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(R) ASSISTANCE TO THE CEMENT INDUSTRY,*
SI/ETH/7[illegible].
ETHIOPIA.

[illegible]: [illegible]

[illegible] for the Government of Ethiopia
of the United Nations Industrial Development Organization,
[illegible] for the United Nations Development [illegible]

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Vienna

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Explanatory notes

The following abbreviations have been used in this report:

EBMC Ethiopian Building Materials Corporation

MTPY metric tons per year

Mention of firm names and commercial products does not imply endorsement of the United Nations Industrial Development Organization (UNIDO).

TABLE OF CONTENTS

TABLE OF CONTENTS

Annexes

I INTRODUCTION

After the overhaul of the existing cement plant in Addis Ababa last July (UNIDO-mission[1]) it became obvious that a new clinker production line should be build up as soon as possible and as close as possible to the raw material deposits.

In 1967 an investigation of limestone deposits and plant sites has been carried out by a Canadian consulting consortium and the main part of this study is still of high value and very useful.

Based on the Canadian study the Government of Ethiopia has now intended to build a cement plant at the New Mugher quarry about 100 km from Addis Ababa. The New Mugher limestone deposit has a proved reserve of 24 million metric tons, based on 409 m of core drillings, enough for 300,000 tons of cement for 50 years.

Various suppliers of complete cement plants have been asked to submit a Budget Proposal for a 300,000 metric tons per year (MTPY) cement plant. It has been confirmed that most of the asked companies will be able to submit their proposal by the end of the year.

This report is concerned with a tender evaluation of one only offer from a company in the German Democratic Republic, thus a follow-up mission will be needed for evaluation of further more offers.

The successful supplier will have to provide the Government with substantial financial facilities covering a complete turnkey supply of a cement plant.

The Ethiopian Building Materials Corporation (EBMC), under the Ministry of Industry, will undertake the implementation of the new cement plant which will be the fourth cement plant in Ethiopia. The existing three

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1/ See technical report DP/ID/SER.A/167.

cement plants have a total rated capacity of 40,000 + 70,000 + 70,000 = 180,000 MTPY.

Most probably a fifth cement plant , also 300,000 MTPY, will be build up simultaneous with the fourth at New Mugher as an extension of the existing Dira Dawa plant (40,000 MTPY), which is the oldest cement plant in Ethiopia.

11 SUMMARY OF FINDINGS AND CONCLUSIONS

(a) More core drillings are desirable for both limestone and clay. About 80-90 m of core drilling with a recovery of at least 90% is normally needed for each one million of raw material exploited e.g. for 24 million tons of limestone is about 24 x 85 = 2,040 m or say 2,000 m core drilling needed.

409 m core with 60% recovery has been drilled.

(b) Plant layout will have to match with the proposed plant site. (Plant site I in the Canadian study, 1967.)

(c) Subsoil investigation of selected plant site should be undertaken by the supplier according to plant layout.

(d) The kilo-price of equipment is very low, about half of normal, but the weight of equipment is very doubtful and will have to be confirmed. A weight tolerance of ± 5% is recommended.

(e) The cost of erection is unbelievable high. Ask for price break down.

(f) Total investment cost will probably exceed US$ 100 million.

(g) Crushing department should be situated at the quarry and the crushed limestone transported to the plant site by means of a rubber belt conveyor about 900 m long.

(h) Preblending of the raw materials is highly recommended.

(k) Raw mill department very sensible to moisture content of raw materials. It could be a very serious bottle-neck in production capacity.

No auxillary furnace is foreseen for start-up and operation in the rainy season.

(l) Clay store capacity too high. should be reduced to 90 days instead of 216 days.

(m) Implementation time for the project too long. Should be reduced to, say 24-30 months instead of 40 months after entering into force of the contract.

(n) Technological guarantees, folder 2.2, will have to be revised particularly with regard to item 1 "Requirements which must be complied with by the buyer concerning the materials used during trial run and performance test."

It is recommended that the supplier undertakes the entire responsibility mentioned in item 1.

2.01 **Alternative Proposal**

Regardless the future supplier of a cement plant at New Mugher it will take at least four years from today before finished cement can be produced. The total investment cost will probably reach US$ 80-100 million excluded road building, which means an ex-factory price of about 70-80 US$ per ton of cement.

If no substantial change can be reached in the cost of the New Mugher cement plant project it would be interesting to investigate, what could be done of improvements of the existing Addis Ababa plant. The writer would recommend as follows:

(1) Investigate how much pumice can be added to the cement clinker by grinding separately pumice to, say, 4000 Blaine fineness and clinker to say 2800 Blaine. After homogenizing the cement can be bagged.

Actually the plant is manufacturing a mixed cement with 20%

pumice added to the clinker and ground together. By separately grinding it might be possible to ad up to 70% pumice and still have a very good cement.

This applies also highly to the New Mugher cement plant project. For this project the cement mill department should be situated in Addis Ababa. Pumice will be supplied from Koka about 70 km from Addis Ababa.

(2) Install a new vertical raw mill inclusive a new electrostatic precipitator, conditioning tower and homogenizing silo.

Use existing electrostatic precipitator as exit gas by-pass which will eliminate clogging of cyclones.

(3) Convert existing raw mill to cement or pumice mill.

(4) Improve further the handling system of limestone and clay by means of rubber belts and reclaimers.

(5) Develop a dispach system of cement in bulk. 10-ton containers which can be used by any kind of trucks, which can carry 10 tons.

Suppose the addition of pumice could reach say 50% and with a steady clinker production of 90,000 MTPY the total cement production could reach 135,000 MTPY.

The total cost of such improvements would be in the range of US$ 8-10 million.

Implementation time will be 12-15 months with few weeks stoppage of the kiln for switching over.

Advantages

No staffing problems.

Good mechanics and electricians immediately available.

Air pollution reduced to a minimum.
People living around the plant will be very happy.

US$ 10 million loan easy to get through development bank or bilateral aid.

Production costs can still be kept low.

Extended production after about 15 months.

Disadvantages

Large suppliers of cement making machinery may not be too interested in such project, thus turnkey supply could be difficult to obtain.

The plant is 14 years old, however, in a surprisingly good shape.

III RAW MATERIALS

3.01 Limestone

According to the Canadian study of 1967 there is plenty of limestone suitable for the production of Portland cement at the New Mugher deposit.

However, only 409 m of core drillings have been done with a recovery of 60% only.

More core drillings will have to be made and in the experts opinion the minimum requirement is about 750 m with a recovery of at least 90% if possible.

This is essential in order to determine the correct raw mix.

3.02 Clay

Core drillings at the proposed clay quarry at Hollotta are indispensable.

About 150 m core drillings with a recovery of 90% would be the minimum requirement..

3.03 **Sand**

As correction for the low silica content in the clay it will be necessary to search for sand (100% SiO_2).

3.04 **Gypsum**

Gypsum of high purity is available in the New Mugher area about 6 km from the limestone quarry.

Yearly consumption will be 286,000 x 0.04 = 11,440 tons.

3.05 **Pumice**

The pumice deposit is situated at Koka about 70 km from Addis Ababa.

Yearly consumption is expected to be 286,000 x 0.2 = 57,200 tons.

A quantitative and qualitative investigation should be carried out. It may be possible to add much more than 20% to the clinker.

IV PLANT SITE

4.01 Subsoil Investigation

After a visit to the proposed plant site I and the limestone deposit at New Mugher on Saturday, 04 November 1978, it has been confirmed that plant site I is appropriate as far as the position is concerned. A subsoil investigation will have to be carried out in order to estimate the cost of civil work.

However, some drillings have been done for water and hard rock has been found in various depths from 5-11 m approximately.

4.02 Plant Layout

The plant layout proposed by the supplier will have to be altered according to the above-mentioned plant site I.

The crushing department will have to be moved to the quarry and connected to the plant site by means of a rubber belt conveyor of approximately 200 m length.

It is recommended only to produce clinker at New Mugher and build up a clinker/pumice grinding plant close to the market or probably extend the existing milling capacity at the Addis Ababa plant.

V TECHNICAL EVALUATION

5.01 Quarry Equipment

Thie equipment will have to be checked carefully. The weight of the equipment ie almoet double than normal quarry equipment.

If poeeible buy thie equipment eeparately.

5.02 Crushing Department

Thie department ehould be eituated at the quarry.

Capacity aßd type of crusher ie appropriate.

Deducting ehould be done by meane of a bag filter and not by cyclonee.

The civil work might be very coetly.
Aek for alternative proposal of a mobile crueher.

5.03 Limestone Transport

Transport from quarry face to crusher ehould be done by meane of heavy duty Off-Highway Trucke e.g. 30 tons payload each. For loading of a 30-ton truck a 5.4 cu.m Wheel Loader would be appropriate (Caterpillar 988B, Readleee).

The crushing department ehould be connected to the plant eite by a 800-mm wide and about 800-900 m long rubber belt conveyer.

Transport from quarry face to crusher should be done by means of heavy duty trucks e.g. 30 tons payload each (Cat. 769B).

5.04 **Clay Transport**

The distance will be about 45 km.
20-ton FIAT long-distance lorries (about US$ 90,000.- each) would be appropriate as used by the existing Addis Ababa plant.

5.05 **Sand Transport**

As for clay transport.

5.06 **Prehomogenizing**

The offered plant layout shows a poor prehomogenizing system for limestone, clay and sand.

It is essential for the dry process of cement manufacturing to prepare the raw mix very carefully.

Only the limestone storage system can perform some blending effect, but very poor. However improvement could be done by building up stock piles consisting of many layers. The mobile and reversible belt conveyor belt, item 11.50, pos. 4, will have to move fast e.g. 30-40 m per minute.

Store capacity for limestone, 2 x 8,500 t, is appropriate.

Store capacity for clay, 4 x 12,750 t, is too big.
2 x 9,000 t equal to 90 days production would be appropriate for the three months rainy season.

Ask for an alternative proposal of a circular prehomogenizing plant for integrated prehomogenising of limestone, clay and sand.

Total store capacity should be about 15,000 t and before the store should be a sample station taking 3-4 sample per houre of receiving raw materials.

5.07 Raw Mill Department

The two-compartment tube mill 4 m$^{\phi}$ x 8 m with cyclone air classifier and reepectively a 1,400 and 200 kW moter, will probably be a serious bottle-neck due to much more moieture content in the raw materials than assumed.

This system cannot handle more than 8-9% moisture without going conaiderable down in capacity.

Also there is not foreseen an auxilliary furnace for etart-up.

It eeems more appropriate to apply a vertical raw mill which can handle up to 15% moieture content in the raw materials.

Before choosing the mill system it is essential to carry out much more core drillings at the limestone quarry which may confirm a higher moisture content than assumed before.

5.08 Homogenising and Storage

A 4,750 t store silo + 185 su.m. mixing silos at the top is appropriate provided a good prehomogenising system, as proposed on page 12, will be applied.

5.09 **Feeding to the Preheater**

Feeding to the preheater is performed by means of a Redler conveyor, 20 - 100 t/h.

This feeding system is simple and appropriate. However no weight tolerance is mentioned. The weight tolerance should be ±0.2%.

5.10 **Preheater**

The one-string shaft type preheater with two cyclone stages and three shaft stages should be appropriate for the raw materials at New Mugher.

However, the suppliers requirements to receiving raw mix should **not** be accepted. Please see Folder 2.2, Technological Guarantees with special regard to item 1.1.

Ask for an additional offer for a 10% exit-gas by-pass which will be indispensable if the chlorids content exceeds 0.015%.

The connection between preheater and electrostatic precipitator should be improved. Too many horizontal ducts can create serious problems.

5.11 **Kiln**

A rotary kiln 4 m^{ϕ} x 60.0 m with 3% inclination is guaranteed a daily clinker production of 900 metric tons at the altitude of 2,500 m above sea-level.

This kiln is appropriate.

5.12 Cooler

A rotary cooler 3.8 m^{ϕ} x 45.0 m with 5% inclination is offered.

This cooler is appropriate.

5.13 Clinker Storage

The transport of clinker from cooler to clinker store is performed by means of a single bucket conveyor.

It is recommended to make a double line from cooler to just outside in order to keep the kiln running in spite of a breakdown of the clinker transport or maintenance.

Clinker open air storage capacity 2 x 14,000 t equal to 2 x 15.5 days production is considered as very large capacity.

1 x 14,000 t capacity would be more than appropriate.

Ask for alternative supply of a 14,000 t clinker silo.

5.14 Clinker Reclaiming and Transport

Reclaiming by means of plow reclaimer from an open air storage is not recommendable. A bulldozer will continously be needed.

In the rainy season it can create serious reduction in milling capacity due to high moisture content of clinker.

Please ask for clinker silo.

5.15 Gypsum Quarrying, Transport and Storage

About 7 km from the plant site I ie a gypsum depoeit. Roads will have to be built for truck tranepert of gypeum to the plant.

The proposed gypsum crueher at the plant can be cancelled

Gypeum can occasionally be crushed by means of the limestone crueher.

One hour production will cover the coneumption of gypeum for 5.5 daye.

Gypeum ehould be kept in a roofed store.

5.16 Pumice Quarrying, Transport and Storage

About 70 km from Addis Ababa at Koka there ie a large pumice depoeit. This impertant additive will have to be inveetigated carefully as eoon ae poeeible. It might be feaeible to eix up to 70% of pumice with clinker provided the pumice can be ground eeparately.

Quarrying and tranepert of pumice ie eaey. No drilling, blaeting or ripping ie needed.

Ethiopia can eave conaiderable foreign exchange by extenaive usage of pumice.

5.17 Cement Mill Department.

It ie recommended to build up the entire cement mill department eloee to the market and the pumice deposit.

The offered closed-circuit cement mill 3.6 m^{ϕ} x 14.0 m with circulating air separator 4500 is guaranteed a capacity of 75 t/h Portland cement by 2250 Blaine (cm^2/g).

Too complicated installation for producing such coarse cement.

An open-circuit mill would be more appropriate for clinker grinding.

When investigations on the use of pumice as additive are finished a new project should be carried out concerning a separate cement mill department situated e.g. in Addis Ababa.

5.18 Cement Transport

The transport of cement from the cement mill to the store silos is mechanically and appropriate. Energy-saving design.

5.19 Cement Storage

Capacity 2 x 6,400 t equal to 13.4 days production.

It is appropriate as far as no separate milling takes place e.g. of pumice. Otherwise homogenizing silos will have to be applied in connection with two mills.

5.20 Cement Dispatch

As much as possible should be delivered in bulk.

Bag/bulk ratio e.g. 25/75.

5.21 **Power Supply**

Power is supposed to be supplied from Addis Ababa by a high tension overhead line.

5.22 **Water Supply**

A preliminary investigation has confirmed that sufficient water can be supplied from wells and the near-by river.

About 1.5 m^3/t cement will be needed.

VI ECONOMICAL EVALUATION

6.01 **Cost of Equipment**

Mechanical equipment $\frac{19,349,737.- \text{ US\$}}{8,781,870 \text{ kgs}} = 2.22$ US$/kg

Electrical equipment $\frac{5,093,500.- \text{ US\$}}{1,079,140 \text{ kgs}} = 4.72$ US$/kg

The kilo-price is almost half of the international prices.

On the other hand the weight of machinery is more than double as normal for a cement plant $\frac{8,701,870 \text{ kgs}}{287,000 \text{ MTPY}} = 30.4$ kg/t cement.

6.02 Cost of Civil Work

After a subsoil investigation of the proposed plant site an estimate of the civil work costs can be done.

However, drillings for water at the plant site have shown 5-11 m depth to reach hard rock. That means a relatively costly foundations will have to be done.

Removing the cement mill department, silos and packing plant to Addis Ababa could reduce the civil work costs considerable.

A guesstimate would be about US$ 20 millions.
(For Dire Dawa Project US$ 23 millions).

6.03 Cost of Erection

Carrying-out of erection of the electrical and mechanical equipment, and direction of commissioning	US$ 18,826,590.-
FOB price of mechanical and electrical equipment	US$ 24,443,237.-

Cost of erection is generaly in the range of 25-30% of the total FOB price, that means 24,443,237 x 0.3 = 7,332,971 or say US$ 8 millions.

Ask for a break-down of the figure US$ 24,443,237.-

6.04 Cost, Insurance and Freight (c.i.f.)

C&F price port of Assab is offered only.
That means insurance will have to be paid by the costumer.

6.05 **Implementation Time**

Scheduled implementation time is 40 months from signature of contract.

The implementation time should be reduced to at least 30 months, but it might be difficult due to possible delay in building the access road to the plant site, of about 60 km

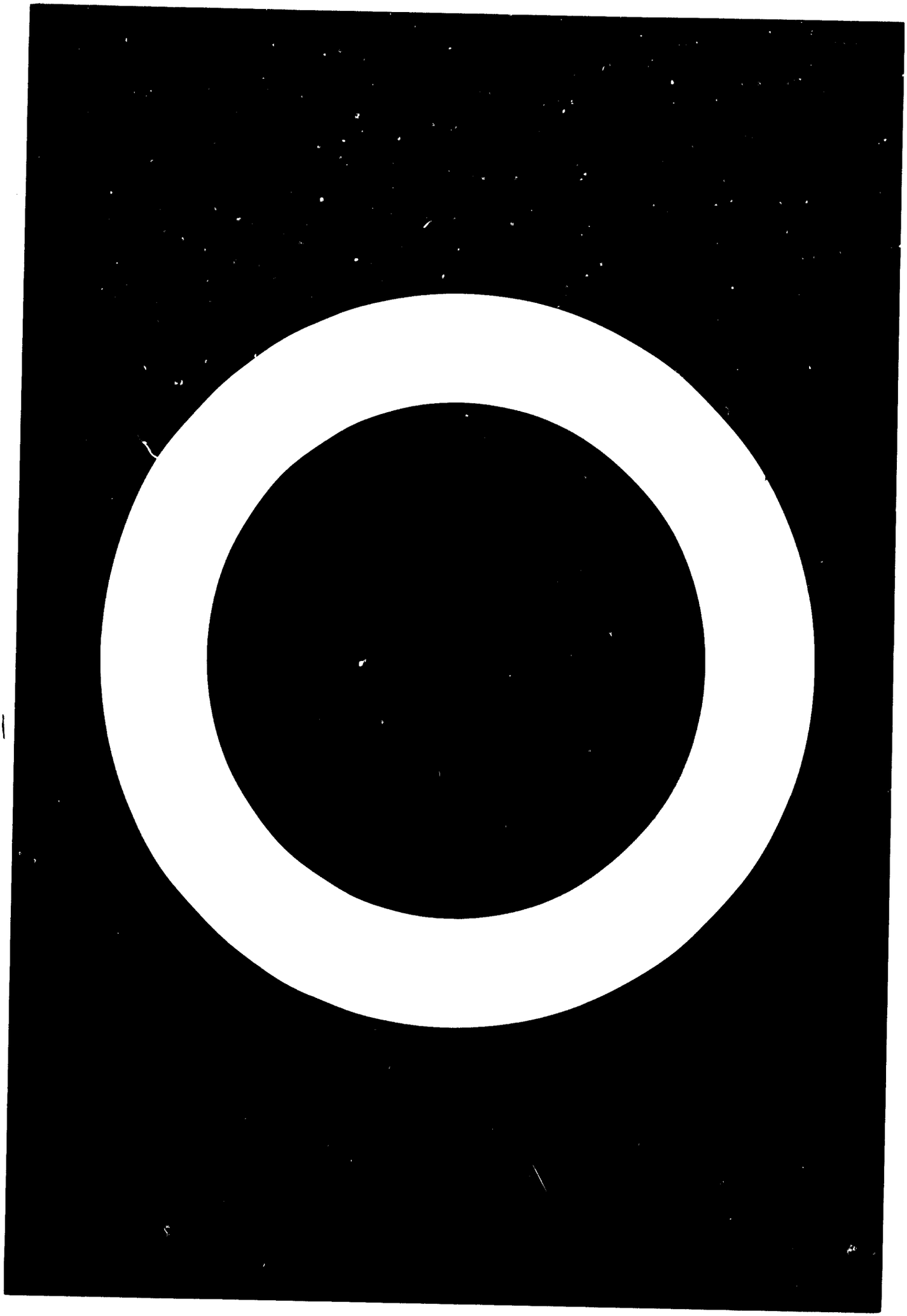
The project will call for a supplier's credit of about US$ 100 millions.

Interest during construction could reach US$ 15-20 millions and even more.

6.06 **Cost of Infrastructure**

The cost of access road, about 60 km, is estimated to US$ 10 millions.

It is strongly recommended to initiate this road building as soon as possible. Otherwise it could be hard to find a supplier who will immediately give a credit.



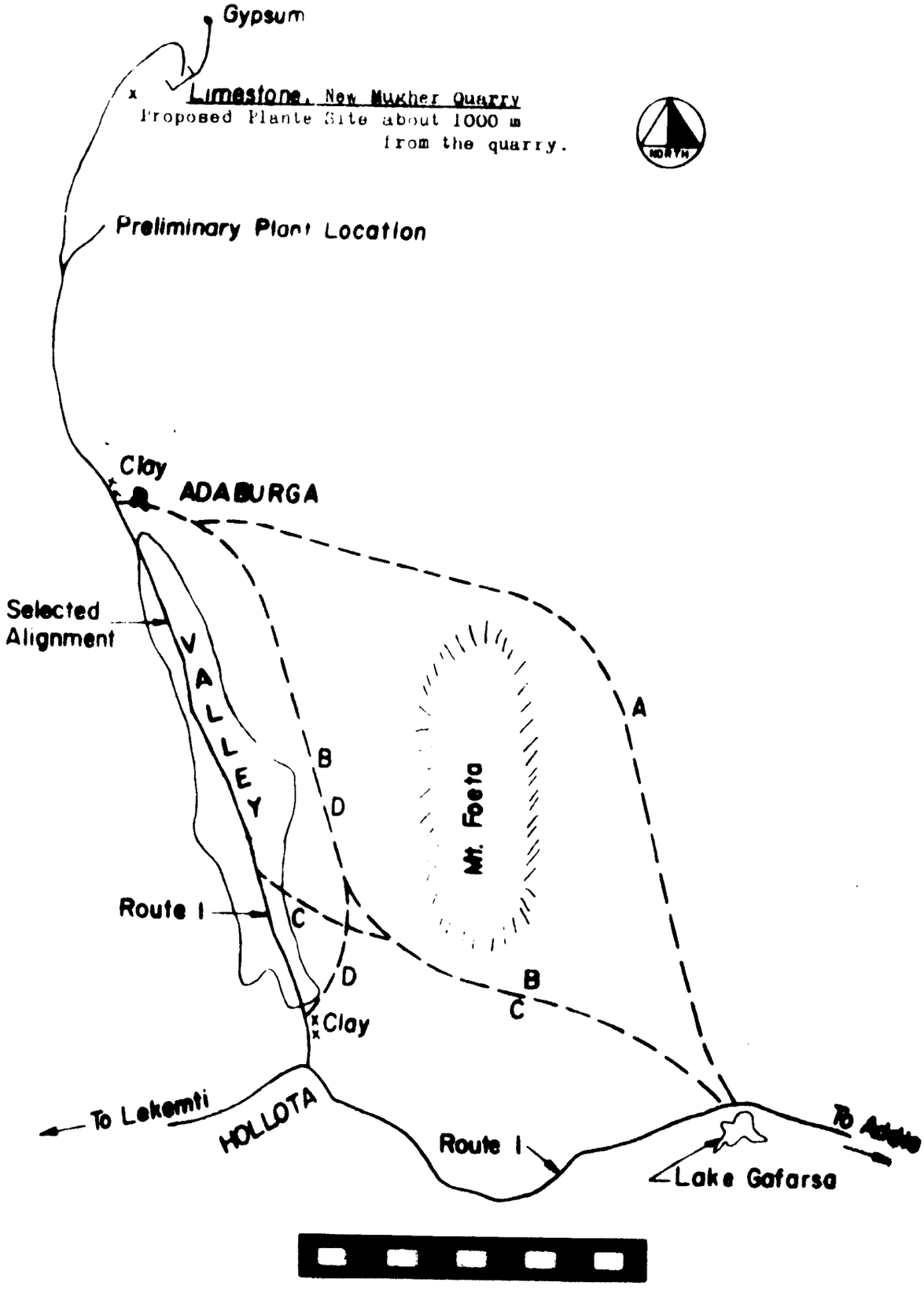
Annex 1

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

POST TITLE:	Cement Expert
DURATION:	One Month
DATE REQUIRED:	As soon as possible
DUTY STATION:	Addis Ababa, with travel within Ethiopia
DUTIES:	The expert will assist the Ministy of Industry in evaluationg a prâject to establish a cement plant of 300 ,000 tons annual output. The Expert is especially requested to advise the Government on the technical part of the proposal.
Qualifications:	Industrial engineer with relevant experience in cement industry.
LANGUAGE:	English
BACKGROUND INFORMATION:	The Ethiopian Building Corporation is responsible for the operation of three cement plants in Ethiopia. The plants are situated in Massawa, Dire Dawa and Addis Ababa with a capacity of respectively 70,000, 40,000 and 70,000 metric tons per year. In view of the growing demand for cement, the Ministry of Industry is planning to establish new production capacity. An offer has been received for a plant of 300,000 tons annual output. Lacking the necessary technical expertise to review the offer the government has requested UNIDO to provide assistance.

Annex II

LOCATION OF QUARRY AND PLANT SITE



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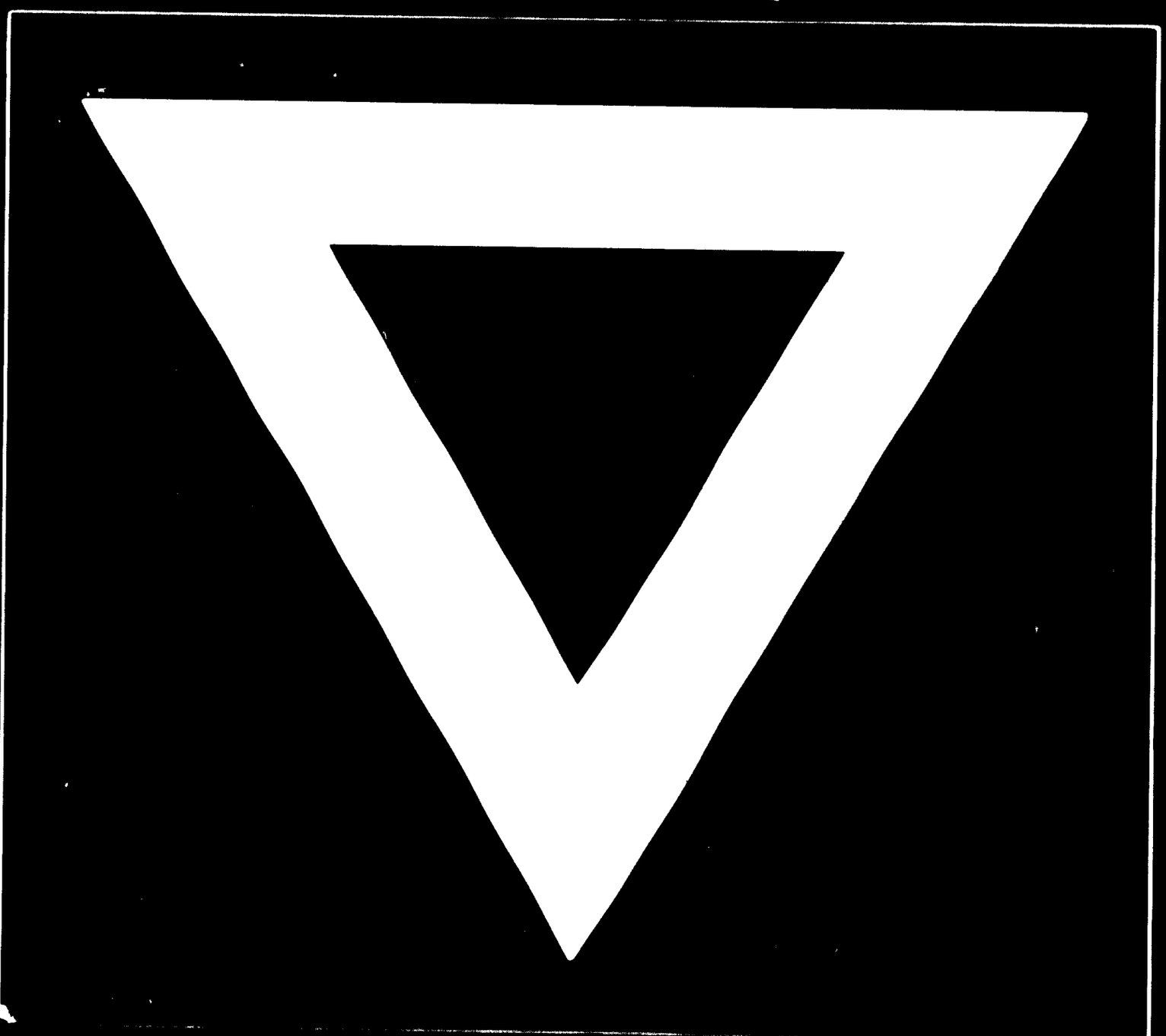

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