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COMMERCIAL APPRAISAL OF A POZZOLANA PLANT IN GHANA

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ABSTRACT

After several years of research, the production of Pozzolana for housing construction has finally commenced in Ghana, albeit on a small scale. However, in order to make a significant contribution towards the national housing policy objective of accelerated delivery of decent and affordable housing units nationwide, pozzolana needs to be exploited commercially and actively promoted. This paper seeks to provide general guidance to potential investors in the commercial production of pozzolana. An appraisal of the commercial viability of a hypothetical 10-tonne per day pozzolana plant in Ghana has been presented. It is reckoned that an initial investment cost of approximately US$156,000 would be required and, provided that given production targets can be met, an Internal Rate of Return (IRR) of about 70 per cent is possible. The estimated payback period (discounted) is 4 years. The appraisal shows that investing in the commercial production of pozzolana can be a very attractive business.

Keywords: Clay Pozzolana, Ordinary Portland Cement, Affordable Housing, Commercial viability of pozzolana production, Ghana

1. INTRODUCTION

Housing construction involves the use of cement as a binding material mostly for concrete works, block making, bonding and rendering. It is, therefore, one of the most essential building materials and its importance is recognised in the construction industry worldwide. In Ghana, cement usage has been increasing steadily due to increasing population growth, rising urbanisation and shift from earth to cement-based buildings. Cement consumed in Ghana is either imported or produced from imported clinker and gypsum.

Since 2001 cement production has been above 2.0 million tonnes. With an average price of $48 per tonne of clinker, not less than US$100 million is spent on clinker and cement importation annually (Ministry of Trade and Industry, Statistical Service, 2003). The price of cement is quite high, ranging from US$4.9 in Accra, US$5.65 in Kumasi to $7.22 per 50 kg bag in the North. Compared with the global price of between US$1.45 - 2.30 (Global Cement Report, 2004), the cement obtained in Ghana is very expensive. This has made housing delivery a very expensive venture and as such beyond the reach of majority of Ghanaians. The need to reduce the cost of cement in housing construction is, therefore, quite important.

The Building and Road Research Institute (BRRI) has, through laboratory and pilot plant studies, successfully produced Pozzolana from clays which can be used to replace at least 30% of Portland cement for housing construction (Atiemo, 1992, 1998). The Pozzolana cement thus produced has been used to construct various housing structures.

This paper presents an appraisal of the commercial viability of a 10-tonne per day Pozzolana plant. The Pozzolana produced will replace 30% of Portland cement for housing construction. The main objective of the study is to promote the use of Pozzolana cement with the aim of reducing the cost of housing construction.

2. WHAT IS POZZOLANA?

2.1 General

Pozzolanas are defined as any siliceous or aluminous materials, which react with lime in the presence of water to form cementitious compounds. Research studies and pilot plant production have shown that Pozzolana can be produced from clays in Ghana. Clays in their natural state are stable and chemically inert. However, on calcination (heating) between 600°C and 1000°C, and grinding to a particle size of 0.045mm or below they become unstable and reactive. The resulting material becomes pozzolanic. Clay Pozzolana can be used to replace at least 30% of Portland cement for housing construction without any loss of strength and durability.

2.2 Strength Properties

The properties of some Pozzolana cements produced and tested at BRRI are shown in Table 1. The results show that the 28-day compressive strengths of the Pozzolana cements, up to 30% replacement, are higher than the standard minimum strength of 24.1N/mm^2 recommended for both concrete works and general construction (ASTM, 1979).

3. HOUSING POLICY AND MARKET ANALYSIS

3.1 Housing Policy and Demand for Cement

The Government's Housing Policy since the 1990's has shifted from being involved in direct construction

of housing units to acting as the main facilitator for financial assistance and technical resources for the private sector in the industry. It also provides the administrative and regulatory framework, as well as coordinating the institutional arrangements in the industry. This policy is intended to accelerate the delivery of decent housing units nationwide.

In Ghana, the construction industry is the sole consumer of cement. The building sector accounts for about 95% of total cement consumption with residential accommodation consuming almost 75% whilst industrial/commercial development (hospitals, offices, schools, factories, stores etc.) accounts for 20% of the cement market. The road sector takes the remaining 5%, mainly for bridges, culverts and drains (Mott McDonald, 1996).

Table 2 gives the trend of cement consumption in Ghana from 1992 to 2003. It shows that cement consumption has increased steadily from 1.02 million tonnes to 2.33 million tonnes annually within the period. It is estimated that 2.5 million tonnes of cement (50 million bags) would be consumed in 2005. The price per bag of 50kg has also increased from ¢1,200 to between ¢45,000 and ¢75,000 (US$5.1 - 8.5) within the same period.

The demand for cement, which has been increasing consistently per annum, is influenced primarily by:

- National housing requirement;
- Rate of housing delivery; and
- Government infrastructural development programme.

These are further influenced by income levels of Ghanaians, availability of funds for public development projects and easy access to capital or mortgage finance. In addition, the rate of population growth in Ghana, about 2.7%, the unstoppable rural urban drift and the need to rehabilitate old dwelling and public houses would further increase the demand for cement for housing.

3.2 Potential Demand for Pozzolana Cement

Portland cement (OPC) is the only type of cement currently used for construction in Ghana. Studies show that about 80% of residential houses built in Ghana are single-storey and that 57% of cement used for housing construction can make use of composite cement (Mott McDonald, 1996). Pozzolana cement is a type of composite cement which can obtain strength values up to 30N/mm^2 at 28 days as shown in Table 1. It is, therefore, used for both concrete and general construction works globally.

BRRI has been producing clay Pozzolana commercially since 2002. The main raw material, clay, is found abundantly in the country and cost averagely about $0.8/tonne. Also, almost all the equipment and inputs were either fabricated locally or found on the local market and agricultural waste is the main fuel for the firing process. All these make the cost of Pozzolana production quite inexpensive as compared to clinker production and thus make the price of Pozzolana cement lower than Portland cement.

Composite cement is cheaper, durable and, in some cases, technically desirable than OPC especially for mortars and plasters (Soroka and Setter, 1977). It is used in both developed and developing countries for housing delivery. Pozzolana cements are used extensively worldwide in building structures such as dams, bridges, roads and high-rise residential buildings. In Ghana, it has been used to construct residential buildings, school blocks, drains and concrete walkways. It would therefore be quite marketable on the Ghanaian market.

4. COMMERCIAL PRODUCTION OF POZ ZOLANA: CASE-STUDY OF 10 TONNES /DAY PLANT

4.1 Production Process

The production process for pozzolana involves drying, milling, mixing, nodulisation, firing, milling and bagging and it is schematically shown in Figure 1.

The clay from the deposit is mined and brought to the production site. The clay is then spread under a shed and dried for at least 48 hours, after which it is milled to a particle size of not more than 100μm by a hammer mill. Concurrently, dry palm kernel shells is ground to powder, and mixed with the milled clay at a predetermined ratio in a mixer. The mix is then turned into nodules with an addition of water in a noduliser and the nodules air-dried for at least 48 hrs. They are then fired in a shaft kiln with the aid of an electric blower.

The fired product is discharged at the bottom of the kiln and ball-milled to a particle size of 75μm and below. The resultant product is called Pozzolana. It is either bagged for sale or blended with Portland cement at a pre-determined proportion to give Pozzolana cement.

4.2 Essential Equipment

The list of essential equipment needed to produce 10 tonnes (200 bags) per day of Pozzolana and their estimated cost is given in Table 3.

4.3 Manpower Requirements and Organisational Structure

The manpower needs for the plant is given in Table 4. The company will be headed by a Managing Director and assisted by a Plant Manager, who will be in

charge of production. The organisational structure of the company is shown in Figure 2.

5. FINANCIAL APPRAISAL OF PLANT

5.1 Investment Cost

The estimated investment cost of setting up a 10-tonne/day Pozzolana plant as presented in Table 5 is ¢1.404 billion ($155,997.78). The working capital for six months is estimated at ¢168.0 million.

5.2 Project Financing

It is assumed that the company/shareholders shall contribute 20% equity of ¢280.80 million ($31,122.00). The remaining amount of ¢1.123 billion ($125,560.00) shall be raised as a loan from either a local or foreign financial institution. This will attract 40% interest payable in 5 years after a one year moratorium.

5.3 Projected Output and Revenue

The projected output of the plant is 2500 tonnes per year. But production will be at 88% capacity in the first year before reaching the peak capacity in the 2nd year. The recommended price for a bag of 50kg of Pozzolana is ¢28,000.00. The projected revenue is ¢1.23 billion (US$136,880.00) in the first year, ¢1.54 billion (US$174,220.00) in the 2nd year and ¢3.36 billion (US$373,460.00) in the tenth year (see Table 6).

5.4 Profitability of the Project

Table 7 shows a summary of the results of the financial analysis of the project. The project will have an annual profit of ¢251.1 million in the first year, ¢509.63 million in the second year and 924.65 million in the tenth year. It gives a Net Present Value (NPV) of ¢2.60 billion (US$288.890.00), and Discounted Payback Time of 3.8 years. To break even, the project should generate at least ¢1.029 billion (US$114,330.00) annually or produce at 84% capacity.

5.5 Sensitivity Analysis

Table 8 shows the sensitivity of some projections in the financial assessment of the Pozzolana Project when the production cost is increased by 10% or revenue is decreased by 10%. The Internal Rate of Return of the project reduces from 67% to 60% with a Discounted Payback Time of 5.1 years when production cost is increased by 10%. If the total revenue is reduced by 10% and production cost is maintained, the Internal Rate of Return reduces to 57% with a Discounted Payback Time of 5.7 years.

The sensitivity analysis shows that the financial returns of the Pozzolana Project remains attractive even when unforeseen increase in production cost or decrease in revenue occur. It is apparent that the project is more sensitive to a decrease in revenue than an increase in production costs. Intensive marketing effort should therefore be put in place to maintain the recommended price of the product.

6. CONCLUSION

Housing is a very important national issue, which must be given a very serious attention because of its strategic economic significance. With the increasing development activities in the construction sector, there is the urgent need to curtail the over-dependence of imported cementitious materials and rather concentrate on the development of durable local resources.

From the market analysis and financial appraisal, the following conclusions are made:

1. Technically, Pozzolana cement is a very suitable and adequate material for housing construction.
2. Pozzolana will have a ready market for housing delivery. This is due to the fact that when blended with cement it will be more affordable to the consumer than Portland cement. In addition, it will provide employment, generate revenue to the State, create wealth and most importantly improve the housing situation in Ghana.
3. The total investment cost in establishing a 10-tonne/day capacity plant is estimated at ¢1.41 billion.
4. The Internal Rate of Return of the project is 67.0%, with a discounted payback time of 3.8 years, and an average annual profit of ¢665.93 million. The financial appraisal shows the project is economically attractive.

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Table 1: Properties of Pozzolana Cement

Clay Sample	Pozzolana Content	Setting Time (min)		Water Absorption	Compressive Strength N/mm^2	
(Region)	%	Initial	Final	%	28 days	60 days
Asokwa (Ashanti)	20	97	265	2.0	34.9	39.1
	25	91	251	2.2	32.4	35.9
	30	83	208	1.8	31.4	34.7
	40	-	-	1.9	22.7	29.6
Mankesim (Central)	20	98	269	2.4	37.6	40.7
	25	90	250	2.4	34.3	37.5
	30	77	105	2.2	29.1	36.8
	40	-	-	2.0	20.5	29.1
Nkonsia (B-Ahafo)	20	99	265	2.5	34.1	36.1
	25	86	241	2.3	31.4	32.1
	30	75	194	1.8	28.4	28.5
	40	-	-	2.4	24.6	25.3
Bibiani (Western)	25	100	272	2.1	32.3	35.5
	30	96	260	2.1	28.9	31.6
	40	-	-	1.85	25.2	27.9

Table 2: Estimated Consumption Trends of Portland Cement in Ghana

YEAR	CEMENT IN MILLION TONNES
1992	1.02
1997	1.56
1998	1.64
1999	1.72
2000	1.81
2001	2.05
2002	2.15
2003	2.33

Table 3: List of Equipment and their Estimated Cost

Equipment	No.	SPECIFICATION	COST,$
Ball mill*	1	25-30hp, 1.5dia., 1.5m long, 30rpm.	25,000.00
Hammer mill	2	15hp, 2700-3000rpm, 2tonnes/hr	4,500.00
Palm kernel crusher	2	10hp, 2400-2700rpm, 2tonnes/hr	4,000.00
Noduliser	2	18-25rpm, 1 tonne/hr	4,000.00
Shaft kiln & accessories	2	6 tonnes/batch	10,000.00
bagging m/c	2	250 bags/day	3,500.00
Conveyor system	1		17,000.00
Mixer	1		1,200.00
Scale	1	50 – 100kg	1,200.00
Storage bins	10		400.00
Safety wear			
- safety boots	20		600.00
- Nose masks			100.00
- Hand gloves			150.00
- Goggles			100.00
Working Tools			
- Shovels	10		300.00
- Wheel barrows	10		400.00
- Tool box	1		60.00
Miscellaneous			
Total			**$72,510.00**

Table 4: Manpower Requirements of Company

PERSONNEL	NUMBER
Managing Director	1
Plant Manager	1
Technician	1
Factory hands	9
Office Assistant	1
Accounts Clerk	1
Driver	1
Security	4
Total	19

Table 5: Investment Cost of 10-Tonne/Day Pozzolana Plant

ITEM	COST, ¢
Land	60,000,000.00
Buildings & Utilities	120,000,000.00
Equipment & Machinery	666,000,000.00
Office equipment/Furnishing	27,000,000.00
Development fee & Consultancy	333,000,000.00
Miscellaneous items & Contingency	30,000,000.00
Working Capital	168,000,000.00
TOTAL	**1,404,000,000.00**

Table 6: Projected Annual Output and Revenue

YEAR	ANNUAL PRODUCTION	ANNUAL REVENUE, ¢m	TOTAL REVENUE, $
1	2200	1,232.00	136,888.90
2	2500	1,568.00	174,00.00
3	2500	1,724.80	191,644.40
4	2500	1,897.28	210,808.90
5	2500	2,087.00	231,889.80
6	2500	2,295.71	255,078.80
7	2500	2,525.28	280,586.60
8	2500	2,777.80	308,645.30
9	2500	3,055.59	339,509.80
10	2500	3,361.15	373,460.80

Table 7. Financial Assessment of Pozzolana Plant

Financial Characteristic	Value
Average Annual Profit, ¢ million	690.86
Net Present Value, ¢ million	2,597.28
Internal Rate of Return, %	67
Discounted Payback Time, years	3.8
Average Debt Service Coverage Ratio	3.28
Average Equity:Debt (E/D) Ratio	12.61
Break Even Point, ¢ million	1,029.48
Average Liquidity (current ratio)	18.64

Table 8: Sensitivity Analysis of Pozzolana Plant

Financial Characteristic	10% increase in Production Costs	10% decrease in sales Revenue
Net Present Value, ¢ million	2,070.00	1977.10
Internal Rate of Return, %	60	57
Discounted Payback Time, years	5.1	5.7

Figure 1: Schematic of Production Process of Pozzolana Cement

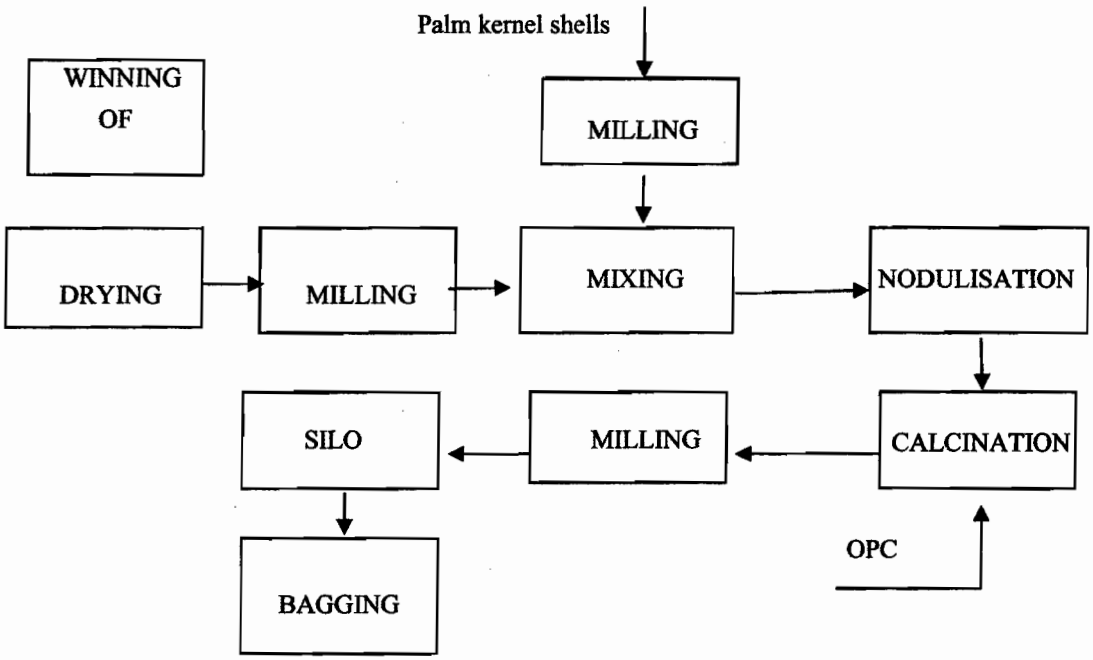

Figure 2: Organisational Structure of a Pozzolana