOOK

The Cement and Concrete Institute projects a growth rate of between 6% and 10% in the cement and concrete industry in 2005/2006 due to the following factors:

- Investments in capital projects are set to boost the utilisation of cement in greater volumes, with the cement and concrete industry standing to benefit substantially from: the capital expenditure programmes of state-owned enterprises, particularly Eskom and Transnet; the Expanded Public Works Programmes; the construction of new stadiums or upgrades leading up to the 2010 Soccer World Cup, as well as road developments and airports upgrades; the Gauteng rapid rail project; and, among others, the infrastructure needs of the Coega industrial development zone;
- Non-residential building has not been as buoyant as the housing market. Given the positive outlook for interest rates, investment in non-residential buildings is expected to accelerate during the next few years;
- Population growth and strong consumer demand creates the need for more suburban shopping centre developments;
- The Department of Housing is expected to deliver about 2.1 million houses by 2006/2007; and
- Stronger than previously anticipated demand from the informal sector, which accounted for up to 20% of cement demand in 2004 and is likely to increase over the next few years.

Although the high levels of investment activity in the residential market have been supported by favourable factors such as a growing black middle class, low interest rates and overall strong economic growth, a slowdown or decline in residential construction is anticipated due to rising building costs, a perceived peaking of house prices, and the decreasing availability of suitable land.

10. GAP ANALYSIS

Market Gaps	Opportunities	Risks	Development returns
Looming shortages of cement	Establishment of cement plants, both in SA and elsewhere in the SADC region.	- High establishment costs. - Cement and concrete are highly dependent on the performance of the volatile construction industry.	- Indirect job creation. - Meet cement demand from local and regional construction industry.
Lack of finance for small independent cement blenders and ready-mix concrete industries.	Potential for growth in the blended cement and concrete making industries.	Compliance with SABS standards can prove to be costly for small manufacturers.	- Job creation. - Poverty alleviation.
Absence of concrete recycling in South Africa.	- Establishment of concrete recycling plants, especially in townships and rural areas. - Supply finished products (aggregates) to cement manufacturers and blenders. - Technology used for limestone crushing can also be used for concrete recycling.	- High cost of transporting rubble and secondary aggregates might make business unviable. - Concrete recycling is still a new concept in SA, although already in use in Europe, Australia and USA. - Shortage of skills.	- Conserve aggregates, which are non-renewable resources. - Creation of jobs in rural and township areas.
Poor participation in BEE initiatives.	Promote BEE participation in the industry through Development Financial Institutions financing activities.	Penetrating the existing markets which are dominated by foreign-based big players.	- Job creation. - Skills transfer and development. - Share ownership by HDIs.

11. THE IDENTIFIED BUSINESS OPPORTUNITY

Maqhawe Technical & Financial Services has identified the most valuable business opportunity for the utilization of ash on behalf of the Waterberg District Municipality and the technology provider and investor into this project shall be the MEGA-Tech Engineering B.V.

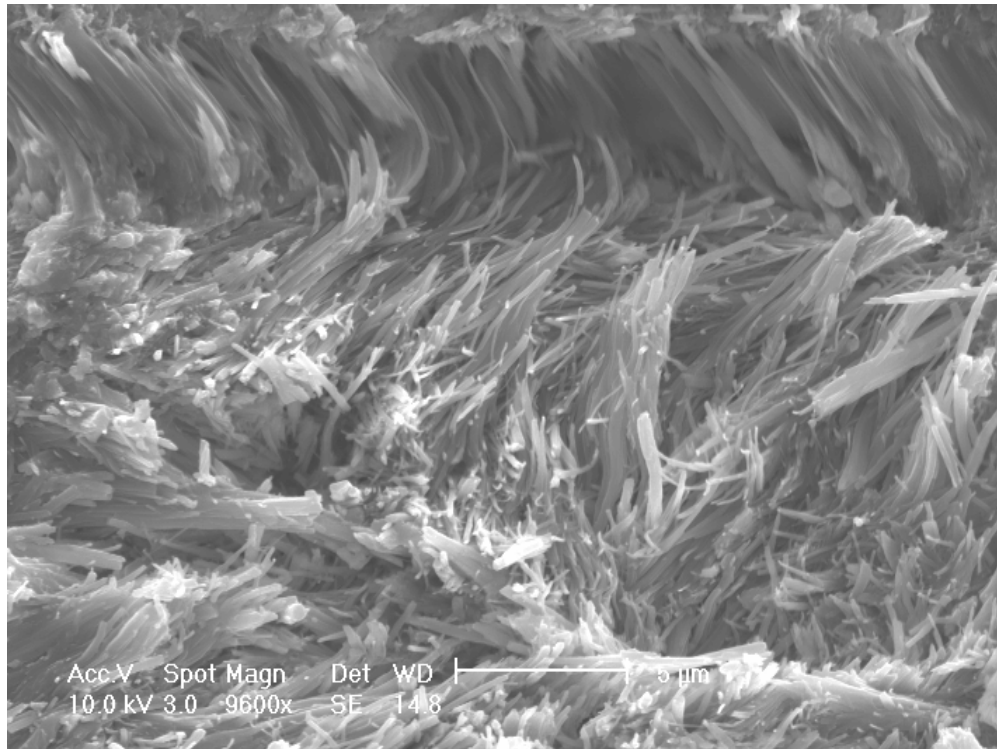
MEGA-Tech Engineering (MTE), which is a company registered in the Netherlands, have developed a ground-breaking product called PowerCem. PowerCem is the brand name for an extra-ordinary stabilization and immobilization product. It is a very fine grain sized additive, which consists of alkaloid, earth-alkaloid elements and zeolites complemented with complex compounds. It is a medium which enhances and increases the quality of cement bounded materials in stabilization and immobilization works. Applications have shown that organic and/or chemical/toxic contaminants can be treated effectively.

Environmental investigations and testing on the end-product has shown that this activator is environmentally friendly. This is indicated and reported by Dutch accredited laboratories after investigating the leaching behaviour of composite materials for a period of 100 years. Composite materials stabilised/ solidified using PowerCem have successfully passed the Dutch Environmental Tests and have been proven to be qualify as Category 1 Building Materials according to the Dutch Building Materials Decree.

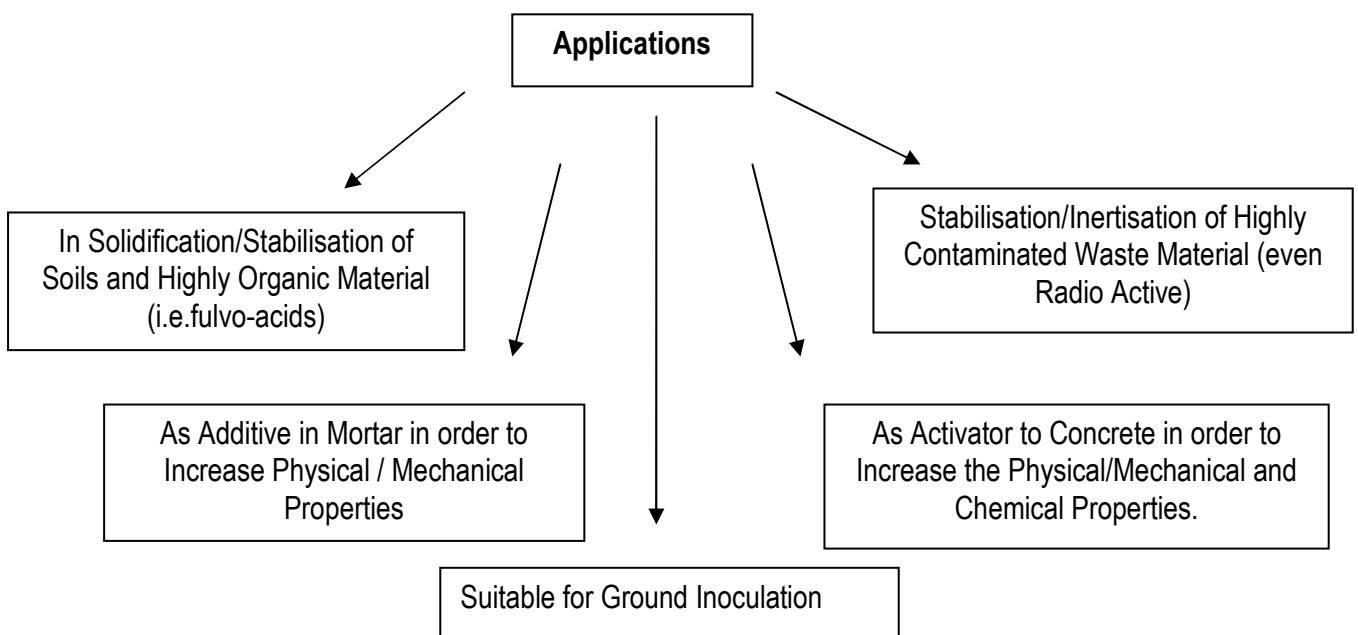
How does PowerCem looks like?



PowerCem accelerates and activates the crystallization process by forming long needle-like crystalline connections in contrast to the short crystalline formations that the ordinary cement forms. It is able to delay or speed up the hydration process. These crystalline formations are clearly illustrated in the figure below. It is also illustrated that the long needle formations are in every direction therefore increasing the strength parameters in every direction.



PowerCem can be used in combination with normal cement in order to increase the properties of cement bounded materials or to enlarge the field of application were cement alone fails. The following diagrammatic illustration gives the full variety of the product applications.



11.1. BACKGROUND

MEGA-Tech Engineering (MTE) has already developed a detailed Business Plan on the implementation of their PowerCem Fly ash mix in South Africa and with their permission, the highlights of this Business Plan shall be shared with the Waterberg District Municipality in the following sections of the report.

The Business Plan was developed to fulfil the requirements of the Department of Trade & Industry (DTI's) Industrial Participation Internal Control Committee, which requires that once a proposal has been approved to qualify for support through the off-set agreement a bankable Business Plan needs to be submitted. For this Fly ash proposal the initial submission date was the 30th June 2005. This date was however extended to the 31st December 2005 due to the request from the beneficiaries and the parties involved in the initiative.

On the 27th December 2004, the technical proposal to convert thirty million tonnes of fly ash was submitted to the DTI. This was approved on the 17th March 2005 on condition that a bankable business plan, with the involvement of the obligors is submitted before the end of December 2005.

As a built up to the development of the business plan obligors and potential role players were invited to participate in the project. These included:-

- Eskom, as the sole provider of fly ash,
- BAE Systems, as an obligor,
- Industrial Development Corporation, as an investment partner,
- Two cement producing companies to provide cement to the project,
- Private Investors to increase the participation of previously disadvantaged investors,
- Science Councils (i.e. CSIR and SABS) and
- Beneficiaries, which includes National Union of Mine workers, small medium enterprises and Women groups.

This resulted into the buy-in and support of the project by BAE systems as an obligor, Industrial Development Corporation, ESKOM, the office of the Minister of Trade & Industry, South African Bureau of Standard (for the certification of the product) and the Council for Scientific and Industrial Research (CSIR).

While CSIR acted as the scientific evaluator of the technology and product, it also adopted the project as one of the projects to be discussed under CSIR/DTI bilateral agreement.

11.2. OBJECTIVES OF THE PROPOSED BUSINESS OPPORTUNITY

The main objective of the proposed Enterprise is to convert 30 million metric tonnes of pulverised fly ash produced by thirteen Eskom's Power Stations into a high-grade cement alternative for local and international export markets. This objective will be achieved by premixing the Fly ash, PowerCem and the Ordinary Portland Cement to produce a stabilizing material to be used as a cement alternative for civil engineering, road construction, mine rehabilitation and environmental management. Preliminary testing of the product by the CSIR has confirmed that the product is excellent for road stabilization.

11.3. RESOURCE AVAILABILITY

More than 300 billion tonnes of fly ash are produced in the world per annum. South Africa alone produces more than 30 million metric tonnes and this is expected to increase with the establishment of the new power stations that are planned to meet the increasing country's energy demands. For example at Lephalale, there is already an advanced plan for the Matimba Power Station # 2, which will double the current 5,4 million tonnes of fly ash production to 10,8 million tonnes per annum. There is currently about 70 million tonnes of fly ash on the dumps at Lephalale.

In South Africa only about 4% of the total fly ash produced is profitably utilized. This is due to limited capabilities of technologies currently applied to exploit fly ash as a resource. However mixed with PowerCem at a ratio of 1% (PowerCem), 40%(Ordinary Portland Cement) and 59%(Fly-ash), Fly ash is converted into a high grade cement binder and soil stabilizer that is used in civil works, concrete and construction.

The use of fly ash as a resource within concrete industry has been practiced in South Africa. In South Africa this industry has developed in a rather unique, somewhat different way to similar industries else where in the world. Recognising the opportunities associated with fly ash, which at the time was regarded as worthless waste, the research community, i.e. National Research Foundation (NRF), CSIR and selected universities provided the fundamental science and technology for sustainable application well before either power generators or cement and construction industries could realize the value of fly ash. Through collaborative research, South African Fly ash industry was thus born with an association of huge mountains of waste of little or no value. Initially the research activities on Fly ash were focused on:

- Alumina,
- Soil amelioration,
- Waste immobilization,
- Refectories,
- Clay bricks,

- Road stabilization,
- Processing aids and fillers for polymers,
- Zeolites,
- Counteracting acid drainage,
- Mine backfilling,
- Functional fillers for rubbers and
- Usage in Cement, Concrete and allied products.

With the introduction of PowerCem in the industry, which is capable of increasing critical parameters of cement and concrete, fly ash has now turned to be a valuable resource that will sustain the infrastructure development needs of Africa and the World.

11.4. TECHNOLOGY AND INNOVATION TO BE USED

PowerCem is a brand name of an extra-ordinary stabilization and immobilisation product. It is a very fine grain sized additive, which consists of alkaloid, earth-alkaloid elements and zeolites complemented with complex compounds. It is a medium which enhance and increase the quality of cement bounded materials in stabilization and immobilization works. Applications have shown that organic and/or chemical/toxic contaminants can be treated effectively through PowerCem. Environmental investigations and testing on the end-product has shown that this activator is environmentally friendly. This is indicated and reported by accredited laboratories after investigating the leaching behaviour of composite materials for a period of 100 years. Composite materials stabilized/solidified using PowerCem has successfully passed the Environmental Tests and has been proven and can be used as Category 1 Building Materials.

11.5. MANUFACTURING PROCESS

11.5.1. INTAKE

The Fly ash will be taken directly from the precipitators via a system of transfer from existing outlet to the intake port of the blending plant. The intake port will be provided with an overload system to offset the excess material to the existing Power station dump site. If, for any reason the blending plant is not able to digest the inflow of Fly ash from the inlet port, the Fly ash material will be conveyed by an appropriate conveyor system and distributed to the buffer silos of each mixer. If and when the moisture content is detected to be higher than normal (i.e. wet), the Fly ash will be conveyed to the dryer before being transferred to the buffer silos of the mixer.

The weight of Fly ash will be monitored through a digitised weighing and monitoring system. The data collected will be journalised and saved into the ICT systems for analysis by the management.

At the end of each work shift an update Fly ash buffer Silo Stock and Journal will take place to signal the intake port to convey supplemental stock.

11.5.2. INTAKE: POWERCEM

PowerCem will be delivered through the containerised bags of 1500 Kg. These will be delivered to the site and as required will be pneumatically transferred from the bags to PowerCem holding silos for each mixer. At this stage PowerCem Waybills will be checked against the procurement and delivery order.

Data entry for the resource management system will be entered from the station into the main system. This will be followed by the update of stock of PowerCem and Journalising of the data for processing.

11.5.3. INTAKE: CEMENT

The cement will be procured from local and foreign sources. The required amount of cement is estimated to be in excess of 10 million metric tonnes. Notably, the combined production of cement in South Africa is 14.2 million metric tonnes per annum, thus even with the planned increase in cement production capacity may not be enough to supply the proposed PowerCem, Fly ash premix project. It will thus be of strategic importance to source cement from foreign producers. It must be noted that the current cement demand in South Africa is well beyond the production capacity.

Data will be entered into the resource management system from the unloading point. The weigh-bill will be checked against the procurement order. Expected mode of packaging from the supplier will be containerised bags and emptied pneumatically to the holding silos at the unloading station. This will be flowed by an update Stock of Cement and Journalising of the data for processing.

11.5.4. BAGS/PALLETS/ CONTAINERS

Bags will be procured from local manufacturer according to the required specification. At full production and estimated 3.5 million bags will be required a day. At each delivery the Weigh-bill will be checked against the procurement order and the data will be entered in the ICT resource management system. This will be in the form of Bags-Pallets-Containers as per the procurement order. The pallets will be manufactured and supplied by local manufactures. However, because of the anticipated large quantities of 58000 pallets per day at full production it will be necessary to source potential suppliers at the earliest convenient time. Data entry to the resource management system will be transferred from the unloading station into the main

system. The Weigh bill will be checked against the procurement order. The incoming material will be unloaded and transferred to the designated warehouse. This will be followed by the update of stock of bags and pallets and journalising of the data for processing.

11.6. PRODUCTION PROCESS

11.6.1. INTAKE

When the moisture content is detected to be high, the fly ash will be transferred to the drying facility via a digitised load cell, to measure the quantity according to capacity of the dryer. The resource management system will record all relevant data and updates stock register time and journalise data for further processing. From the dryer the fly ash will be simultaneously recorded and the stock will be updated and time will be registered for further processing. The second intake will be PowerCem and shall be delivered according to the required ration followed by the last intake of cement.

11.6.2. BLENDING

The blending process will be a homogenous mixing of three materials, i.e. Fly ash, PowerCem and OPC (Cement) in a prescribed ratio and speed. The blending will take place in a batch mixture of sufficient capacity and which creates within a programmed time period a homogenous blended end product.

The blending process will take place in three stages. First the amount of Fly ash will be loaded into the mixer. While the mixer runs with the Fly ash, PowerCem will be added into the mixer and subsequently the OPC cement and the mixer will continue to run until the prescribed time is exhausted. The bottom of the mixer will be opened at the correct time and the mixture will be discharged into a buffer intake hopper for bagging or to the pneumatic transport to the bulk silos and / or big bag packaging. The production process will take place in 24 hours with 5 shifts to facilitate continuous production. All machines will be centrally controlled through the command and control room through direct connections to the resource management system for processing.

11.7. PACKAGING AND DISTRIBUTION

The product will be made available to customers in 25 kg bags, big bags of 1500 – 2000 kg or in bulk. The 25kg bags will be bagged with a bagging machine connected to the buffer hopper and operated by two operators once the command and control room release the machine for operation. The 25kg bags will be sealed and released onto the discharge conveyor to the pallet carousel which will also serve as a buffer for the hand operated palletising.

From the pallet carousel the bags will be hand stacked on the pallet up to 10 or 12 layer of six bags per layer. The pallets will be rolled into a foil installation to wrap all individual pallets with foil wrap. From the foil installation equipment the pallets will be placed on a roller automated

conveyor for further transfer to the warehouse or distributor centre and subsequently to the loading bays for dispatch to customers.

The distribution centre will distribute the pallets to different loading bays where the trucks and railway wagons will be docked for loading. Bill of loading and packing list will be printed at each loading port. Data will be fed back to the resource management system for the accounts receivable department through automated invoicing.

The big bags on pallets will be pneumatically filled from the buffer hopper and placed on roller conveyors to the warehouse or distribution centre. The distribution centre will convey the big bags to the big bag loading bay transport or will be directed to the containerisation bays for dispatch in containers for export.

Data of the big bags will be led back to the resource management system for the accounts receivable department for automated invoicing. The bulk product will be transported from the mixer discharged buffer hopper pneumatically to the end product bulk silos for storage. The order portfolios will determine the packaging of big bags from packaging station. The bulk tankers/trucks will be pneumatically charged at the bulk loading port and data will be fed to the resource management system for the account receivable department through automated invoicing.

11.8. MARKETING PLAN AND ANALYSIS

Three market segments have been identified for this Fly ash, PowerCem and OPC premix product. These are Stabilization, Immobilization and Mining. Each segment is explained from the viewpoint of delivering relevant products and services. Customer potential has been analysed with a view of branding of the product and branding the services around the product. For this purpose a Competitor analysis has been performed. The result of this analysis is that within the three segments there are hardly any competitors of the product. Furthermore, the necessity of Strategic Business Partnerships is pointed out. A SWOT Analysis is then discussed. To define the USPs (Unique Selling Points), first an overview of the Unique Product Qualities (UPQS) is given. For the Marketing and Sales Department it would be necessary to fully understand the Critical Success Factors. This will finally result into a Marketing Strategy with a Vision, a Mission statement and a marketing approach in which the Marketing Mix (Price, Promotion, Product, Place and People) is formulated.

11.9. MARKET SEGMENTATION

Fly ash Technologies will operate within the following markets:

11.9.1. The Stabilization Segment

- Infrastructure,
- Civil Engineering,
- Building material,
- Agricultural engineering.

11.9.2. The Immobilization Segment

Remediation of contaminated soils,

Contaminated water remediation,

Waste recycling.

11.9.3. Mining Industry

Mine slime treatment (to render it harmless, reducing environmental impact),

Mine dumps cladding (to stop the environmental hazard to the population),

Mine rehabilitation disuse mine (back fill or water proofing),

Mine rehabilitation asbestos mines,

Mine shaft waterproofing,

Mine dump utilization for building materials and road construction.

11.10. STABILIZATION MARKET

Stabilization is a process of taking any available material *in situ* and homogenously mix it with the premix product and water to create a composite material which has strong physical and unique chemical properties that make it suitable for other applications. In this process it does not matter whether the material is contaminated with pollutants as all pollutants will be stabilised and immobilised and will not be available to the environment again.

11.10.1. Infrastructure

The premix composite material is most suitable to construct road base and wearing course. South Africa has 500 000 km of unpaved road that is older than 40 years, thus the product will be needed to improve these roads. With the proposed investment plan of R420 billion in infrastructure, it is clear that the premix product will find a share of the market through this Government budget.

Moreover the fact that premix will create a substantial reduction in the construction costs of up to 40%, this will serve as an additional strong selling point. The Unique Product Qualifications (UPQs) will also deliver an economical cost competitiveness. The UPQs for Road Construction may result in materials reduction of more than 50% which not only results in materials costs, but also in costs for foundation construction (i.e. reduction of materials displacement, logistics & transportation, temporary storages, depots, etc).

11.10.2. Civil Engineering

Any Civil engineering works, like dam, harbour terminal, airport runways, rail, road construction and any works that involve earth movement like embankment and bunds will take advantage of the composite material properties, especially from the point of view that the composite material is chemically inert. This means that the composite material will not be subjected to the wear and tear of even adverse climatic conditions and thus will not deteriorate over time.

11.10.3. Building Material

Manufacturing of bricks with low-grade material is suitable for urban and rural community. This holds an advantage for the communities as it reduces the costs of expensive transportation of raw materials. The scenario of application in this market segment is multi-fold.

11.10.4. Agricultural Engineering

With the specific properties of the premix composite material the challenges of agricultural engineering to control erosion, irrigation canals, and all other works can be addressed.

11.11. IMMOBILIZATION MARKET

Immobilization of waste materials is another possible market. Using PowerCem, Fly ash premix, performs immobilization. The premix will capture the waste in a matrix on micro level.

11.11.1. Remediation of contaminated soils

With the current discovery, here is South Africa that contaminated soils can be treated successfully with the composite material. This will open the market for the product within the soil remediation sector.

11.11.2. Waste recycling

The above statement (and the overall project) indicates that the product is capable of replacing current methods of waste management whereby waste is converted into a valuable resource whether this is of domestic or industrial nature.

11.12. COMPETITOR ANALYSIS

PowerCem, Fly ash Premix product is not in competition with concrete and cement, because of the small utilization of concrete and cement in the market areas. In South Africa only 280,000 metric tons of cement are used in the stabilization sector, and hardly any cement or concrete is used in the other sectors.

PowerCem, Fly ash Premix is in direct competition with refuse incinerators as a mode used to get rid of waste and contamination and other modes of operating with waste like waste dumping, etc.

When we look at the composite materials of PowerCem, Fly ash Premix, the competition in the waste sector is a driver. In concrete roads, Fly ash is largely used. With concrete the maximum percentage of Fly ash to be used is 7% (Netherlands), while in some countries a higher percentage is acceptable (India up to 30%). In South Africa, CSIR, through its conducted tests has recommended that with a content of 59% of Fly ash, the material is suitable for road stabilization.

As waste material is not used in incinerators, no contamination is brought into the environment. The matrix around the contamination has endured tests of pulverizing, drilling, etc.

All in all it can be concluded that the only product with which PowerCem, Fly ash Premix will compete with is PowerCem itself.

11.13. STRATEGIC BUSINESS PARTNERSHIPS

The construction sector is very conservative and legislation around construction projects is very tight. The most natural approach in this circumstance is to develop strategic partnerships with the larger players in the construction industry. As this will not be possible in the first years, a strategy to reach this goal will have to be developed. The certification process to be initiated with the SABS will upon completion develop confidence on the technology within the sector and will open doors for strategic partnerships.

11.14. SWOT ANALYSIS

11.14.1. Strengths

Cheap Material – although the basic product costs R2,150 per metric ton, the application as a stabilizer, immobilization material of infrastructure material is cheap because between 82-92% of the soil can be used, in which case the end product is 40 - 60% cheaper;

Proven Market – In the past years Fly ash premix has been proven as an infrastructure construction material on the A2 in Poland (Poznan) and several tests in South Africa have proven that Fly ash Premix is stronger, cheaper, and weather proof – also in tropical areas.

11.14.2. Weaknesses

- **New Company** – Fly ash Technologies is a start-up company with historical background; this problem will be mitigated through the development of business partnerships with the multinational business partners;
- **Regulation** – The largest challenge is the monolithically innovation culture and the regulations within the construction market in the Western countries; due to the legislation around the use of new products, new ways of production and new ways of contracting. These make it difficult to introduce new products and production methods.

The introduction of new products and production methods is a long-term process and will be approached in the following ways:

Use PowerCem, Fly Ash Premix in contamination and waste projects worldwide;

Start construction projects in developing countries where the legislation is adaptive;

Work on promotion of PowerCem, Fly ash Premix as a new way of construction engineering;

The initiated process of certification with SABS to obtain the SABS mark and publication thereafter in the Government Gazette as an approved binder.

- **New Applications** – The combination of new base materials (materials like soil, contaminated materials, etc.) will always have to be scientifically engineered and evaluated, because the blending of materials with PowerCem, Fly ash premix creates a new product;

To accommodate these new applications a special Business Unit within Fly Ash Technologies Engineering will be founded.

- **Warranties** – Many construction companies give guarantees for their buildings and construction works. Scientific proof of durability tests will be not be enough. In many cases insurances for the construction projects results will be necessary;

11.14.3. Opportunities

- Hardly any competitor;
- High Customer Potential;
- Several very large projects on the verge of execution;
- Back-up of the South African Government;
- Strategic Business Partnerships.

Limitless opportunities – Further research and product development will not be limited to the base product (PowerCem, Fly ash Premix), but specifically towards new types of applications. The fact that PowerCem, Fly ash Premix develops a matrix around the added material, its unique strength characteristics, its impermeable, its plasto-elasticity, etc will result in new properties in applications that are not foreseeable at this moment.

11.14.4. Threats

- Low to no Brand perception;
- Take-overs by Large and Financially strong multinationals;
- Fly ash is associated with cancer: ill-willing companies may take advantage of this.

11.15. CRITICAL SUCCESS FACTORS

- The market that is easiest to penetrate is the waste market;
- Due to regulations, the non-Western construction markets are easier to penetrate;
- When participating in construction projects it is necessary to be able to give warranties and insure the projects against engineering and construction errors;
- To insure that the new applications or mixtures with new materials will deliver the promised results, it is necessary to set up a Business Unit that shall help engineers and evaluators of Business Partners (Construction Projects) – Fly ash Technologies Engineering;
- Fly ash Technologies Engineering will have to be responsible for pending patents and managing technical claims;
- To manage threats from building materials/cement producers, it is necessary to set up Fly ash Technologies' own PowerCem, Fly Ash Premix factories worldwide. Ensuring that

production is not sabotaged and especially the geographically spread of the factories, will not only help to build up defences against these producers, but also endure possible peaks in the demand can be handled.

11.16. MARKETING STRATEGY

11.17. ORGANISATION

Each factory will be managed by a Factory Manager. Factory Managers will be responsible for the overall general management of workings in the factories and factory offices and will be accountable to the Head Office housing the office of the CEO.

11.18. PROJECTS AND OPPORTUNITIES FOR THE PRODUCT

11.18.1. SOUTH AFRICA

- Merafong Dolomite Project 140, 000 tones;
- Merafong City Municipality Roads 91,000 tones;

- Merafong City Municipality Storm Roads 17,500 tones;
- Merafong City Municipality Sewage 14,000

The following half year the following projects come of age:

- Sedibeng City Municipality Roads 24,780 tones;
- Governmental Infrastructure Projects 1,350,000 tones/quarter
- Mine Slime Treatment 5,250 tones/quarter

Fly ash technologies also foresee an opportunity for the production of sleepers in the Railway Infrastructure area, starting in the second half of their year of operation with a plausibility of 60% 1,125,000 tones/quarter

Most projects will start in the second half of the year of operation:

- Private sector infrastructure projects 87,500 tones/quarter;
- Mining Infrastructure projects 21,250 tones/quarter;
- Remediation of Contaminated Soils 43,750 tones/quarter;
- Waste Recycling 52,500 tones/quarter;
- Mine dumps cladding 6,563 tones/quarter;
- Mine Rehabilitation Disused Mines 5,250 tones/quarter;

In the third year of operation it is foreseen that the following projects will start:

- Mine Rehabilitation, Asbestos Mines 2,500 tones/quarter;
- Mine shaft waterproofing 13,125 tones/quarter;
- Mine Dump Utilization 18,250 tones/quarter.

And there are many projects that are foreseen in the SADC countries by Flyash Technologies thereby expanding their market size.

12. CONCLUSION

Maqhawe Technical & Financial Services is pleased to declare that we have reached the expected milestone of our assignment given by the Waterberg District Municipality of identifying the business opportunities of utilizing the Fly ash generated by the Matimba Power Station as an input material for the construction industry. We are proud that we could not only conduct an academic study but as promised in our proposal and discussions with the Waterberg District Municipality during the briefing session in the beginning of the assignment, we have in fact converged the study into a viable business plan by identifying the technology provider and operator in the name of MEGATech through Fly Ash Engineering (Pty) Limited.

As promised in our brief, we shall remain to the service of the Waterberg District Municipality with respect to the ultimate implementation of this project at Lephalale. The details of this engagement can however be discussed between the Waterberg District Municipality and ourselves at a convenient date after the current closure of this assignment.

It is to our interest as Maqhawe Technical & Financial Services to see a project that we have been part of becomes not only Lephalale and the Waterberg District Municipality success but also the success of South Africa at large and we are certain that MEGATech / Flyash Engineering (Pty) Ltd in their PowerCem Fly Ash Premix product have found the solution that should revolutionize the utilization of an abundant ash from our Eskom Power Stations and thereby help to create close to 14,000 jobs in South Africa alone.

Maqhawe further recommends that the Waterberg District Municipality support this identified business opportunity by availing themselves to assisting the potential investor, Flyash Engineering (Pty) Ltd with all the necessary regulatory matters within their scope as a the Local Government (i.e. resolving issues such as land acquisition, connections to water & sanitation reticulation system, electricity supply & connections, permits to operate, etc.). This is your project and your support to it shall ensure that you meet your expected goals of enhancing the economic development of the Waterberg District.

ANNEXURE A

1. MAIN TYPES OF CEMENT

CEM 1 - Portland cement: comprising Portland cement and up to 5% of minor additional constituents

CEM II - Portland composite cement: comprising Portland cement and up to 35% of other single constituents

CEM III – Blast-furnace cement: comprising Portland cement and higher percentages of blast furnace slag.

CEM IV - Pozzolanic cement: comprising Portland cement and higher percentages of pozzolana.

CEM V - Composite cement: comprising Portland cement and higher percentages of blastfurnace slag and pozzolana or fly ash.

A - indicates higher proportion of Portland cement clinker e.g. CEM IIA

B - indicates medium proportion of Portland cement clinker e.g. CEM IIB

2. MAIN CONSTITUENTS OF CEMENT

Pure cement has to have 5% of extender material added to it in order to make it more effective. These additives or extender materials come in various forms:

- **Gypsum** – a chemical powder that shows determine the setting process of cement.
- **Blast-furnace slag** – a by-product of the manufacture of pig-iron in blast-furnaces, which is produced by a reaction between silica and other impurities in iron ore, limestone and dolomite.
- **Fly-ash** – used as an additive to cement to improve the workability of concrete.
- **Silica Fume** – like slag, it enhances the strength development of cement but is an extremely fine powder which has to be densified before used in the mixing process.
- **Lime or limestone** – masonry cements are manufactured by integrating clinker, gypsum and limestone. The limestone and lime improve workability or slow down drying time when cement is used for plastering.
- **Aggregates** – are crushed stones, gravel or other materials used with cement and water to form concrete.

ANNEXURE B

CEMENT PROCESS DESCRIPTION

The typical manufacturing process of Portland cement requires about 80 distinct and continuous operations, the use of large-scale heavy machinery and equipment, and a large amount of heat and energy. Large volumes of fossil fuels are required to maintain high combustion levels in kilns (for every 100 tons of clinker produced, approximately 15 to 16 tons of coal have to be burnt).

The manufacturing of cement involves the following nine processes (refer to the Figure B1 on page 43):

1. Quarrying/raw material acquisition:

The most commonly materials used are: limestone, shells and chalk and marl combined with shale, clay, slate or blast furnace slag, silica sand, iron ore or gypsum. In certain South African plants, low-grade limestone is the only raw material feedstock for clinker (cement) production. Most of the plants are located within a major limestone belt so as to minimise the transportation costs e.g. Ulco and Lime Acres.

2. Raw milling:

Raw milling involves grinding the extracted raw material into a fine powder in order to achieve the required particle size for optimum fuel efficiency in the cement kiln and strength in the final concrete products. Three types of processes may be used:

- Dry;
- Wet; or
- Semi-dry techniques.

Once the fine powder has been sifted from the coarse particle, the fine material is transferred to a blending silo.

3. Blending:

The fine powder is then properly mixed to form a homogenous blend. This blended material is then transferred to a storage silo, known as kiln-feed silo.

4. Calcining and clinkering:

In the calcining process, a raw mix is heated to produce Portland cement clinker. This process usually involves three steps of drying or preheating, calcining and burning. The clinkering process takes place in the burning/kiln section. The most critical manufacturing process takes place in the huge rotary kilns. Kiln-feed is fed into one end of kiln and pulverised coal is burnt on the other. The raw meal (raw materials) slowly cascades down the inclined kiln towards the heat and reaches temperature of about 1 550 degrees in the burning zone, with the process being called "clinkering".

5. Clinker cooling:

After the clinkering process, the nodules of the clinker drop into coolers. The most common types of coolers are planetary and rotary cooler types. Conveyers and bucket elevators are then used to transfer the clinker nodules to the clinker storage silos.

6. Clinker storage:

The clinker nodules are normally stored on site for about two weeks and are later transferred to the finish mill.

7. Finish milling:

Finish milling is the final stage of Portland cement production. During this process, the clinker is ground with other materials (a small quantity of gypsum, and/or natural anhydrite and other chemicals) into a fine powder called cement. The grinding process occurs in a closed system with an air separator that divides the cement particle according to size. Incomplete ground material is sent through the system again.

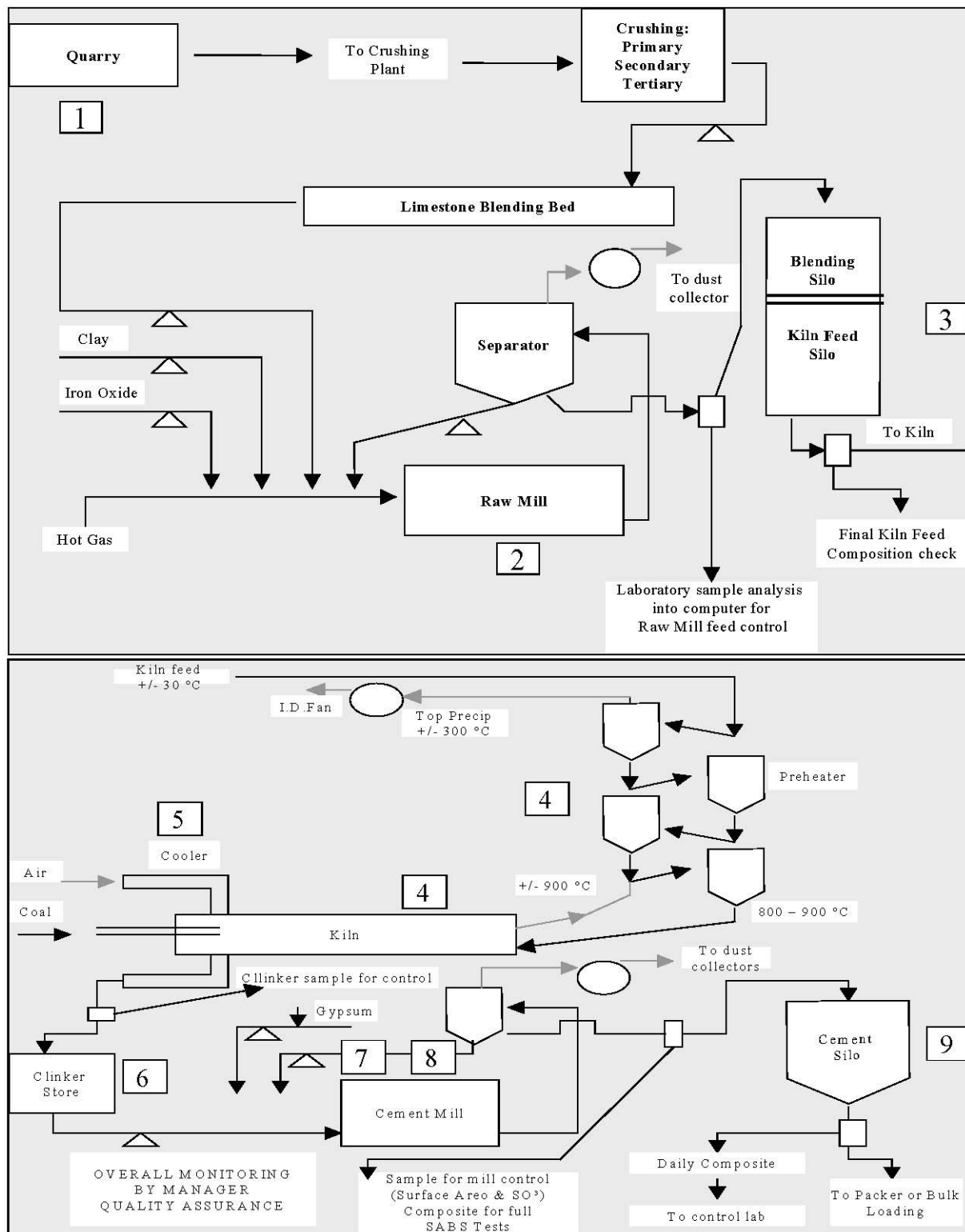
8. Advanced blending:

The finished cement is stored in silos where further mixing ensures consistency.

9. Packing and loading:

Once production of Portland cement is complete, the finished product is transferred using bucket elevators and conveyers to large storage silos in the dispatching department. Cement is then dispatched either in bulk or packed in 50kg bags and distributed from the factory in rail trucks or road vehicles.

Figure B1: Crushing and blending process



**FOR THE WATERBERG DISTRICT MUNICIPALITY
LIMPOPO PROVINCE
SOUTH AFRICA**

ANNEXURE C

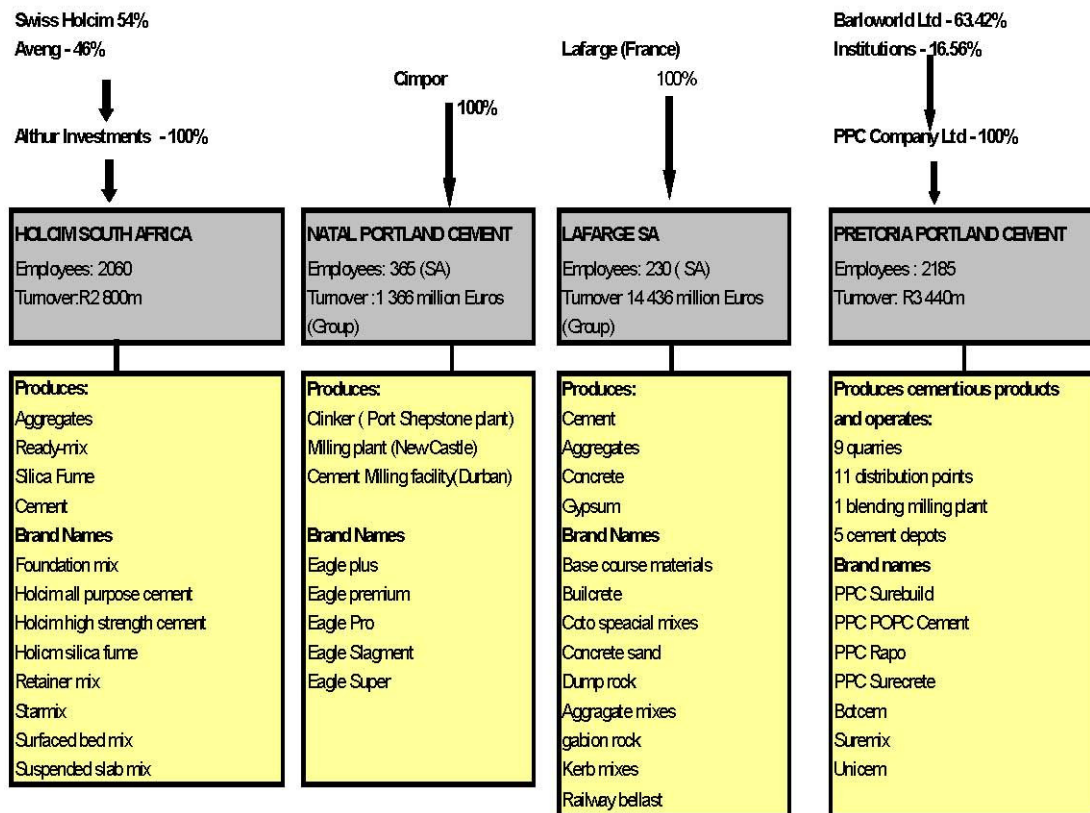
SOME OF THE MANUFACTURERS OF CONCRETE PRODUCTS

NAME OF COMPANY	NO. OF EMPLOYEES	PROVINCE	BEE OWNERSHIP %
Concrete Beams			
ALLIED CONCRETE PRODUCTS	160	Western Cape	No
Pressessed - beams			
INFRASET	1300	Gauteng	No
CONCRETE UNITS (PTY) LTD	100	Western Cape	No
MOKETE SLABS	N/A	Gauteng	No
Pressessed - lintels			
LOWEN BLOCKS	12	Kwa-zulu Natal	Yes
INFRASET	1300	Gauteng	No
SINDELE HOLDINGS (PTY) LTD	350	Gauteng	No
HOLCIM (SOUTH AFRICA) (PTY) LTD (AGGREGATE & READY MIX)	1680	Gauteng	No
THUSANANG GAST (PTY) LTD	130	Gauteng	Yes
Foamed concrete			
INFRASET	1300	Gauteng	No
SINDELE HOLDINGS (PTY) LTD	350	Gauteng	No
HOLCIM (SOUTH AFRICA) (PTY) LTD (AGGREGATE & READY MIX)	1680	Gauteng	No
THUSANANG GAST (PTY) LTD	130	Gauteng	Yes
Concrete additives- conductives			
MULTI CONSTRUCTION CHEMICALS (PTY) LTD	89	Gauteng	No
CEMCRETE (PTY) LTD	150	Gauteng	No
HI-TECH REFRACTORIES CC	19	Gauteng	No
THERMAL CERAMICS SOUTH AFRICA (PTY) LTD	155	Gauteng	No
Concrete chemicals acceleator			
CHEMSERVE PERLITE (PTY) LTD	100	Gauteng	No
MULTI CONSTRUCTION CHEMICALS (PTY) LTD	89	Gauteng	No
AQUATITE (PTY) LTD	4	Western Cape	No
DGN MANUFACTURING	4	Kwa-zulu Natal	No
DRIKON (PTY) LTD	4	Gauteng	No
ALLIED CONCRETE PRODUCTS	160	Western Cape	Yes
BLITZ CONCRETE SOUTH AFRICA (PTY) LTD	200	Western Cape	No

Source: Ezeedex

ANNEXURE D

LARGE CEMENT PRODUCERS



Source: Who Owns Whom & Bloomberg

LIST OF SOURCES

Battelle Institute (2002). *Towards a sustainable cement industry*.
Bloomberg online financial database
Bureau of Economic Research
Cement and Concrete Institute, (2004). *Cement and Concrete Review*.
Engineering News articles
Freedonia Group (2005) *World cement and concrete additives (Abstract)*
Holcim SA (Pty) Ltd. www.holcim.co.za
International Cement Review.
www.cemnet.com/public/global_cement_overview_2005/player.html
Lafarge SA (Pty) Ltd www.lafarge.co.za
Natal Portland Cement (Pty)Ltd website. www.npc.co.za
Pretoria Portland Cement (PPC) Co. Ltd. www.ppc.co.za
Quantec database
South African Reserve Bank (2005, June) Quarterly Bulletin
Statistics South Africa
UBS Investment Research report, (2005).PPC
Who owns Whom (2003). *Manufacture of cement, lim*
MEGATech Engineering Consulting B.V.
Ash Resources (Pty) Ltd.
Eskom, Matimba Power Station