OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

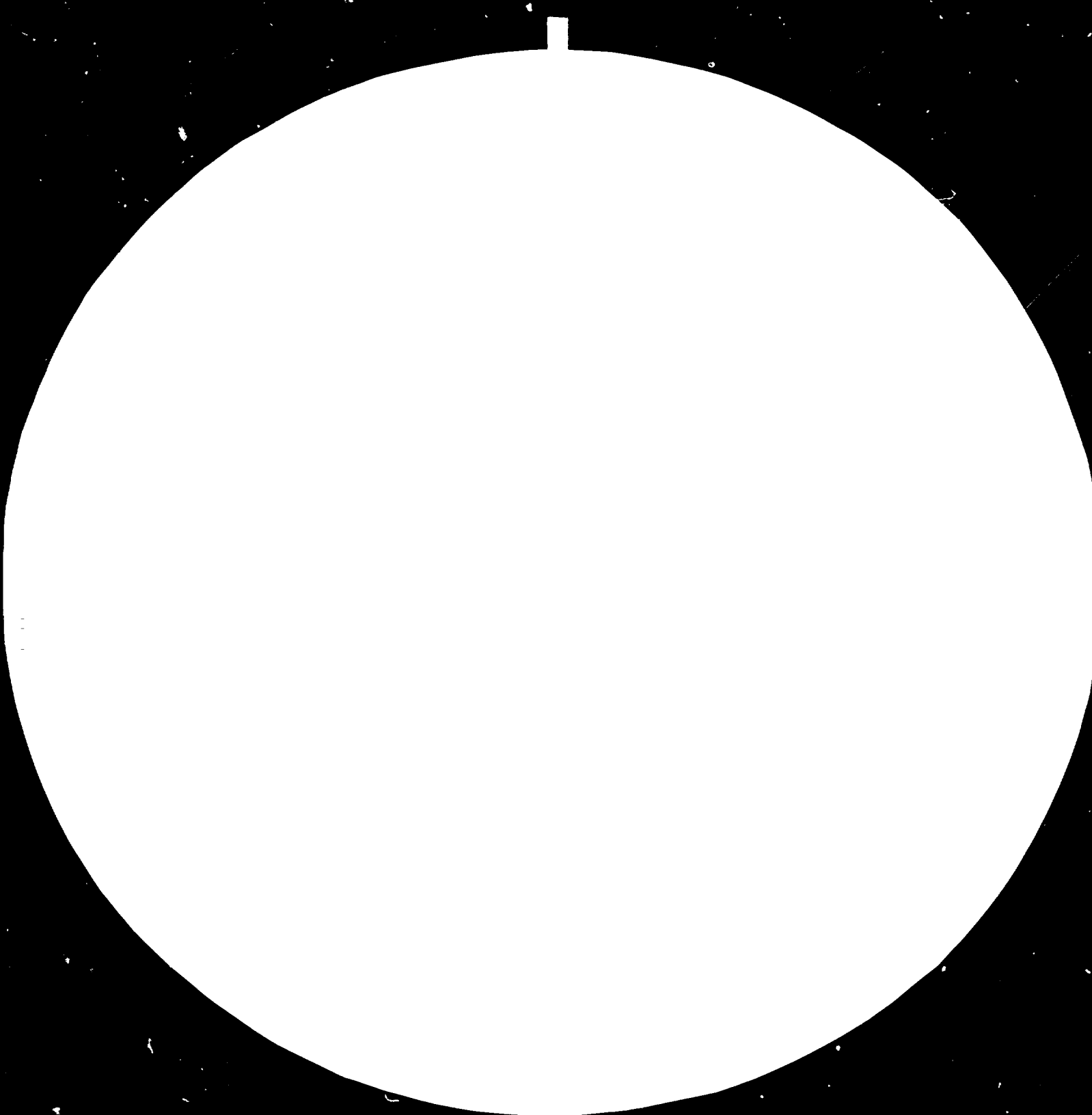
FAIR USE POLICY

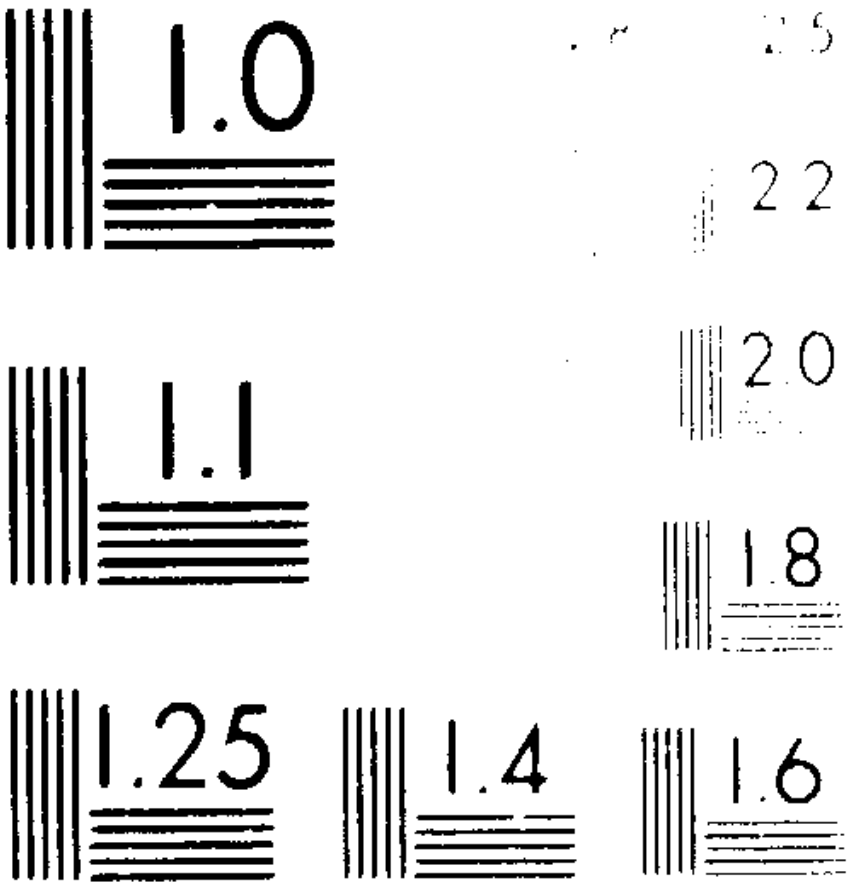
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org




1.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

RESTRICTED

10898

Aden, October 25, 1981.

English

BATIS CEMENT PLANT PROJECT

CAPACITY 250,000 METRIC TONS PER YEAR PORTLAND CEMENT .

DP/PDY/76/014/11-55/31.6.A

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

Techno-Ecomomic Report:

MARKETING STUDY

Prepared for the Government of
the People's Democratic Republic of Yemen
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Harald C. Boeck, Cement Consultant

United Nations Industrial Development Organization
Vienna

DK-2960 RUNGSTED KYST, BYSKELLET 9, DENMARK, PHONE: INTERNATIONAL 45 2 86 65 65, CABLES. CEMBOECK

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Explanatory Notes

Exchange rate : 1.- US$ = 0.3415 YD (Yemen Dinars)
1.000 YD = 1000 fils = 2.93 US$

According to Bank of America NT & SA,
Economic Department, London,
Wednesday, August 05, 1981.

Abbreviations :

PDRY	People's Democratic Republic of Yemen
GNP	Gross National Product
GDP	Gross Domestic Product
C+F	Cost and Freight
FOB	Free on Board

mt	metric ton = 1000 kg
mtpd	metric tons per day
mtpy	metric tons per year
gallon	Imperial gallon = 4.546 litres

A full stop (.) is used to indicate decimals

A comma (,) is used to distinguish thousands and millions

.../03

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

A B S T R A C T

The Government of the People's Democratic Republic of Yemen (PDRY) has requested the United Nations Industrial Development Organization (UNIDO) to perform a Marketing Study for the demand of Portland cement covering both the local demand and the possibility of exports.

On 22 August 1981 the author arrived Aden for a two-month mission but due to the rather complex study the Government has requested an extension of the mission of two weeks.

Figures regarding the cement consumption in the First, Second and Amended Second Five-Year Plan (1974-78, 1979-83 and 1981-85) have been made available to the author, and furthermore estimates for the Third Five-Year Plan (1986-90).

It is tentatively scheduled that the Batis Cement Plant Project (BCPP) should be implemented in the period of 1983-88.

Based mainly on the figures given by the Government of the PDRY, and together with other figures made available from various studies, the conclusion has been reached that an appropriate size or capacity of the BCPP would be :

150,000 Metric Tons of Clinker per Year

instead of the former envisaged capacity of 250,000 mtpy, which was based on a feasibility study made in 1975.

Recommendations are given for a step-by-step approach as the cement demand may have a modest growth and export of excess production very difficult.

On 01 November the author is leaving for debriefing in Vienna.

.../04

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

TABLE OF CONTENTS

		Page
	INTRODUCTION	07
I.	FINDINGS AND RECOMMENDATIONS	09
	1.1 Findings	09
	1.1.1 Population growth rate	09
	1.1.2 Per Capita Gross National Product	09
	1.1.3 Cement Consumption	09
	1.1.4 Building Materials Consumption	10
	1.1.5 Industrial Efficiency	10
	1.1.6 Export Possibilities	10
	1.1.7 Techno-Economic Aspects	10
	1.2 Recommendations	11
	1.2.1 Appropriate Plant Capacity	11
	1.2.2 Step-by-step Approach	12
	1.2.2.1 Core drillings, Batis II	12
	1.2.2.2 Feasibility study of a clinker-grinding plant	12
	1.2.2.3 Feasibility study of a clinker-production plant	12
	1.2.2.4 Clinker-import survey	13
	1.2.2.5 Manufacture of different low-energy cements	13
	1.2.3 Electric Power Supply	14
	1.2.4 Manpower Requirements	14
	1.2.5 Bulk Cement Dispatch	14

.../05

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

		Page
II	LOCAL MARKET SURVEY AND DEMAND PROJECTION	15
	2.1 Methodology	15
	2.2 Population Growth Rate	15
	2.3 Gross Domestic and National Product	16
	2.4 UNIDO Regression Equation	21
	2.5 Cement Consumption related to total Investment in the Construction Sector	23
	2.6 Five-Year Plans for the PDRY	25
	2.7 Major Cement Consumers	25
	2.7.1 Factory for Prefabricated Concrete Elements	25
	2.7.2 Factory for Tiles and Hollow Blocks	27
	2.7.3 Ministry of Industry	27
	2.7.4 Ministry of Construction	29
	2.7.5 Public Corporation for Construction	29
	2.7.6 Other Consumers	30
	2.7.7 Summary	31
III	IMPORT - EXPORT OF CEMENT	32
	3.1 Imported Cement	32
	3.1.1 Supplying Countries and Prices	32
	3.1.2 Quantities	33
	3.2 Export Possibilities	33
	3.2.1 Prospective Buyers	34
	3.2.2 Competition	34
IV	CEMENT PRODUCTION - A STEP-BY-STEP APPROACH	35
	4.1 Clinker-Grinding- and Packing Plant	35
	4.1.1 Appropriate Capacity	35
	4.1.2 Location	36
	4.1.3 Cement Types	36
	4.1.4 Production costs	36

.../06

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

		Page
	4.2 Clinker-Production Plant	38
	4.2.1 Appropriate Capacity	38
	4.2.2 Location	39
	4.2.3 Production Costs	39
V	FURTHER UNIDO ASSISTANCE	40
	5.1 Feasibility Studies	40
	5.1.1 Clinker-grinding- and Packing Plant	40
	5.1.2 Clinker-production Plant	40
	5.2 Research and Development	40
	5.2.1 Low-energy Cements	40
	5.2.2 Raw Materials for Prefabricated Concrete Elements	41
	5.3 Fellowships	41
	5.3.1 Visit to a Clinker-grinding Plant	41
	5.3.2 Visit to a dry-process Cement Plant	41

A N N E X E S

I	Job Description	42
II	Persons met in the PDRY	45
III	Questionnaires 1-9	47
IV	Leading Cement Producing Countries	56
V	10 tons Container for Bulk Cement	57
VI	Comments on the Batis Cement Plant Project	58
VII	Conclusion made by the State All-Union Institute, Leningrad	64

.../06a

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK, PHONE: +45 2 86 65 65,
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

TABLES

		Page
II-1	1973-2000 Populations Estimates for the PDRY	16
II-2	Second Distribution for the Gross Domestic Product	17
II-3	UNIDO Regression Equation	21
II-4	Investment related to cement consumption	23
II-5	Per capita consumption, 1971-80 and projections for 1981-85	23
III-1	Present cement price in the PDRY, August 1981	32
III-2	Break down of the price of cement	32

FIGURES

II-1	Gross Domestic Product 1969-79	20
II-2	Cement Consumption in the PDRY	22
II-3	Cement Consumption, 1971-80 and Projections for 1981-85	24
II-4	Ministry of Industry Investment Employments 1972-79, and 1981-85	28

.../07

BYSKELLET 9, DK-2900 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

I N T R O D U C T I O N

Since 1969 the establishment of a cement plant in the PDRY has been considered and several proposals have been given. Concerning the basic raw materials, limestone and clay, it seems finally that adequate deposits have been found.

The limestone deposit, from the latest proposal, is named Batis II and is located in the Abyan Governate, about 8-10 km to the north-east of the Batis village. From Aden the distance by road is about 100 km toward the north-east.

A preliminary investigation indicates a tentative reserve of about 45 million tons of minable limestone of good quality.

The clay deposit is located about 6-8 km to the south-west of the limestone deposit Batis II. A tentative reserve of 6 million tons seems insured.

Other raw materials as iron ore and gypsum are available but from distant places, about 140 and 276 km respectively.

Based on the above-mentioned raw materials reserves and the following Marketing Study the capacity of the envisaged cement plant should be determined.

The market study is based on informations given by the Government of the PDRY to a maximum extent as possible.

Unfortunately, the trend of cement consumption in the past few years has been declining, and actually the cement demand is suppressed, thus a real estimation of the present demand is rather difficult.

.../08

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK, PHONE: +45 2 86 65 65,
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

It is reccommendable to be strictly objective, thus the Government of the PDRY may take a step-by-step approach, as export of surplus cement production only can be made with sizable losses.

The direct production costs without depreciation and interest charges are by a prospective supplier of the plant estimated to be 28.700 YD/mt (84.- US$/mt). Adding depreciation costs, interest charges, 100 km road hauling and handling in Aden harbour, the FOB price Aden harbour may reach 40 YD/mt (117,- US$/mt) or even more.

In order to compete in the cement-export market the FOB price Aden harbour should be in the region of, say 15 YD/mt (45.- US$/mt), which is a far cry even from the expected ex-factory price.

Actually, the C+F price Aden harbour for imported cement is around 26.000 YD/mt (78.- US$/mt).

Therefore, the determination of the plant capacity should be made according to the local demand only.

.../09

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

I. FINDINGS AND RECOMMENDATIONS

1.1 Findings

1.1.1 Population growth rate

Latest census has been held in 1973 where the Population reached 1,590,000.

Annual growth has been estimated to be 2.6%. This figure might be too optimistic. An annual growth rate of 2.0% seems more realistic. However, a new census only can give the correct answer.

1.1.2 Per Capita Gross National Product

This information was not available.
Gross-Domestic-Product figures have been made available only.

1.1.3 Cement Consumption

Recent import figures show a modest consumption but due to a suppressed market a real consumption figure is difficult to reach.

Following imports have been made :

1978	77,207 metric tons
1979	83,411 metric tons
1980	62,215 metric tons

.../10

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK, PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

1.1.4 Building Materials Consumption

Very few figures available but consumption seems modest even with an expected annual growth of 20%.

1.1.5 Industrial Efficiency

Very few figures available but seems to be, as normal for developing countries, in the region of 50-80%.

1.1.6 Export Possibilities

Very poor due to strong competition.

1.1.7 Techno-Economic Aspects

A feasibility report on a 250,000 metric-tons-per-year cement plant has been made available.

However, this report should be considered as a pre-feasibility report, as no marketing study has been included.

Production cost is on the high side due to excessive consumption of energy.

.../11

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

1.2 Recommendations

1.2.1 Appropriate Plant Capacity

An appropriate capacity of the clinker-production unit, consisting of crusher, raw mill and kiln, would be :

150,000 Metric Tons of Clinker per Year

taken into consideration fuel consumption and that export of surplus production most probably would be extremely difficult.

The above-mentioned capacity calls for a daily kiln capacity of 500 metric tons, and this size of a dry-process preheater kiln is considered the smallest feasible taken into consideration fuel consumption and investment costs per metric tons per year.

To-day price of a complete 150,000 mtpy cement plant on a turn-key basis would be in the region of YD 15-17 million (US$ 44-50 million) without power station. An appropriate power station of 5 MW would cost about YD 1.7 million (US$ 5 million).

Specific investment cost would be about 113 YD per metric tons of cement per year (330 US$/mtpy).

Specific investment cost of the proposed 250,000 mtpy cement plant is 128.7 YD/mtpy (377.- US$/mtpy) inclusive a 19 MW power station.

.../12

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK, PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

1.2.2 Step-by-step Approach

1.2.2.1. Core drillings, Batis II

Core drillings in the limestone deposit Batis II should be completed as soon as possible, confirming quantity, and quality of the limestone, and how to mine it.

1.2.2.2 Feasibility study of a Clinker-grinding plant

Cement production (clinker grinding) is market oriented, thus a clinker-grinding plant should be built up next door to the Factory for Prefabricated Concrete Elements and the new Japanese power station (60 MW).

Capacity 20-25 t/h equal to about 120-150,000 mtpy of cement.
Power requirement about 2 MW
Total investment cost about YD 3.4-5.1 million (US$ 10-15 million).
This plant could easily go onstream in 1984.

1.2.2.3 Feasibility study of a Clinker-production plant

Clinker production is raw-material oriented. Thus, clinker production should take place near the raw materials specifically limestone and clay.

The construction of the clinker-production unit, and probably one cement mill for producing masonry cement, should be accelrated and go onstream latest in 1988.

.../13

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK, PHONE: +45 2 86 65 65,
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

It should be noted that the costs of cement plants have increased about 20% per year in the period of 1969-79, and unfortunately this trend seems to continue.

1.2.2.4 Clinker-import survey

C+F price Aden for Portland clinker would probably be about 3-4 YD (US$ 10.-) cheaper than C+F price Aden of Portland cement.

A survey should be carried out concerning prospective suppliers, port facilities for receiving bulk clinker in Aden harbour.

1.2.2.5 Manufacture of different low-energy cements

Considerable savings in foreign currencies can be made by producing e.g. pozzolana Portland cement by adding 20% pumice to the clinker and ground it together with 3-5% gypsum in a cement mill.

By a consumption of, say 100,000 tons cement per year, a saving in foreign currency could reach about 530,000.- YD/year (US$ 1.5 million/year).

Such cement is produced for example at Addis Ababa cement plant in Ethiopia.

.../14

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK, PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

1.2.3 Electric power supply

The Batis Cement Plant should be supplied by electric power from outside. Power plants inside cement plants have rarely been successful in developing countries due to dust problems and heavy maintenance costs.

1.2.4 Ma power requirements

Manpower requirements should be limited to 2 m-h/mt (m-h/mt = man-hour/metric ton) of cement.

In the Feasibility Report made by GIPROCEMENT, Leningrad, the figure is 4.8 m-h/mt of cement.

2 m-h/mt is equal to 1 man per each 1000 mt of cement annual production. This means that a 150,000 mtpy cement plant should not employ more than 150 people.

1.2.5 Bulk cement dispatch

Dispatch of bulk cement is highly recommended, e.g. the use of containers of, say, 10 tons capacity each would be very interesting for the PDRY.

The cost of bags for 1 ton of cement would reach about YD 1.500 (US$ 4.40 per mt cement).

.../15

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

II. LOCAL MARKET SURVEY AND DEMAND PROJECTION

2.1 Methodology

The study is mainly based on informations given by the Government of the PDRY either through questionnares (see Annex III) or given verbally.

It should be mentioned that out of nine questionnaires only two, no. 1 and 2, have been returned to the author.

The accuracy of the estimates and projections are poor due to unavailability of regular figures of consumption and imports. Following parameters have been applied :

(a) Correlation between per capita GNP and/or per capita GNP.

(b) Correlation between investment in the construction sector and the cost of cement consumed.

(c) The common sense.

2.2 Population Growth Rate

The latest census has been held in 1973, and according to figures received (questionnaire 1) the following figures have been used in this study :

.../16

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE. CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

TABLE II-1

1973 - 2000 Populations Estimates for the P D R Y
(,000)

Year	Total	Urban	Rural + Novads
1973	1,590	529	1,061
1975	1,674	557	1,117
1980	1,903	633	1,270
1985	2,164	720	1,444
1990	2,460	878	1,582
1995	2,797	930	1,867
2000	3,180	1,057	2,123

Source : Central Statistical Office through the Ministry of Planning.

An annual growth rate of 2.6 percent has been foreseen. This maybe an optimistic figure. A growth rate of 2 percent seems to be more realistic.

However, this can only be confirmed by a new census.

2.3 Gross Domestic and National Product

Due to unavailability of real figures for the Gross National Product (GNP) the questionnaire 2 has been provided with figures showing the Gross Domestic Product (GDP).

Nevertheless, through a report made by the Ministry of Planning some figures for the estimated GNP have been discovered. It is a matter of fact, that the remittances from Yemeni emigrants working in the oil-rich countries are not fully known but efforts are made to clear this problem.

.../17

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

TABLE II-2

Second Distribution for the Gross Domestic Product

(In current prices, value in Thausands of Dinars)

Sectoral Commodities

(See figures next page)

(1) Agriculture, forestry and fisheries
(2) Extraction industries, petroleum, mines
(3) Convertible industries
(4) Electricity, water and gas
(5) Building and construction

Distributive Sectors

(6) Trade, hotels and restaurants
(7) Transport and communications and storage
(8) Financing, banking less banking charges, insurances

Services Sectors

(9) Housing
(10) Government services
(11) Other services

- Gross Domestic Product at cost price
- Net after indirect taxes
- Gross Domestic Product at market price

Source: The Ministry of Planning
through Central Statistical Office

.../18

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Second Distribution for the Gross Domestic Product

(In current prices, value in Thausands of Dinars)

	1969	1970	1971	1972	1973	1974
(1)	14,048	13,836	15,326	16,031	16,414	17,164
(2)	32	47	47	55	75	150
(3)	17,879	17,184	9,810	10,385	7,502	13,713
(4)	1,479	1,567	1,596	1,492	1,282	1,015
(5)	603	745	1,638	3,509	4,293	5,644
(6)	16,305	14,455	13,391	11,987	15,048	17,671
(7)	5,526	5,535	5,486	5,396	5,990	8,262
(8)	861	1,083	1,105	1,170	1,329	1,169
(9)	1,800	1,800	1,650	1,500	2,380	2,380
(10)	10,979	12,668	13,115	13,903	18,559	16,541
(11)	843	852	853	746	2,640	3,442
-	70,355	69,772	64,017	66,174	75,512	87,151
=	909	1,064	1,201	1,401	8,517	10,933
-	71,264	70,836	65,218	67,575	84,029	98,084

Source: The Ministry of Planning
through Central Statistical Office

.../19

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Second Distribution for the Gross Domestic Product

(In current prices, value in Thausands of Dinars)

	1975	1976	1977	1978	1979
(1)	17,716	24,532	25,437	19,670	23,435
(2)	150	177	339	297	209
(3)	6,627	9,268	15,617	19,619	19,838
(4)	1,927	2,004	2,738	3,102	3,191
(5)	8,684	10,368	15,253	25,561	24,015
(6)	19,244	22,953	27,539	24,290	30,587
(7)	9,549	13,480	18,279	21,348	27,495
(8)	480	1,259	1,828	2,592	4,546
(9)	2,527	2,612	2,802	2,176	2,024
(10)	18,273	21,472	25,660	30,979	39,357
(11)	4,016	4,207	4,489	1,445	1,511
-	89,193	112,332	139,981	151,079	176,208
-	11,593	15,299	20,198	25,114	29,887
-	100,786	127,631	160,179	176,193	206,095

Source: The Ministry of Planning
through Central Statistical Office

.../20

HARALD C. BOECK
INDEPE DENT CEMENT CONSULTANT

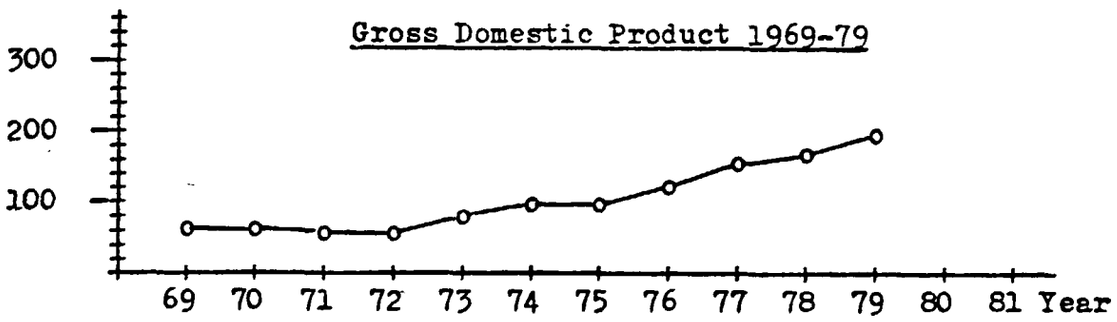
Second Distribution for the Gross Domestic Product

(In current prices, value in Thausands of Dinars)

Year	GDP at market price (,000)	Increace/ decreace	%
1969	71,264		
		-428	-0.6
1970	70,836		
		-5,618	-7.9
1971	65,218		
		2,357	+3.6
1972	67,575		
		16,454	+24.3
1973	84,029		
		14,055	+16.7
1974	98,084		
		2,702	+ 2.8
1975	100,786		
		26,845	+26.6
1976	127,631		
		32,548	+25.5
1977	160,179		
		16,014	+10.0
1978	176,193		
		29,902	+17.0
1979	206,095		

FIGURE II-1

Gross Domestic Product 1969-79



Source: The Ministry of Planning
Through Central Statistical Office

.../21

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

2.4 UNIDO Regression Equation

$$\log Y = 3.22 \log X - 0.43(\log X)^2 - 3.27$$

Where X = per capita GNP in US$
Y = per capita consumption of cement in kgs.

TABLE II-3

Year	"X" 1/	"Y"	Population	Cement consumption UNIDO Reg. Eqt. (mtpy)
1973	155	52.5	1,590,000	83,475
1974	176	62.0	1,632,000	101,184
1975	176	62.0	1,677,000	103,974
1976	217	80.5	1,723,000	138,702
1977	265	101.8	1,769,000	180,084
1978	285	110.5	1,808,000	199,784
1979	322	126.1	1,855,000	233,916
1980	-	-	1,903,000	-
1981	296	115.2	1,952,000	224,870
1982	304	118.6	2,003,000	237,556
1983	326	127.8	2,055,000	262,629
1984	351	138.1	2,109,000	291,253
1985	375	147.7	2,164,000	319,623

1/ GDP per capita from 1973-79 according to the Central Statistical Office, and GNP from 1981-85 according to report from the Ministry of Planning.

.../22

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Year	Consumption according to the UNIDO regression equation (mtpy)	Actual consumption (mtpy)
1973	83,500	109,616
1974	101,200	62,515
1975	104,000	28,448
1976	138,700	49,575
1977	180,100	70,000
1978	199,800	77,207
1979	233,900	83,411

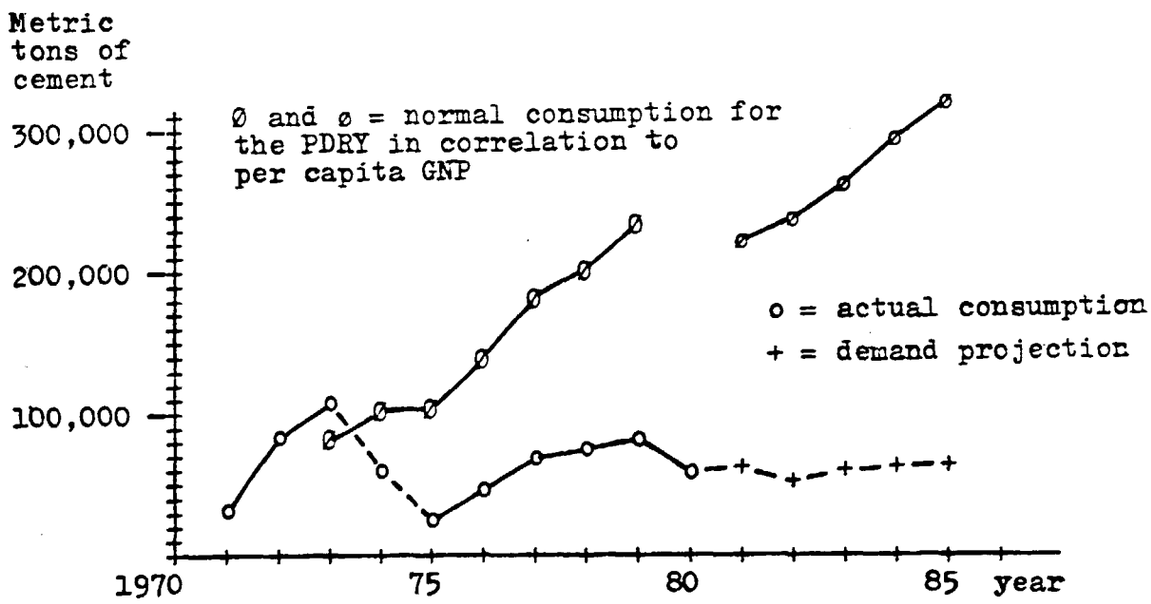


FIGURE II-2 : Cement consumption in the PDRY

Note: In August 1972 the nationalization of housing took place.

—— Real figures for per capita GNP are not available, thus above Ø and ø figures are indicative figures.

The real per capita GNP suppose to be higher due to remittances in foreign currencies coming from about 600,000 Yemini emigrants working in oil-rich countries.

.../23

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

2.5 Cement Consumption related to total Investment in the Construction Sector

For estimation of the cement consumption during the Second Amended Five-Year Plan, 1981-85, it is assumed that 5 persent of the investment employments will be used for import of cement. Following table II-4 shows a break-down of the investmens during 1981-85 and the related cement consumption according to the above-mentioned.

TABLE II-4

Year	YD	5%	Metric tons of cement a 50 YD/mt
1981	62,583,900	3,129,195	62,584
1982	55,317,900	2,765,895	55,318
1983	60,920,500	3,046,025	60,921
1984	64,995,400	3,249,770	64,995
1985	66,008,700	3,300,435	66,009
TOTAL YD	309,826,400		

TABLE II-5

Per capita consumption, 1971-80 and projections for 1981-85

Year	Population	Cement consumption (metric tons)	Per capita consumption (kg/head)
1971	1,511,000	33,941	22
1972	1,550,000	80,523	52
1973	1,590,000	109,616	69
1974	1,632,000	62,515	--
1975	1,677,000	28,448	17
1976	1,723,000	49,575	29
1977	1,769,000	70,000	40
1978	1,808,000	77,207	43
1979	1,855,000	83,411	45
1980	1,903,000	62,215	33

continued next page.

.../24

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

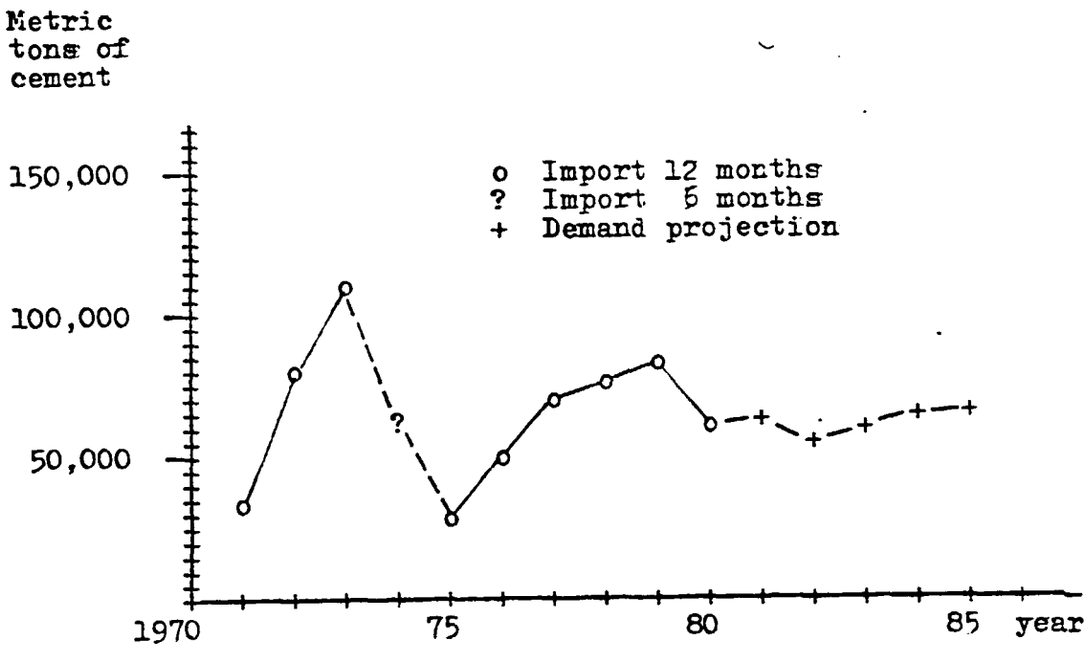


FIGURE II-3 : Cement consumption, 1971-80 and projections for 1981-85

TABLE II-5 (continued)

Year	Population	Cement consumption (metric tons)	Per capita consumption (kg/head)
1981	1,953,000	62,584	32
1982	2,003,000	55,318	28
1983	2,055,000	60,921	30
1984	2,109,000	64,995	31
1985	2,164,000	66,009	31

Total investment employments for the Second Amended Five-Year Plan are YD 508,200,000.- 1/

1/ Source: Aden News Agency, Daily Bulletin, Monday, September 07, 1981, p.17.

.../25

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Calculating 3 percent of the YD 508,200,000.- for cement consumption and a cement price of 50 YD/mt, makes a yearly average consumption of about 61,000 mtpy.

2.6 Five-Year Plans for the PDRY

First Five-Year Plan	1974 - 1978
Second Five-Year Plan	1979 - 1983
Amended Second Five-Year Plan	1981 - 1985
Third Five-Year Plan	1986 - 1990

Amendment has been made in order to synchronize with other eastern countries.

2.7 Major Cement Consumers

2.7.1 Factory for prefabricated concrete elements

Visit has been paid on 04 October to the Factory for Prefabricated Concrete Elements located in Aden next door to the new Japanese 60 MW power station, which actually is under construction.

Existing factory built and went onstream in 1979.

Nominal rated capacity is 500 flats/year = 500 x 100 m^2 = 50,000 sq.m. of flats.

Actual production : 280 flats/year = 28,000 sq.m.

Efficiency = $\frac{28}{50}$ = 0.56 = 56%

.../26

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Reason for the low efficiency :

(1) Lacking experience.
(2) Delay of supply (gravel and cement).
(3) Handling of cement bags, e.g. cutting of bags.

A Hungarian team of 19 people shall arrive for training of the local people in the period of November 1981 - May 1982. It is expected that the Hungarian team would be able to boost the production in the six-month period up to 250 flats, i.e. the nominal rated capacity of the factory.

Existing factory would possibly be on full capacity in, say, 1984.

Cement Consumption

1 flat: 22 cu.m reinforced concrete, 350 kg/cu.m
44 cu.m. light-weight concrete, 250 kg/cu.m.

22 x 0.35 + 44 x 0.25 = 18.7 mt of cement/flat

1980 :	18.7 x 280	5,236 mt of cement
1986 :	18.7 x 500	28,050 mt of cement

Three plants are in stock.

One will be erected in 1982 next door to the existing plant. Capacity 500 flats/year. Onstream in mid-1983.

One more plant under consideration for erection, but not in Aden. The erection may be undertaken by the Danish company SCANTURN.

.../27

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Staff + labours at the existing plant 84
Power unit, 200 kW.

$\frac{84 \times 2000}{280}$ = 600 m-h/flat in 1981, or 9.1 m-h/cu.m. concrete

$\frac{84 \times 2000}{500}$ = 336 m-h/flat after 1984, or 5.1 m-h/cu.m. conct.

1 block element 3.6 sq.m.
1 roof element 6.0 sq.m.

2.7.2 Factory for Tiles and Hollow Blocks

A visit to the Factory for Tiles and Hollow Blocks has been paid on Saturday, October 03, and following informations have been received :

Expected consumption of cement :

	1981 (mt)	1986 (mt)
Tiles	850	3,450
Hollow Blocks	1,250	15,000
Total consumption	2,100	18,450

In 1986 the consumption of cement is at the maximum capacity of the factory after its planned expansion.

2.7.3 Ministry of Industry

From the Ministry of Industry, Implementation Section of Industrial Projects, following informations have been received :

.../28

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Amended Second Five-Year Plan 1981 - 1985

22 industrial projects under implementation.

Total investment employments YD 8 million including erection of machinery and prefabricated elements.

For the cement plant is estimated about YD 5.1 million equal to about 64 percent of envestments for the whole period

TABLE II-6

Yearly Investment Distribution

1981	YD 800,000
1982	YD 1,000,000
1983	YD 550,000
1984	YD 2,200,000
1985	YD 3,500,000
Total investment 1981-85	YD 8,050,000

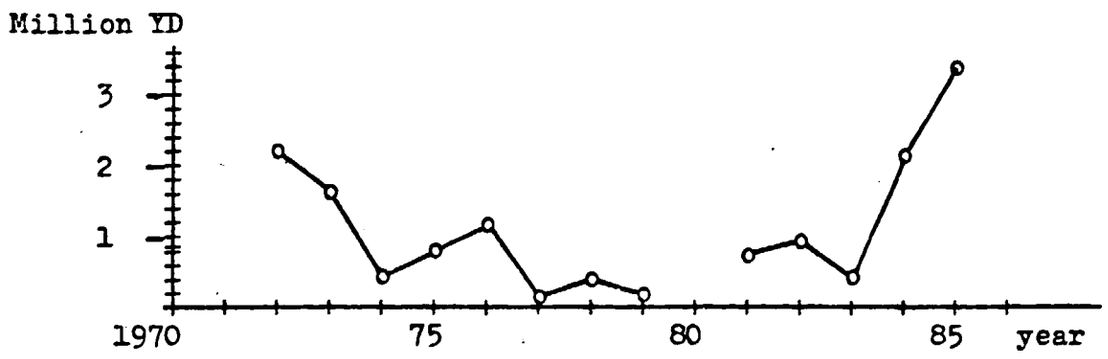


FIGURE II-4 : Ministry of Industry
Investment Employments 1972-79 and 1981-85

.../29

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Cement consumption

Assuming 3 percent of investment will be used for cement á 50 YD/mt the total cement consumption would be

$$8{,}050{,}000 \times 0.03 \times 50^{-1} = 4{,}830 \text{ mt/5 years}$$

or in 1985 :

$$3{,}500{,}000 \times 0.03 \times 50^{-1} = 2{,}100 \text{ mtpy}$$

2.7.4 Ministry of Construction

Following informations have been received from the Ministry of Construction :

The calculating factor for cement consumption per cubic metre of concrete is 500 kg/cu.m. inclusive spillage.

For 1981 about 15,000 cu.m. of concrete has been consumed for normal building constructions.

In 1982 the consumption may reach 25,000 cu.m. concrete equal to 12,500 mt of cement.

Actually the cement market is suppressed, thus nobody knows the real cement demand, thus figures for future consumption are not available.

2.7.5 Public Corporation for Construction

From the Public Corporation for Construction following informations have been received concerning cement consumption :

.../30

BYSKELLET 9, DK-2980 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

1981: About 20,000 mt by YD 4,500,000 investment equal to 4,444 mt cement/million YD investment or say 4,400 mt/million YD. This is a rather high figure, which explains something is wrong.

1982: 22,000 mt of Portland cement (2.5 YD/bag)
3,000 mt of sulfatic cement (4.- YD/bag)
1,000 mt of white cement (4.- YD/bag)

Expecting increase in cement consumption is 20 percent per year.

1988: About 55,700 mt cement

Planned investment for 1982 is YD 6 million.

Cement costs at the Home Trade Company 2.100 YD/bag
Sales price from storage 2.500 YD/bag
In above-mentioned consumptions are included prefabricated elements and tiles.

2.7.6 Other consumers

Other consumers would be the private sector and projects made as a foreign aid to the PDRY.

Figures are rarely available for these consumptions. The consumption of cement for an agriculture project made by the Russians is as follows :

	1976	6,641.300
	1977	634.-
	1978	9,557.350
	1979	3,701.200
	1980	5,204.500
Up to 12 September	1981	7.144.650
	Total	32,883.-

or say 6,000 mt/year.

.../31

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

An ongoing fishing-port-facility project just started would in 3-4 years consume about 4,000 mt of cement. With a total investment cost of about YD 12 million the specific cement consumption per million YD investment = 333 mt/million YD.

With a cement price of 50 YD/mt the cost of cement is $50 \times 4000 \times 12^{-1} \times 10^{-6} = 0.017 =$ 1.7% of total investment.=

The private sector in turn could be a sizable consumer of cement but this would call for some political changes in the housing sector, which at present is nationalized. About 600,000 Yemeni emigrants are surely looking forward to have their own private house at home in the PDRY.

2.7.7 Summary

Estimated cement consumption in 1986 :

Factory for Prefabricated Concrete Elements, 3 plants, efficiency 70% $3 \times 28{,}050 \times 0.7$	58,900 mt
Factory for Tiles and Hollow Blocks	18,500 mt
Ministry of Industry	2,100 mt
Ministry of Construction	20,000 mt
Public Corporation for Construction $6{,}000{,}000 \times 0.02 \times 50^{-1}$	2,400 mt
Other consumers	20,100 mt
Total consumption	122,000 mt

or say :

Portland cement	110,000 mt
Supersulphated cement	10,000 mt
White cement	2,000 mt

.../32

BYSKELLET 9, DK-2980 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

III. IMPORT - EXPORT OF CEMENT

3.1 Imported Cement

3.1.1 Supplying countries and prices

TABLE III-1

Present cement price in the PDRY, August 1981.

Imported from	FOB price US$/mt	C+F price Aden US$/mt
Greece	44.-	78.-
Kenya	48.-	78.-
Romania	42.-	85.-
Turkey	40.-	78.-
U.S.S.R.	n.a.	72.-

Source: Ministry of Industry.

TABLE III-2

Break down of the price of cement 1/

	YD/mt	US$/mt
C+F Aden	26.640	78.-
Costum duty, 20%	5.300	15.52
Handling in Aden harbour	10.060	29.28
Cost price at the Home Trade Co.	42.000	122.80
Handling and storaging	8.000	23.43
Sales price from store house Construction Corporation	50.000	146.23

.../33

1/ Estimated by the author.

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK, PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

3.1.2 Quantities

See table II-5, page 23 under 'cement consumption'.

3.2 Export Possibilities

TABLE III-3

Cement-Export Possibilities for the PDRY
(,000)

Country	Local production 1980 1/	Expansion program 1/	Consumption 1990 (est.) 2/	Export possibility
Algeria	5,400	4,500	n.a.	
Bahrain 3/	200	1,624	1,065	yes
Egypt	4,090	8,850	5,520	
Iraq	7,075	4,200	10,151	
Jordan	800	2,000	2,110	
Kuwait 3/	1,425	75 4/	3,628	yes
Libya	3,900	1,000	6,440	yes
Lebanon	2,452	100 4/	n.a.	
Mauritania	n.a.	n.a.	n.a.	
Morocco	4,692	3,120	6,994	
Oman	392	1,000	n.a.	
Qatar	270	n.a.	1,145	yes
Saudi Arabia	4,960	9,300	16,408	yes
Syria	2,313	3,630	6,170	
Somalia	100	1,000	1,175	
Sudan	370	1,725	827	
Tunisia	2,750	2,800	5,205	
UAE	1,871	2,470	7,755	yes
Yemen A.R.	250	1,500	2,250	yes

Source: 1/ PIT & QUARRY, January 1981
ROCK PRODUCTS, April 1981

2/ Jordanian Building Materials Research Centre and the Arab Union of Cement and Building Materials (1979 study).

3/ Clinker-grinding plant only. 4/ White Cement. .../34

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

3.2.1 Prospective buyers

According to table III-3 following Arab countries could possibly be considered as future prospective buyers of cement produced in the PDRY :

Bahrain
Kuwait
Libya
Qatar
Saudi Arabia
United Arab Emirates
Yemen Arab Republic

3.2.2 Competition

Strong competition will have to be expected in the export market. The Batis Cement Plant Project is not suited for future export market, as production costs are too high, about 29.000 YD/mt (85.- US$/mt).

In order to compete the plant capacity must be at least 1,000,000 mtpy and provision made for excellent port facilities, cheap fuel and electric power. FOB price will have to be about 14 YD/mt (41.- US$/mt), which seems next to impossible to achieve in the PDRY.

The total investment cost for such 1 million-tons-per-year plant would be about YD 60-70 million (US$ 175-205 million), without power plant, capacity about 35 MW.

.../35

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

IV. CEMENT PRODUCTION - A STEP-BY-STEP APPROACH

4.1 Clinker-Grinding- and Packing Plant

It is highly recommendable to start with a clinker-grinding- and packing plant consisting of following main equipment :

(a) Receiving hopper for clinker, additive(s) and gypsum.

(b) Silos for clinker, additive(s) and gypsum.

(c) Feeders for clinker, additive(s) and gypsum.

(d) Open circuit cement mill

(e) Cement silo(s)

(f) Packing machine for bagged cement

(g) Facilities for bulk-cement dispatch

For a capacity of, say, 150,000 mtpy the total investment cost would be about YD 5-6 million (US$ 14.6-17.6 million) for new mashinery.

By buying second-hand mashinery considerable savings could be made.

4.1.1 Appropriate Capacity

According to the market study a mill capacity of, say, 20-25 mt/h would be appropriate. However, a feasibility study should be carried out soonest.

.../36

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

4.1.2 Location

The clinker-grinding plant should be located close to the main consumers, thus next door to the existing Factory for Prefabricated Concrete Elements, where also the new Japanese 60 MW power station is located.

4.1.3 Cement Types

Pozzolana Portland cement made by adding maximum 20 percent pozzolana (vulcanic rocks, pumice etc.) could be a very interesting cement to produce saving the PDRY a vast amount of foreign currency.

Pozzolanic cement may also be produced, if raw materials can be found. This cement contains up to 40 percent pozzolana.

Pozzolana is raw materials having pozzolanic properties, which means ability to combine with lime (CO) at normal temperature and in presence of water to produce compounds having hydraulic properties.

Italy and France are highly specialized in this field.

4.1.4 Production costs

	YD/mt cement
Clinker, 75%, a 68.- US$/mt C+F Ader and 30,- US$ for handling	25.100
Additive, 20%, say	2.000
Gypsum, 5%, say	1.400
Manpower, 0.5 m-h/mt a 0.300 YD/m-h	0.150
Electric power, 36 kWh/mt a 0.027 YD/kWh	1.000
	29.650

.../37

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

	YD/mt cement
	27.650
Bags, 21/mt, 200.- U$/1000	1.430
Balls + plates, 250 g/mt cement	0.085
Maintenance	0.400
	29.565
Overheads, 10%	2.960
Interest charges $15,000,000 \times 0.5 \times 0.12 \times 150,000^{-1} \times 0.3415$	2.050
Depreciation $15,000,000 \times 0.07 \times 0.3415 \times 150,000^{-1}$	2,390
Bagged cement	36.965
Bulk cement	35.535

With a profit of, say 20 percent ex-factory price would be :

Bagged cement	44.360 YD/mt
Bulk cement	42.640 YD/mt

.../38

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

4.2 Clinker-Production Plant

The clinker-production plant consists of following major equipments :

(a) Limestone crusher
(b) Clay crusher
(c) Pre-blending bed(s) for limestone and clay
(d) Raw mill
(e) Homo silos
(f) Preheater
(g) Kiln
(h) Cooler
(j) Clinker storage

Total investment cost for a 150,000 mtpy clinker-production plant would be about YD 14-16 million (US$ 41-47 million), without a 3.5 MW pover station.

The cost of a power station is about 350,000 YD/MW (about US$ 1 million/MW)

4.2.1 Appropriate Capacity

A 500 mtpd preheater kiln is considered the smallest size taken into consideration the fuel economy. This capacity would be appropriate for the Batis Cement Plant Project.

If suitable pozzolanic materials can be found and 20 percent added to the clinker before the cement mill the total cement production capacity would reach 180,000 mtpy.

However, a feasibility study should be carried out soonest.

.../39

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

4.2.2. Location

The clinker-production plant should be located as close as possible to the raw materials, limestone and clay.

The study already carried out by the Russians shows an appropriate plant site about 100 km toward nord-east by road from Aden.

4.2.3 Production Costs

Production cost of clinker would be 28.700 YD/mt cement minus milling of clinker, storage and packing, which would amount to, say, YD 7.500 equal to 21.200 YD/mt of clinker.

By a ton-km price of, say, 0.100 YD/t-km the transport cost from clinker-production plant to clinker-grinding plant would be 10.- YD/mt clinker, thus clinker landed at the clinker-grinding plant would probably cost 31.200 YD/mt.

Using 75 percent clinker the cost of clinker per ton of cement would be 23.400 YD/mt cement, and thus the cost of finished pozzolana Portland cement would be about

42.320 YD/mt

.../40

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

V. FURTHER UNIDO ASSISTANCE

5.1 Feasibility Studies

5.1.1 Clinker-grinding- and Packing Plant

A feasibility study should be carried out on a clinker-grinding- and packing plant with a cpacity of, say, 150,000 mtpy pozzolana Portland cement.

5.1.2 Clinker-production Plant

A feasibility study should be carried out on a clinker-production plant, capacity about 150,000 mtpy of Portland clinker.

5.2 Research and Development

5.2.1 Low-energy Cements

Plenty of vulcanic rocks appears in the PDRY. Samples should be sent to e.g. the Cement R & D Centre in Ankara for testing of the pozzolanicity. An expert in this field should be sent to the PDRY for planning and carrying out a survey.

.../41

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

5.2.2 Raw Materials for Prefabricated Concrete Elements

The concrete lab at the Cement R & D Centre in Ankara should assist in a survey of suitable raw materials for concrete in the PDRY. Specifically the sand is not suitable resulting in a excessive consumption of cement.

5.3 Fellowships

5.3.1 Visit to a Clinker-grinding Plant

Visit(s) should be paid by Yemeni cement experts to a clinker-grinding plant, e.g. in Benin, Kuwait or Bahrain.

Address in Benin : M. Sulkifouli SALAMI
Directeur Général de la Société
Nationale des Ciments
B.P. 448
C o t o n o u
The People's Republic of Benin

5.3.2 Visit to a dry-process Cement Plant

Visit(s) should be paid by Yemeni cement experts to a modern cement plant. It would be recommendable to visit Ethiopia, where the New Mugher Cement Plant Project just is ongoing. A 300,000 mtpy cement plant supplied by SKET in East Germany. Valuable experience could be gained. The New Mugher Cement Plant is located about 60 km from Addis Ababa.

Address: Ethiopian Building Materials Corporation
P.O. Box 5782
Addis Ababa
Ethiopia

.../42

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

J O B D E S C R I P T I O N

Post title	Consultant on Cement Industry
Duration	Two months
Date required	As soon as possible
Duty station	Aden with travel in the country

Purpos of project

The Government of Democratic Yemen intends to establish a cement manufacturing plant in the country for which a feasibility study is under consideration. The Government are desirous of a study on the marketing and plant capacity before embarking on the conduct of a full fledged feasibility study.

Duties

The expert will be attached to the Ministry of Industry's Department of Investment and Construction and will undertake the following in co-ordination with the UNIDO Industrial Advisory Unit.

Appraise various studies conducted on the subject during the past few years along with the evaluation carried out by the UNIDO Expert, Mr. Basman etc.

Assess part imports of cement and their future trends, volume and price.

Estimate present consumption and siae of demand, its past growth, major determinants and indicators.

Estimate future demand vis-a-vis development of National Economy in the framework of the Five-Year Plan 1981-1985 presently under preparation.

Account for the present production capacity for cement manufacturing in the neighbouring countries such as Y.A.R., Somalia, Djibouti, Sudan, Saudi Arabia, U.A.E., Kuwait, Qatar, Bahrain etc. as well as their plans for expansion or creation of new capacities, if any.

.../43

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Analyse the cost of production or price levels prevailing and projected in the said neighbouring countries and the C+F Aden prices of cement presently being imported from various countries.

Examine the scope of exports of cement from Democratic Yemen especially to neighbouring countries.

Determine appropriate capacity of the proposed cement pla nt in relation to the domestic demand and exports.

Undertake any other work relating to the above.

The consultant will be expected to jointly prepare a report on completion of the study setting out his findings and recommendations to the Government on the size/capacity of the envisaged cement plant.

Language: English

Background Information

The Government of PDRY conceived the idea as far back as 1969 of establishing a cement factory based on exploitation of its mineral resources. A Romanian team was entrusted with the task of a geological survey with a view to investigate the qualitative and quantitative potential of major raw materials, viz. limestone, clay, gypsum etc. In their report completed in 1971 they suggested a wet process plant of 100,000 tons yearly capacity for location in the Sarar/Dirjaj surroundings, based on their raw material and demand projections.

Subsequently in 1974 another consultant firm were appointed in order to undertake a comprehensive geological survey to ascertain raw materials availability as regards to quality and quantity for the foreseen dry process cement plant of 250,000 tons yearly capacity and to prepare a complete techno-economic feasibility study. It was concluded by them that :

a. the limestone reserves of Djebel Sarar investigated earlier with new reserves affixed by them in the extension areas cover the limestone requirements of a cement plant of 250,000 tons annual capacity of a minimum period of 200 years,

b. the clay reserves of Wadi Hassan investigated earlier with new reserves affixed by them in the said area and Wadi Dharba covered the clay requirements of a cement plant of 250,000 tons annual production for a period of 100 years,

c. the chemical composition of both the limesto ne and clay were suitable for the dry process technology.

.../44

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

The study was unaccomplished needing bore-hole drilling. Furthermore, the deposits of limestone could be classified as probably reserves whereas those of clay as evaluated reserve. on account of the defficiencies in the topographical and geological survey, the Ministry of Industry in 1978 co-ordinated efforts with the geological department for further intensive investigations.

Another team was assigned, investigations have been completed.

Before full pledge techno-economic study for establishing a cement manufacturing plant in the country is conducted, the Government is desirous of a study as to the determination of plant capacity based upon an in depth analysis of the present and projected demand and marketing possibilities (domestic and abroad).

Hence the project.

.../45

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Persons met in the P D R Y

03 SEP 81	Mr. Othman Abdul Gabbar	Deputy Minister of Industry
03 SEP 81	Mr. Fadel Hasan Yehya	Assistant Deputy Minister for Production
03 SEP 81	Mr. Taher Bin Yehya	Acting Assistant Deputy Minister for Planning
03 SEP 81	Mr. Salim Al-Ammari 1/	Cement Project Manager
03 SEP 81	Mr. Fuad Abdul Karim 1/	Assistant Cement Porject Manager
08 SEP 81	Mr. Saleh Ahmed Al-koli	Head of Implementation Section of Industrial Projects
09 SEP 81	Mr. Salih Abdalla Assani	Director Planning Dept. Public Corporation for Construction
16 SEP 81	Mr. Aldullah Saeed Abaddan	Deputy Minister of Planning (Sectors)
23 SEP 81	Mr. Talib Jafer Shamlan	Deputy Minister of Construction
03 OCT 81	Mr. Mohammed Bari	Director of Production Department Public Corporation for Construction and Industrial Installations

1/ Counterparts

../46

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Persons met in the P D R Y (continued)

03 OCT 81	Mr. Mohammed Maqbell Al-Sumatiy	Production Supervisor Factory for Prefabricated Concrete Elements
03 OCT 81	Mr. Sadkey Gwad Humcharey	Electric-Unit Supervisor (200 kW) Factory for Prefabricated Concrete Elements

.../47

RYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

ANNEX III

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Aden, September 19,1981

Batis Cement Plant Project

Q U E S T I O N N A I R E 1

1973 - 2000 Populations Estimates for the P D R Y

(,000)

	Total	Urban	Rural(+ Nomads)	Nomads
1973	____	____	____	____
1975	____	____	____	____
1980	____	____	____	____
1985	____	____	____	____
1990	____	____	____	____
1995	____	____	____	____
2000	____	____	____	____

Remarks :

.../48

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

ANNEX III

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Aden, September 19, 1981.

Batis Cement Plant Project

Q U E S T I O N N A I R E 2

Yearly Gross National Product (GNP) of the P D R Y

from 1974 through 1980

and average estimates of the periods 1981-1985 and 1986-1990

(YD ,000,000)

Sector	1974	1975	1976	1977	1978	1979	1980	81/85	86/90
Oil Refinery									
Agreculture & Fishing									
Public Administration									
etc.									
T o t a l									

.../49

ANNEX III

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Aden, September 19, 1981.

Batis Cement Plant Project

Q U E S T I O N N A I R E 3

Yearly Gross National Product Per Capita of the P D R Y

from 1974 through 1980

and average estimates of the periods 1981-1985 and 1986-1990

	YD	Growth Rate %
1974	—	—
1975	—	—
1976	—	—
1977	—	—
1978	—	—
1979	—	—
1980	—	—
1981-1985	—	—
1986-1990	—	—

Remarks :

.../50

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 1*600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

ANNEX III

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Aden, September 19, 1981.

Batis Cement Plant Project

Q U E S T I O N N A I R E 4

Cement Consumption in the P D R Y (1974-1980)

(metric tons)

	Imported (Recorded)	Through Grants or loans (Non-recorded)	T O T A L
1974	_____	_____	_____
1975	_____	_____	_____
1976	_____	_____	_____
1977	_____	_____	_____
1978	_____	_____	_____
1979	_____	_____	_____
1980	_____	_____	_____

Remarks :

.../51

ANNEX III

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Aden, September 19, 1981.

Batis Cement Plant Project

Q U E S T I O N N A I R E 5

Implemented Industrial Projects during the First Five-Year Plan, 1974-1978, in the P D R Y

Product produced	Went onstream (year)	Rated capacity (units/year	Actual total production in the fiscal year of 1979 (units/year)
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____
•	____	_____	_____

Remarks :

.../52

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Aden, September 19, 1981.

Batis Cement Plant Project

Q U E S T I O N N A I R E 6

Building Materials Consumption during the First Five-Year Plan, 1974-1978, in the P D R Y

	1974	1975	1976	1977	1978	TOTAL
Investment costs in the First FP (in million YD)	___	___	___	___	___	___
Consumption of hollow blocks (in cu.m.)	___	___	___	___	___	___
Consumption of pre-fabricated concrete elements (in cu.m.)	___	___	___	___	___	___
Consumption of concrete at the construction sites (in cu.m.)	___	___	___	___	___	___
Consumption of cement-lime mortar at the construction si tes (in cu.m.)	___	___	___	___	___	___
Other cement-consuming elements (in units)	___	___	___	___	___	___

Remarks :

.../53

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Aden, September 19, 1981.

Batis Cement Plant Project

Q U E S T I O N N A I R E 7

Building Materials Consumption during 'part' of the Second Five-Year Plan, 1979-1983, in the P D R Y

	1979	1980	(1981)	(1982)	(1983)	TOTAL
Investment costs in the Second FP (in million YD)	____	____	____	____	____	____
Consumption of hollow blocks (in cu.m.)	____	____	____	____	____	____
Consumption of pre-fabricated concrete elements (in cu.m.)	____	____	____	____	____	____
Consumption of concrete at the construction sites (in cu.m.)	____	____	____	____	____	____
Consumption of cement-lime mortar at the construction sites (in cu.m.)	____	____	____	____	____	____
Other cement-consuming elements (in units)	____	____	____	____	____	____

Remarks :

.../54

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Aden, September 19, 1981.

Batis Cement Plant Project

Q U E S T I O N N A I R E 8

Estimates of Building Materials Consumption during the Amended Second Five-Year Plan, 1981-1985, in the P D R Y

	1981	1982	1983	1984	1985	TOTAL
Investment costs in the Amended Second FP (in million YD)	___	___	___	___	___	___
Consumption of hollow blocks (in cu.m.)	___	___	___	___	___	___
Consumption of pre-fabricated concrete elements (in cu.m.)	___	___	___	___	___	___
Consumption of concrete at the construction sites (in cu.m.)	___	___	___	___	___	___
Consumption of cement-lime mortar at the construction sites (in cu.m.)	___	___	___	___	___	___
Other cement-consuming elements (in units)	___	___	___	___	___	___

Remarks :

.../55

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK, PHONE: +45 2 86 65 65,
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

Aden, September 19, 1981.

Batis Cement Plant Project

Q U E S T I O N N A I R E 9

Estimates of Building Materials Consumption during the Third Five-Year Plan, 1986-1990, in the P D R Y

	1986	1987	1988	1989	1990	TOTAL
Investment costs in the Third FP (in million YD)	___	___	___	___	___	___
Consumption of hollow blocks (in cu.m.)	___	___	___	___	___	___
Consumption of pre-fabricated concrete elements (in cu.m.)	___	___	___	___	___	___
Consumption of concrete at the construction sites (in cu.m.)	___	___	___	___	___	___
Consumption of cement-lime mortar at the construction sites (in cu.m.)	___	___	___	___	___	___
Other cement-consuming elements (in units)	___	___	___	___	___	___

Remarks :

.../56

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

LEADING CEMENT PRODUCING COUNTRIES

(in million metric tons)

Country	Production 1978	Total cement capacity (est.) 1979	1980
U.S.S.R.	129.3	140.	n.a.
Japan	84.4	109	n.a.
United States	72.5	91.5	95
China	68.	n.a.	n.a.
Italy	38.5	50.	n.a.
Germany (West)	33.	35.	35.
Spain	32.1	39.9	44.
France	31.2	36.6	36.9
Brazil	23.2	27.	30.
Poland	21.7	n.a.	n.a.
India	19.6	22.8	26.5
United Kingdom	16.6	19.6	19.4
Korea (South)	15.5	20.3	23.3
Turkey	15.4	18.7	19.6
Mexico	15.3	16.9	19.5
Romania	14.	n.a.	n.a.

For the first time, cement production declined in the Soviet Union, output fell from 129.3 million to 123 million tons. (1979).

Top exporters among the CEMBUREAU COUNTRIES (the European Cement Association) in 1979 were :

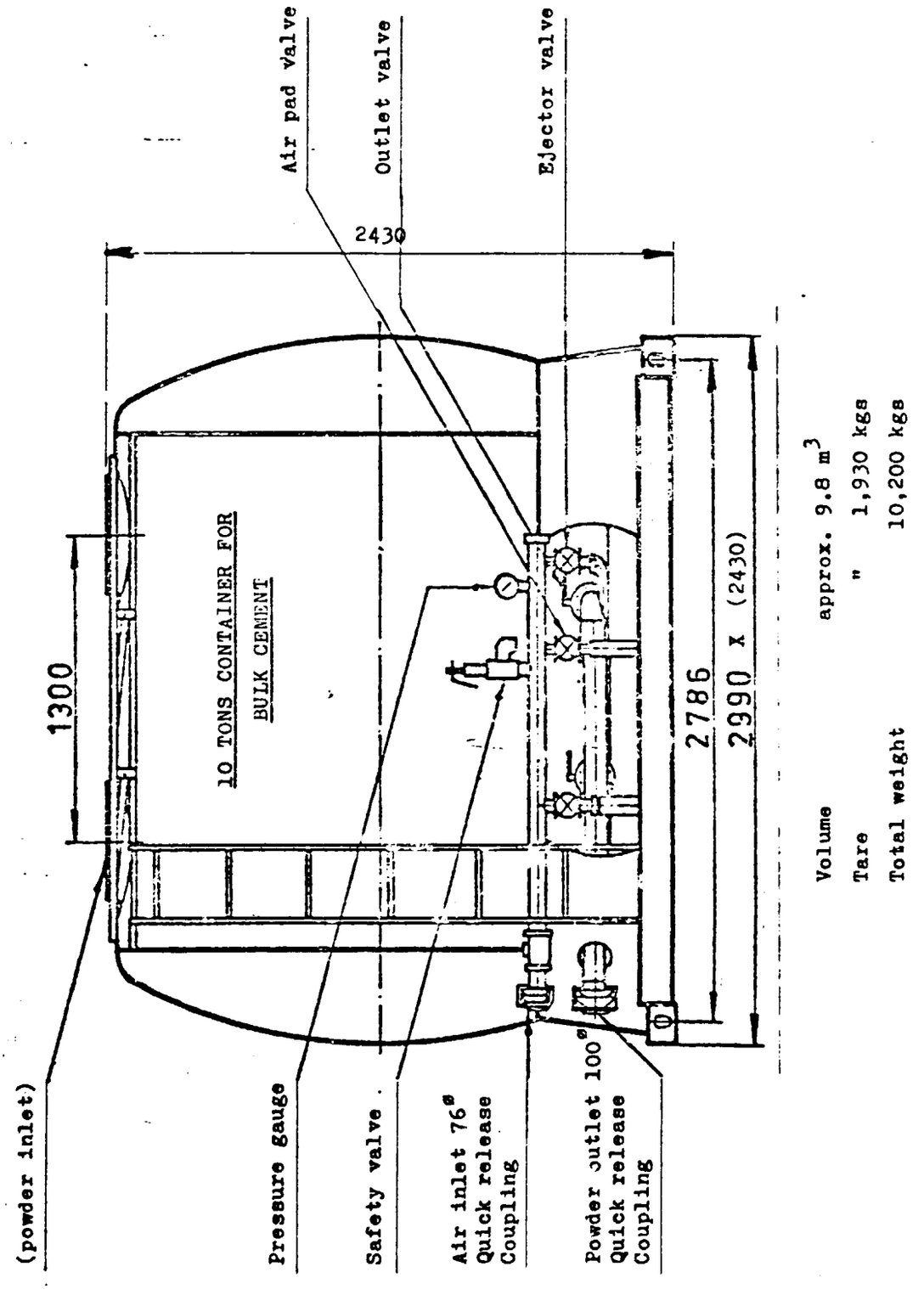
Spain	8.7 mmt
Greece	4.9 mmt
France	2.8 mmt
Great Britain	1.4 mmt

Source: PIT & QUARRY, January 1981, p. 110.

.../57

BYSKELLET 9. DK-2960 RUNGSTED KYST. DENMARK. PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT



Source: BRIAB AB, P.O. Box 108, S-311 01 Falkenberg, Sweden
Telex 38 087 Inter S
Cable Interbulk

.../58

ANNEX VI

COMMENTS ON THE BATIS CEMENT PLANT PROJECT

Limestone Quarry

(1) Blasting system should be explained clearly. Hole diameter, type of explosive (ANFO or dynamite). Remember, crushing and homogenizing starts with the blasting system.

(2) Crushing should take place at the quarry and not at the plant. This will reduce maintenance costs of the trucks.

(3) Quarry equipment should be specified in terms of capacities and fuel consumptions. Not by type numbers.

(4) If possible crushing should be made by one crusher only.

(5) For future expansion provision should be made for limestone transport from quarry to plant site by means of a rubber-belt conveyor.

(6) Truck capacity should be changed from 10 tons to about 25 tonns
For crushed stones a normal highway truck + trailer could be used.

Clay Quarry

(1) For proper pre-blending the clay may pass a roller mill.

(2) It should be confirmed that an excavator can handle the clay wityout prior ripping.

.../59

Iron Ore and Gypsum

(1) Buffer stock pile, crushing and storing should take place at the plant site.

(2) A A single-shaft hammer crusher could be used.

Pre-Blending Beds

(1) Largely oversized. 500/200 t/h stacking/reclaiming would be more appropriate.

(2) For limestone a circular pre-blending bed with a bridge-scraper reclaimer is recommendable.

(3) For clay and iron ore a rectangular pre-blending bed with a portal-scraper reclaimer would be appropriate.

Raw Mill Department

(1) Raw mill largely oversized. Extensive energy consumption.

(2) The drive and motor should be split up in 2 x 1000 kW.

(3) If possible a regular air-swept mill, single-compartment mill with air recirculation should be applied.

(4) Raw-meal transport should be made by mechanical means and not by air. Energy consumption too high.

(5) Super-fine alkali dust should be taken away from the electrostatic precipitator (discharge near outlet of filter).

.../60

Two-Storey Blending Silo

(1) Old type with high energy consumption.

(2) If possible change it to a modern low-energy system using less air. Remember, air is very expensive to move.

Rotary Kiln

(1) Kiln slope excessive. Less slope and higher speed are making longer life of the brick lining and better fuel economy.

(2) Sealings kiln-pre-heater and kiln-cooler must be of a high quality in order to save fuel.

(3) Fuel-oil burner must be ao low-primary air type, max. 5% primary air in order to save fuel.

(4) Heat resistant ring section at kiln outlet must be of high quality in order to keep high temperature of secondary air which makes fuel savings.

Grate Cooler

(1) Each compartment should be provided with separate fan.

(2) Fan motors should be with fixed speed. Easy maintenance.

(3) Traveling grate should be in two parts.

(4) Dedusting should be made by a gravel filter and not a multicyclone.

.../61

Clinker Storage

(1) Clinker should be stored in a silo and not in a open storage with a traveling overhead crane for transport of clinker to the cement mills.

Such a storage system is highly undesirable as it gives tremendous maintenance problems.

Air Lift

(1) The kiln is provided with an air lift for transport of the raw meal to the pre-heater tower.

The raw meal transport should be made by mechanical means, which will save considerable energy and no false air will be supplied to the pre-heater.

(2) Root blowers for the above-mentioned air lift are extremely noisily, and have to operate 24 hrs./day.

Electrostatic Precipitators

(1) The kiln is provided with two EP one for the pre-heater and raw mill and another for the by-pass system.

Dust content in the cleaned gases should not exceed 100 mg/Nm^3.

(2) The dust from the pre-heater-raw-mill filter should be returned to the homo silo via the raw mill feed.

.../62

(3) Dust from the by-pass filter will have to be removed from t the raw meal system.

Suppose the super-fine alkali dust does not content chlorine it could be used as fertilizer. Otherwise the dust is waste and store place will have to be provided for.

Alkali-dust production per day would be in the range of 15-20 tons, or say 6000 tons per year.

Cement Mill Department

(1) This department seems appropriate. However provision for production of blended cement should be made by adding a third silo for additives as pure limestone or pozzolanic materials.

(2) By producing blended cement it would be advantageous to have one mill working in a closed circuit, i.e. with separator.

Packing Plant

(1) Appropriate but provision should be made for dispatch of bulk cement.

(2) Container system for bulk transport of cement should be investigated. 10 tons capacity container seems appropriate.

.../63

Compressor Station

(1) Compressed air supply should be made as close as possible to the consumer. Thus decentralization of compressors is recommended.

(2) In general the use of compressed air should be kept at a minimum as it calls for too much energy.

Power Station

(1) Proposed power station largely oversized by 6 x 3.16 MW = 18.96 MW.

4 x 3.16 = 12.64 MW would be appropriate. Even with the very high power consumption of the designed plant, 142 kWh/t cement, 2 x 3.16 = 6.32 MW are sufficient. However, by start up of mills three generators will be needed.

(2) About YD 1.7-2.0 million can be saved by reducing the power station from 6 to 4 units. Investment cost per installed MW is about YD 340,000.-.

(3) Bunker C fuel oil should be used for the diesel motors. The same fuel as for the kiln.

Yearly consumption of diesel fuel is by the supplier estimated to be 17,000 tons for a production of 52 x 10^6 kWh. This is considered very high consumption. Also, the supplier estimates 142 kWh/t cement, which is a very high figure. 110 kWh/t cement should be maximum acceptable power consumption for a to-day cement plant using the dry process. As low as 85 kWh/t cement can be obtained.

Using four generators only and a well-designed cement plant with a power consumption of 110 kWh/t cement, a saving of fuel costs could reach about YD 1 million per year.

.../64

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

C O N C L U S I O N

made by

the State All-Union Institute

for

Designing Plants of Cement Industry, GIPROCEMENT, Leningrad,

in their Feasibility Report on the Batis Cement Plant Project,

dated 1980

Cement Production in the PDRY can be organized through construction of a cement plant comprising one dry process line equipped with a Ø 4,0 x 60 m kiln and suspension preheaters in the vicinity of Batis settlement nearby carbonaceous and clayey raw materials.

The limestone section Batix II seems to be more favourable for construction and exploitation of a quarry and the main quarry road. Hence the section Batis II on confirmation of limestone suitability for cement production in its chemical composition and the stock amount can be recommeded as a carbonaceous base of the cement plant under design.

The annual capacity of the plant is to be 255,000 metric tons.

The construction cost is estimated at 32,828,600.- YD (US$ 96,200,000.-), the cost price of 1 t of cement being 29,000 YD (US$ 85.- per metric ton).

The cost price of cement of the Batis cement plant is higher than that of the imported one (cost and freight harbour of Aden), when selling cement of own production in the town of Aden at a market price the profit will comprise 9.200 YD (US$ 27.-), that is in

.../55

BYSKELLET 9. DK-2960 RUNGSTED KYST, DENMARK. PHONE: +45 2 86 55 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK. ATT. CEMBOECK RUNGSTED KYST

HARALD C. BOECK
INDEPENDENT CEMENT CONSULTANT

the order of 30 per cent of the production expenditure.

By the time of developing and estimating engineering concepts of the present feasibility report the Customer didn't submit adequate initial data. Therefore a certain correction of the basis engineering and economical indices for the plant will be required at the subsequent stages of design.

BYSKELLET 9, DK-2960 RUNGSTED KYST, DENMARK, PHONE: +45 2 86 65 65.
CABLE: CEMBOECK RUNGSTED KYST TELEX: 16600 FOTEX DK, ATT. CEMBOECK RUNGSTED KYST