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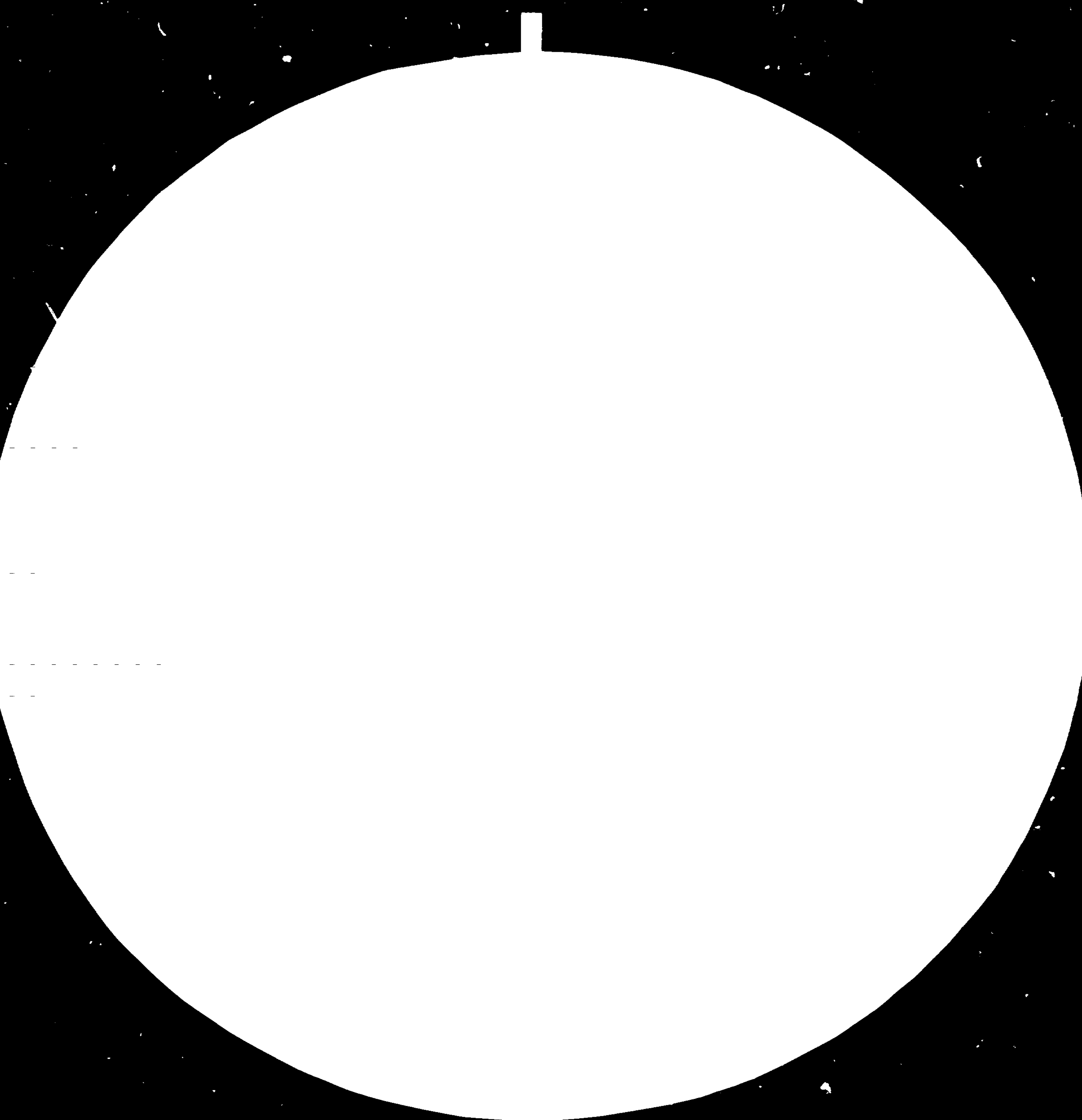

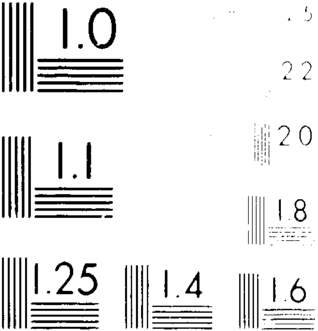
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CLARK CERAMIC CONSULTANTS

UNIDO INDUSTRIAL DEVELOPMENT CONTRACT

NO T81/20 DP/ETH/80/013

FINAL REPORT

TECHNICAL AND ECONOMIC/FINANCIAL EVALUATION OF ONE FEASIBILITY STUDY AND COMMERCIAL OFFER FOR THE ESTABLISHMENT OF A PRODUCTION PLANT FOR CLAY BRICKS AND ROOFING TILES IN ETHIOPIA

11308

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and
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NOVEMBER 1981

TECHNICAL AND ECONOMIC/FINANCIAL EVALUATION OF ONE FEASIBILITY STUDY AND COMMERCIAL OFFER FOR THE ESTABLISHMENT OF A PRODUCTION PLANT FOR CLAY BRICKS AND ROOFING TILES IN ETHIOPIA

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TECHNICAL AND ECONOMIC/FINANCIAL EVALUATION OF ONE FEASIBILITY STUDY AND COMMERCIAL OFFER FOR THE ESTABLISHMENT OF A PRODUCTION PLANT FOR CLAY BRICKS AND ROOFING TILES IN ETHIOPIA

1. ABSTRACT

At the request of the United Nations Industrial Development Organisation Clark Ceramic Consultants in conjunction with Soil Mechanics Ltd., carried out an evaluation of a raw material study and technical offer made previously to Ethiopia. The work involved a desk study and site visits in Addis Ababa. The raw materials and plant site proved satisfactory with plant layout requiring some modification and clarification.

TECHNICAL AND ECONOMIC/FINANCIAL EVALUATION OF ONE FEASIBILITY STUDY AND COMMERCIAL OFFER FOR THE ESTABLISHMENT OF A PRODUCTION PLANT FOR CLAY BRICKS AND ROOFING TILES IN ETHIOPIA

2. INTRODUCTION

In March 1981 Clark Ceramic Consultants assisted by Soil Mechanics Ltd., were contracted by U.N.I.D.O., Vienna to evaluate a proposal and feasibility study for the establishment of a Clay Brick Block and Tile factory near Addis Ababa, Ethiopia. The study had been prepared by "Technoexport" of Sofia, Bulgaria, on behalf of the Ethiopian Building Materials Corporation.

In May 1981 Mr. John Clark of Clark Ceramic Consultants and Mr. Richard Whittle of Soil Mechanics Ltd., visited the offices of Ethiopian Building Materials Corporation in Addis Ababa, the various sites and existing brickworks and received all the relevant documentation available on the offer.

Investigations were made exactly as in the terms of reference of U.N.I.D.O. which for the sake of clarity are as follows:-

A. Availability and suitability of raw materials.

B. Pre-selected plant site.

C. Plant layout.

D. Pre-selected production process on technology, also, in the light of indicated energy requirements and wastage levels against norms for international performance standards.

E. Proposed equipment, tools and devices.

F. Proposed price in the light of international levels.

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3. PRELIMINARY SECTION

Due to inadequate information and often poor translation especially of geological terms and the lack of an individually priced technical quotation it has been difficult, if not impossible, to provide specific comment on every aspect but our report indicates:-

1. The raw material at Gedamba is the most suitable source and should be used in the ratio of 30% clay - 70% tuff for bricks and hollow blocks and 40% clay - 60% tuff for tiles (see Laboratory Report, Appendix 8) not a 50/50 mix as recommended by Technoexport.
2. The proposed site at Alemgena appears to be geologically and strategically ideal.
3. The factory layout according to drawing No. 13897/79 (architectural) and working drawing 14533/79 are acceptable with some minor modification to equipment.
4. Initial production should be brick and hollow blocks only and these not mixed on individual cars but have separate production runs. Tile production equipment should be included in the scheme but production introduced after experience in plant operation had been gained.
5. Boiler house equipment should be deleted and heavy oil be used similar to that currently being used at existing brick factories, electric outflow heaters be fitted to oil storage tanks with oil pipes trace heated by electricity where necessary.
6. Ceiling blocks should be included in the production plan as the use of these in construction gives a strong floor

with low reinforcing thus a saving in the import of steel.

7. Alternative I - clay preparation, clay storage, extrusion and finished product storage - 300 working days per annum at 6 working day week in two 8-hour working shifts; drying and firing shall be a continuous working process - 350 days per annum working in three shifts/day. recommended by Technoexport precludes the easy doubling of production by the addition of a second kiln and dryer at a later stage as the layout does not lend itself to future expansion.

8. Alternative II - clay preparation, clay storage, extrusion and finished product storage - 300 working days/year but only in one working shift/day of 8 hours. Drying and firing shall be the same as with Alternative I, is condemned by Technoexport because of lower initial profitability but does not take into account, the benefits which would result from a second kiln and dryer added at a later stage to give a 100% increase in output for only 25% - 30% of the original total cost thus increasing profitability by 35.9% on the figure in the study for Scheme I (see Appendix 5).

9. The offer by Lingl and Rieterwerke allows for future expansion by extending the dryer and adding a second kiln. The equipment offered is technically more complete and each item separately priced (see Appendix 7).

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4. PROJECT ASSESSMENT

4.1. Availability and suitability of raw materials

Technoexport considered several deposits during their search for raw materials suitable for manufacturing bricks and tiles. The preliminary stages of their work led them to concentrate mainly on two sites, Stela Meda and Gedamba. All other deposits were dismissed by them as being too small, too far from Addis Ababa or as having unsuitable raw material. Insufficient evidence was presented in the reports to allow an independent quantitative assessment of deposits other than Stela Meda and Gedamba, and the amount of data available for qualitative assessment of the deposits varied considerably. (Fig. 1)(Appendix 1).

Examination of the geological information and test results shows that there are likely to be three, not two potentially suitable deposits: (see Appendix 9).

STELA MEDA

GEDAMBA

CERAMICAL

It is considered that the data supplied in the reports are insufficient to reject Ceramical on the grounds that the material is unsuitable for the production of tiles. Each of these sites will be considered here and relevant features discussed: the most relevant features are quantity, quality and location of the deposit.

STELA MEDA

The report states that there are 2.5 million cubic metres of material available enough for about 50 years production at proposed rates of usage. The raw material consists of layers of volcanic materials and alluvial clays, each layer having varying geological, chemical and technological properties. The technological testing appears to have run into difficulties with the material. The nature of the deposit is such that the raw material would need selective digging and close quality control to avoid accidental usage of undesirable materials and incorrect blending of the different clays.

It is considered that whilst there are more massive, homogeneous deposits available at other suitable locations, Stela Meda should not be considered further for this project.

CERAMICAL

The report states that there are 3.8 million cubic metres of material available, enough for about 75 years of production at proposed rates of usage. The report does not adequately discuss the geological investigations or the various materials present at the site. A limited number of chemical and particle size tests appeared to show that the material is suitable for the manufacture of bricks and tiles (fig. 1).

Thirty technological tests showed that the material is suitable for "building-ceramical products," which the report later states to mean bricks and tiles. The deposit appears to have been dismissed by the report as being unsuitable for tile manufacture. This conclusion appears to contradict the actual test results and it is difficult to understand why the investigators rejected the deposit on such grounds. (See Appendix 1).

During the field visit in May 1981 an abandoned quarry in the Ceramical deposit was inspected. The quarry had been excavated in a light coloured volcanic tuff. The material seen was rock, not clay, and to excavate it and then reduce it by crushing and milling to a grain size suitable for brick and tile manufacture would be a costly process. The report does not mention the rock-like nature of the material nor are there borehole logs or any account of the actual investigations at Ceramical. It is not known if all or only part of the deposit is rock. The surrounding topography is steep and uneven, implying that the underlying material is rock-like rather than clay-like. For this reason it is recommended that the deposit should not be considered further for this project. It should be borne in mind that geological information relating to the Ceramical deposit was not available in the report and it is therefore, rejected because of the rock like nature of the deposit seen in the field and the physical difficulties which would be encountered in trying to work the deposit and secondly the problems of reducing the material to a consistency suitable for brick and tile production.

GEDAMBA

The report states that there are 2.8 million cubic metres of material available, enough for about 55 years of production at proposed rates of usage. The calculations of volume presented in the report do not, understandably, take into account loss of otherwise exploitable material due to quarry development, access ramps, benches and sideslopes to the workings. Despite this there appears to be ample raw material available for many years of working, and opportunity to possibly extend the limits of the deposit in the future by additional exploratory drilling.

The Gedamba deposit consists of two separate materials, volcanic tuff and alluvial/colluvial clay. The report states that equal quantities of each material need blending to produce a clay suitable for brick and tile manufacture. The tuff consists of sloping layers of clay interspersed with layers of weak rock. The deposit is overlain by such a rock-like layer. Some of these layers are about 5 m thick, and at worst might be expected to reduce the total quantity of available clay by about 50% in some parts of the quarry, although the overall reduction in volume of available clay should only be about 25%. These hard layers can probably be ripped and crushed to provide a clay-like product and consideration should be given to providing plant and machinery capable of handling the layers. It is recommended that the tuffs be dug commencing in the small existing quarry, extending the working face in an east-west or northeast-southwest direction to expose to weathering as much material as possible. It will be necessary to strip the existing hard bed from the surface of the hillside using a ripper. The hillside should eventually be "benched-out" in a series of working faces and benches giving access to higher levels; it should be thought of as a quarry rather than a pit.

The clay deposit, on the lower slopes of the hill appears to be formed of almost completely weathered material derived from the tuff and possibly from the weathering products of other volcanic materials in the area. The clay contains layers of iron-rich nodules up to about 10 mm across. The effect of these, and any other impurities found within the clay beds will be minimised if they can be diluted before processing. Stockpiling at the plant site is one way of trying to ensure the material is well-mixed. Beds of tuff should be expected during excavation of the clays.

4.2 Pre-selected plant site

The site chosen for the brick and tile works is on gently sloping land at Alemgena, about 20 km south west of Addis Ababa. The Gedamba raw material source is some 10 km south of Alemgena. The deposit, the plant site and Addis Ababa are connected by existing roads. The site appears to be geologically ideal for the construction of the plant; the ground is well-drained and is believed to be underlain by hard clay (this was confirmed during site inspection of two old trial pits dug as part of the Technoexport investigations and by an additional shallow auger hole carried out during the site visit). There is no reason to believe that the clay beneath the site will be unable to bear the foundation loads imposed by the brickworks of 2 kg per cm^2 for both machinery and kiln and dryer areas and it is recommended that as even slight differential settlements will disrupt operation of the tunnel kiln, a site investigation covering (a) standard ground loading tests and (b) checks for swelling or collapsing soils should be carried out by a responsible civil engineering consulting company.

Geological conditions deep beneath the site are unknown and if it is intended, as recommended by Technoexport, to construct a bored well system to supply water for the plant a considerable amount of work, including exploratory drilling, will have to be done to see if water is present at depth and available in sufficient quantity but this may not be relevant as we were informed that Alemgena has power and water supplies and has apparently been chosen for these and possibly other reasons. Although there are no doubt many other possible locations for the plant site, there is no reason to believe that any would prove more suitable than that at Alemgena. Other sites, particularly on lower ground, would need careful checking to ensure that they are clear of dangers from flooding and are not situated on the black-cotton soils believed to exist in the region.

In view of the adequate power supply we suggest only a small standby generator to cover kiln and dryer operation in the event of power failure.

C. 4.3 Plant layout

The four layout drawings were considered in relation to the schemes proposed under Feasibility Report item III Working Hours Schedule which sets out two alternatives as follows :-

Alternative I - Clay preparation - Clay storage, extrusion and finished product storage - 300 working days per annum at 6 working days per week in 2 x 8 hour working shifts; drying and firing shall be a continuous working process - 350 days per annum in three shifts per day, one production line.

Alternative II - Clay preparation - clay storage, extrusion and finished product storage - 300 working days per year but only in one working shift per day of 8 hours and one production line only. Drying and firing shall be the same as with Alternative I i.e. 350 days per annum in three shifts per day.

NB. Offer under Technological quotation states two production lines.

Drawings 13897/79 (architectural) and 14533/79 (working) were selected as those we would recommend but with the following ammendments.

a. In order to allow for a second kiln and dryer, those already planned should be moved down the site towards the road to allow sufficient space for the second kiln parallel and adjacent to the first, the dryer would also be adjacent to the first dryer keeping the materials flow exactly as planned. (see Appendix 2).

b. Omit the boiler house completely and move the oil tanks to a position midway along the dryer and provide for electrical outflow heaters together with electrical trace heating of the oil pipelines to kiln and dryer.

c. Consider making a separate entrance to the site for raw materials, possibly using the contour of the land to enable tipping of the clay and tuff into suitably designed bunkers from a high level, thus keeping the main entrance free from wet sticky clay.

D. Production Process

Under Item II TECHNOLOGICAL section 2 and 3 of the offer Assortment of Output and Finished Product Quality quotes various sizes and later in the text reference is made to Bulgarian standards. I suggest that all sizes and standards referred to should be Ethiopian, (see Appendix 6 typical standards)

STANDARD SIZES (MM)

Brick (solid)	60 x 120 x 250	55 x 115 x 245
Hollow	80 x 200 x 300	120 x 250 x 300
	150 x 200 x 300	100 x 150 x 250
	100 x 250 x 300	

Planning has been carried out on a six day working week but as the norm is now $5\frac{1}{2}$ days per week, should not a 5 x 8 hour working week be planned, the main difference being in the size of extruder as adequate capacity appears to be built in elsewhere i.e. dryer and kiln storage tracks.

Alternatives I and II have been considered very carefully and while Alternative I with two shifts per day to produce the 20,000,000 per annum will be more profitable initially, Alternative II should be to produce the 20,000,000 on one 8 hour shift, working one production line but allowing for a second dryer and kiln with production on 2 x 8 hour shifts. This would give a 100% increase in output at only 25% - 30% extra cost thus a higher profitability than Alternative I which layout precludes the doubling of production except with greatly increased imports, i.e. a complete new identical factory would be necessary.

Clay Preparation

The tuff material stockpiled in the works should be handled by the rubber tyred loading shovel to an apron feeder with metal detector then to kibbler or toothed crushing rolls and if necessary a disintegrator before passing to a box feeder. There are hard bands on the surface and throughout the bed which can be removed by Bulldozer (hired for short term work not purchased as suggested) but which could be included in the sample and machinery will have to be capable of handling it.

Red clay will be loaded to box feeder by same tyred loader but the first slat conveyor should be changed to a rubber belt type to enable a metal detector or electro-magnet to be installed.

This rubber belt conveyor would be common to both box feeders each of which should have means of adjusting the feed as the mixture of clay and tuff may be critical. Pan and high speed rollers are a typical layout but rollers should be provided with grinding equipment for maintenance purposes. After the double shaft mixer it is planned to discharge the prepared clay by conveyor to a clay store having capacity for fourteen days. I suggest that consideration be given to installing a silo having capacity of a half to three quarter days storage which is normally all that is required for the water in the clay to become evenly distributed and some "souring" of the clay to take place in order to render it more suitable for thin walled hollow block or tile production.

As we have dispensed with the very expensive boiler equipment should steam be required during extrusion then

This could be provided by a small oil fired package steam generator of capacity 1800 kg/hour at oil consumption 119 kg/h. Cost of this unit complete with boiler, water softener, feed tank and dosing plant would be in the region of 100,000 Birr.

The main auger for extruding bricks, blocks and tile bats should be of sufficient capacity to produce the equivalent of 15,000,000 plus 5,000,000 tiles working a 48 week year 7 hours per day x 5 days per week, i.e. say 17,500,000 solid bricks in 1,680 hours = 10,416 per hour. This allows seven hours production and one hour for breakdown and/or maintenance everyday. Should production still be planned for six days per week then corresponding auger size will be 8,680 bricks per hour.

Dryer size quotes bricks per chamber 17,476 on page 7 and 19,496 on page 10 but the number of chambers at 16 is adequate.

Setting

The setting of the kiln cars is a most vague operation according to the layout drawing and the offer and be clarified in any subsequent proposal.

There is no arrangement provided for inching the cars slowly forward beneath the setting belts, no mention of setting frames etc.

I also consider the suggestion of kiln car movement in this and throughout the storage area by means of twelve females and two tow trollies to be dangerous, unproductive and expensive as a mechanised system could be provided for approximately 220,000 Birr, which would give much better control in the setting area and be safe to operate. It should be borne in mind that kiln car movement has to be carried out over 24 hours per day 7 days per week.

The offer states a certain percentage of solid bricks and tiles or hollow blocks and tiles are to be set on each kiln car (Appendix 3), in my opinion the kiln should burn longer runs of solid bricks only, hollow blocks only or tiles only as generally all three products have different firing and especially pre-heating and cooling characteristics. I therefore recommend that tile production be held in abeyance until the factory is operating smoothly on bricks and blocks.

Kiln

Setting height on kiln cars should not exceed 1.75 m, especially for hand setting. The lower the setting height, the greater is the stability of the kiln car load and less operational difficulties will be experienced.

Wastages and Consumptions

The kiln and dryer wastage percentages appear realistic and consumption figures for fuel, oil and electric power are satisfactory when compared with figures for similar factories erected throughout the world.

The fuel oil consumption for both drying and firing could be reduced considerably if a decision is made to adopt a standard for solid bricks which is common to British Standards "3921 Part 2: 1969 Metric Units." (Appendix 4). Briefly this allows for a solid brick to have up to 25% perforations thus making drying easier and firing can be carried out with less fuel.

E. QUALITY OF EQUIPMENT

It is only possible to assess the quality of equipment if this is:-

(a) from a specified source i.e. names of producer and country of origin as I am conversant with the main suppliers in U.K., U.S.A., West Germany and Italy.

(b) if I can actually see the equipment at it's place of manufacture or in operation.

In order to comment on the equipment I must have the information in (a) or a visit as (b).

(b) was arranged by Technoexport but too late for me to accept before writing this report and have since appeared reluctant to provide the manufacturer's name.

F. PRICES

The usual international procedure on quotations to enable fair comparisons to be made is that a completely individual priced pro-forma invoice is submitted. As this was not done by Technoexport it is most difficult to see how it compares internationally, or how much saving can be achieved by the suggestion to modify the factory. In it's present state the figures quoted are near to average world prices but the local supply as follows:-

kiln erection (masons) and kiln car masonry,
kiln steelwork,
kiln firing hole and thermo-couple hole castings,
kiln rails,
dryer rails,
machinery supports,
conveyor steelwork,

are certainly items which would normally form an inclusive part of a suppliers contract and could add a high percentage on to the total price, apart from the fact that refractory brickwork construction is a highly specialised trade which it would be unwise to leave to local masons. Castings required for the kiln would be most difficult to produce without a foundry and all the necessary patterns and moulds.

Some supply items have been greatly understated eg., quotation includes, under Annex No. 1 item 3, Skoda-Madara 705 - MT - 24 one off, when Technological Manpower Scheme indicates two drivers per shift and I am of the opinion that four vehicles will be required.

The tunnel kiln foundation should be designed and concrete casting supervised and guaranteed by the supplier not the purchaser so that a clear responsibility exists if there is a kiln structure failure.

Comparisons on offer of equipment between Technoexport and Lingl/Rieterwerke using Technoexport list, Annex 1 - 7 as follows :-

TECHNOEXPORT	LINGL/RIETERWERKE
1) CLAY TRANSPORTATION	
1 Dumper lorry 1 Bulldozer 1 Lorry mounted loader 3 Front end loaders	5 Tipper lorries 1 Bulldozer 2 Crawler loaders 2 Front end loaders
2) CLAYFEED	
No hoppers or supports for box feeders, conveyor etc. supplied.	All hoppers, supports and complete conveyors supplied.
3) EXTRUSION	
Similar in both offers except clay storage is in a separate building with extra civil costs.	Similar in both offers plus two large box feeders extra in lieu of clay store. Also better treatment of Tuff material by separate pre-crushing arrangement.
Overhead crane supplied.	No overhead crane supplied.
4) TILES	
Pressed.	Extruded thus lighter in weight.
5) MECHANICAL HANDLING	
Automatic to and from dryer.	Automatic to and from dryer.
No mechanical setting or kiln car movement.	Fully automatic setting and kiln car movement.

6) DRYERS

Chamber type no installation. No rails. Erection by outside contractor.	Chamber type complete installation. Rails supplied. Erection by outside contractor.

7) KILN

Only fans and refractories, kiln doors, hydraulic pusher, oil burners and kiln cars supplied. No rails, steel structures, sand box, castings for burner orifices or ducting. No supports for fans or chimney, no installation of equipment.	Complete kiln supplied with rails, kiln cars, sand box, castings, supports etc., and ducting. Complete installation of equipment.
No kiln erection of red brick or refractory work, price should be negotiated. Estimated cost 850,000 DM.	No kiln erection of red brick or refractory work but this should be negotiated together with the foundations responsibility.
Completion in 18 months after last parts delivered plus delivery period of 18 months i.e. 36 months erection period.	Kiln 3/4 months after order. Setting machine 7 months, i.e. total time approximately 18/20 months for completion.

8) ELECTRICAL

All electrics (excluding sub-station equipment for 11 KV) and lighting, also telephone and public address system provided. No standby generator. All cables but no installation material.	No sub-station or transformer equipment but all electrics including cables and installation material from switch cabinet to the motors of individual machines, lighting for hall extra at 30,000 DM. No telephone or public address system. No standby generator.

9) OIL STORAGE

Tanks and pumps plus steam boiler and all piping.	Tanks plus pumps but hot air heating in lieu of boilers, hence cheaper to operate. Electrical standby for start up.

10 DOMESTIC

Kitchen equipment.	No kitchen equipment.
Workshop and Garage	Workshop and Garage.
Tools and equipment for fitters, electricians and joiners provided also for oil store and garage.	None provided.
Laboratory provided.	No Laboratory.

	TECHNOEXPORT	LINGL/RIETERWERKE
	U.S. $ 1979	DM. Oct. 1981
Technological equipment as Annex 1-7	3,503,300	17,599,337 (7,914,368 US $)
Spare parts for 2 years operation	245,000	1,842,830 (828,715 US $)
Design	160,000	240,000 (107,927 US $)
Technical Assistance	76,000	1,551,092 (697,521 US $)
TOTAL	3,984,300	21,233,259 (9,548,532 US $)

Points which should be raised with Technoexport are :-

1) Why have they omitted three clay transporting vehicles when four drivers are shown?

2) Will they supply all castings and rails for dryer and kiln?

3) Can they provide an explanation of their proposed setting method for tiles?

4) Can they explain how they will arrange for the bricks to be hand set on the kiln cars in a pattern which will not allow the bricks to touch the sides of the kiln, i.e. setting templates are required?

5) Why are no dies provided for fitting to the Auger machine in order to produce the different types of bricks required?

The offer otherwise appears to be quite comprehensive except the preparation machinery layout is inadequate for the "tuff" material which should be as follows :-

Box feeder, conveyor, metal detector, roller crusher, conveyor, disintegrator, conveyor, to one of two main feeding box feeders.

The figure for spare parts for two years appears low and Technoexport should provide actual lists of spare parts before a contract is signed.

Auxilliary buildings are more than adequate and such items as Boiler House and Garage for cars could be eliminated. The main repair facilities and laboratory are adequate and essential but some savings could be made by modifying the clay storage arrangement.

I would also strongly recommend that the Ethiopian Building Material Corporation should have direct contact with kiln and machinery suppliers as for example Lingl and Rieterwerke who have a much better understanding of requirements for a brick and tile factory than is possible by a company such as Technoexport who would only purchase and re-export a manufacturers' equipment.

There would also be a much better chance of obtaining specific guarantees on :-

a. Output

b. Quality

See Item 6 GUARANTEES.

The question of tunnel kiln v hoffman kiln raised as a separate issue can be assessed as follows :-

HOFFMAN KILN	TUNNEL KILN
1) Cheaper to erect.	1) Expensive compared to Hoffman kiln.
2) Difficult to control.	2) Control easy and automatic.
3) Products vary greatly in size, shape and quality. Thus greater rejection.	3) More accurate size, i.e. less variation and less waste. Higher physical qualities such as crushing strength and absorption.
4) Increasing difficulties in finding labour suitable and prepared to work in hot, dusty, dirty conditions.	4) Labour operating under more factory like conditions thus output per man shift increases.
5) Greater difficulty in insulating and preventing air leakage therefore no more fuel efficient.	5) Easy to utilize latest fuel saving devices such as insulation, hot gas recirculation and waste heat usage.
6) Not easy to vary product range and maintain high quality.	6) Flexible on product range due to automatic firing control and kiln car scheduling.

I would therefore, recommend the adoption of the tunnel kiln system for this modern factory.

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5. TERMINAL SECTION

CONCLUSIONS AND RECOMMENDATIONS

Raw-Materials

It is concluded that the Gedamba deposit is the most suitable source of raw-material for a brick and tile manufacturing plant at Alemgena. The raw materials exist in sufficient quantities and can be easily blended to provide a clay with desirable properties. The deposit is located some distance from the proposed plant but there would be no advantage in moving the plant closer to the deposit. The existing roads will have to be repaired and maintained to a better standard than they are at present. It is suggested that the Stela Meda and Ceramical deposits be dismissed from further consideration for the purposes of this project, but that they be borne in mind as sources of clay for future projects.

Site

The proposed plant site at Alemgena appears to be geologically and strategically ideal and there is no reason to believe that a more suitable site can be found.

Plant

The overall plant and equipment, if modified to provide separate pre-grinding of the tuff material, possibly less storage capacity for souring purposes, mechanised kiln car handling through setting and storage areas, will provide a modern factory producing bricks and blocks which are badly needed for the overall plan of improving the housing needs of the mass of the population.

The raw material would lend itself to production of bricks by the stiff extruded method but it is expensive on power and would not be as flexible as soft extrusion where bricks, hollow blocks and possibly tiles are required through the same production line.

Each burner group should have separate temperature control and regulation, not just one group as stated.

STANDARDS -

Ethiopian standards to be adopted.

TUNNEL KILN

The kiln supplied should be complete with castings, supports, rails, sand seal and auxilliary items.

The quotation from Lingl/Rieterwerke indicates much more clearly what is on offer and The Building Materials Corporation should insist that Technoexport supply a quotation based on similar lines if they wish to have a direct cost comparison of a factory they can easily construct and operate in a reasonable period of time.

Proposed and amended layout drawings Appendix 10 and 11.

TECHNICAL AND ECONOMIC/FINANCIAL EVALUATION OF ONE FEASIBILITY STUDY AND COMMERCIAL OFFER FOR THE ESTABLISHMENT OF A PRODUCTION PLANT FOR CLAY BRICKS AND ROOFING TILES IN ETHIOPIA

6. GUARANTEES

These should cover replacement of machine parts which fail due to other than wear and tear in a two year period from the date of acceptance after full rated output has been achieved.
The guarantee given could be out of date before the factory was erected due to the length of period allowed for erection (18 months from the date of the last delivery of essential equipment).
The guarantee should usually be covered by a 10% performance Bond which shall expire 24 months after commissioning as confirmed by issue of handing-over certificate but not later than 42 months for machinery or 30 months for kiln and dryer.
An independant Consultant should be available to monitor progress, issue acceptance certificates and generally liase with purchasers and suppliers and inspect all equipment before shipment from suppliers.

TECHNICAL AND ECONOMIC/FINANCIAL EVALUATION OF ONE FEASIBILTY STUDY AND COMMERCIAL OFFER FOR THE ESTABLISHMENT OF A PRODUCTION PLANT FOR CLAY BRICKS AND ROOFING TILES IN ETHIOPIA

7. APPENDIX

1. As part of the evaluation of the feasibility study for the establishment of a brick and tile production plant in Ethiopia a document entitled:

> "Report on the results from the geological prospecting and technological tests of clay and tufas (sic) for the production of compact and latticed bricks and tiles in the Addis Ababa region, Socialist Ethiopia, carried out in 1978 and 1979, with calculated reserves to January 1st 1979"

was examined in detail. This report formed the basis of the independent assessment of the deposits carried out by Soil Mechanics Limited for Clark Ceramic Consultants.

It would appear from the geological report that enough work has been carried out on the project to allow the selection of a source of raw material for the manufacture of bricks and tiles. However, the reasons for selection or rejection of the various deposits are often unconvincing and in no case are arguments presented to allow the reader to evaluate the reasoning leading to decisions. The reader is therefore presented with conclusions and decisions without having been led through a scheme of logical argument, leaving him to search through the report to find material which would in some way justify the statements made. In many cases it was difficult or even impossible to substantiate statements made in the report or to justify conclusions.

The report is made more confusing by an extremely poor translation, particularly of geological terms, often leading to ambiguities, eg.throughout the text "tufa" is referred to as the main source of raw material. Tufa is a calcareous (limestone) deposit formed by precipitation of calcium carbonate from lime-rich waters. "Tuff" is a volcanic ash deposited in sedimentary beds, often decomposing to clay. It is this material, not that of calcareous origin that the geologists are referring to. The term "mouldy tufas" in the report should read "decomposed tuff". There are many errors of similar importance in the text.

The "Conclusions" section of the report contains a number of relevant and irrelevant items, and a disproportionate amount of the section is devoted to the introduction of a list of suggested plant and equipment for processing the clays.

Examples of ambiguous statements and conclusions occurring in the report are as follows:

1. More work has been done in the feasibility study on the Gedamba deposit than any other and it is the one chosen in the report for eventual production; yet on page 29 it states "These (deposits) are not satisfactory as far as the geological structure, thickness and quality of the raw material are concerned". Nothing can be found to substantiate such a statement.
2. The report dismisses the Ceramical deposit (page 30). "The second drilling was started and later stopped at depth of 5 metres because the technologist of the group ! - Vasilev proved in a laboratory manner that the raw material is not suitable for production of tiles". Inspection of the test results show that the chemical composition is suitable for the production of bricks, stoneware and pottery, and on the Avgustinnik Diagram the results plot on the limits of the "suitable for tiles" zone. It should be noted that only three samples

were used, insufficient for dismissing any deposit; additional samples may have plotted within the "suitable for tiles" zone, which itself surely has a somewhat arbitrary boundary. The results of whole rock analysis in terms of oxides have been used to plot the Avgustinnik Diagram. The plot appears to be incorrect; a mixture of two materials should plot between the end-members, not well away from either. This could be significant, implying that rejection of the Ceramical deposit as being unsuitable for tiles could even have been the result of inaccurate plotting. The "technological tests" (page 52) show that a mixture of the clay and tuff from Ceramical "have the required technological qualities and physical-mechanical indicators for the production of building-ceramical products". On page 55 "building-ceramical products" is shown to mean bricks and tiles.

The Ceramical deposit appears to have been rejected solely on the rather uncertain results of three tests, a statistically unsatisfactory situation. No useful geological information relating to the deposit was presented with the report.

NAME OF DEPOSIT	QUANTITY (millions of cubic metres)	ASSESSMENT OF DEPOSIT BASED ON LABORATORY TESTS								COMMENTS	SUITABLE SOURCE OF RAW MATERIAL?
		CHEMICAL	No. of tests	TECHNOLOGICAL	No. of tests	PARTICLE SIZE	No. of tests	PLASTICITY	No. of tests		
Gedamba	2.8	Bricks and tiles from both clay and tuff	24	Bricks and tiles from both clay and tuff	73	Bricks and tiles from clay and tuff mixture	20		20	Quantity satisfactory. Material suitable. The tuff is very weak rock.	Yes
Stela Meda	2.5	Bricks from tuff. Clay unsuitable	15	High variability of raw material. Many problems	55	Bricks	3	Bricks	3	Quantity satisfactory. Material would need selective exploration and quality control. Some undesirable materials.	No-
Ceramical	3.8	Bricks from tuffs. Bricks from clay + tuff mixture	?	Bricks and tiles from clay + tuff mixture	30		2		2	Quantity satisfactory. Tuff is all or part rock, not clay. Deposit might be suitable - not proven otherwise.	Not proven
Akaki	Insufficient	Bricks and tiles		High shrinkage, not suitable			2	Bricks and tiles	2	Quantity unsatisfactory. Report does not allow independent assessment of the deposit	No
Sendaf Road										Only referred to in location map of report, not in text	No
Sebata Road	Insufficient									Report does not allow independent assessment of the deposit	No
Alemgena	Insufficient	Bricks and tiles from clay + Gedamba tuff mixture	4							Quantity unsatisfactory. Plant site. Small quantity of clay for blending with tuff	No
Len Dak										No information given in report. Report does not allow independent assessment of the deposit	No
Addis Shekla	Insufficient									Report does not allow independent assessment of the deposit	No

Notes : Table based upon information supplied in reports, supplemented by enquiries and observations made in the field. Blank space indicates data not presented in reports or insufficient to allow comment or assessment. Four additional tests of each type carried out, not specified for which deposits.

Soil Mechanics

Location ETHIOPIA BRICK PLANT

Title SUMMARY OF SUITABILITY OF DEPOSITS OF RAW MATERIALS

Loc No 7076

Fig.

APPENDIX

2. The suggestion of a second kiln and dryer was made on page 1 of the offer but then alternatives I and II developed and a conclusion reached without taking into consideration the benefits from a second kiln and dryer.

3. Kiln capacity and car loading (page 12 kiln specification)

   No. of cars in kiln 40

   No. of cars required 70

   Firing time 48 - 52 hours

   Cycle for 1 car - 78 minutes

   No. of products per car :-

   2,380 NF bricks + 816 roof tiles or
   1,830 1 - 3 NF bricks + 816 roof tiles or
   490 4 - 86 NF blocks + 816 roof tiles

4. B.S.S. 3921 Part 2 1969
   Specification Chapter 1
   Definition 3 (d) I Solid

   "In which small holes passing through or nearly through a brick do not exceed 25% of it's volume or in which frogs (depressions in the bed face of a brick) do not exceed 20% of it's volume. For the purposes of definition, a small hole is a hole less than 20 mm wide or less than 500 mm^2 in area. Up to three larger holes not exceeding 3,250 mm^2 each may be incorporated as aids to handling, within the total 25%

   II Perforated

   In which holes passing through a brick or block exceed 25% of it's volume and the holes are small as defined in (I) above up to three larger holes, not exceeding 3,250 mm^2 each, may be incorporated as aid to handling".

APPENDIX

NOTE:- The provision in sub-clause 3 of (I) that bricks containing up to 25% of holes are considered as "solid" requires explanation. It has been included because it is known that bricks with not more than this modest degree of perforation can be treated in the same way as bricks without holes when calculating permissible pressures on brickwork from the strength of the bricks determined in accordance with clause 43, (testing by crushing after certain fixed preparation methods) and this artifice should ensure that such bricks are automatically so treated. It need not be concluded that similar relations between the strength of bricks and the strength of brickwork do not subsist when the bricks contain more than 25% of holes, but where a designer feels any doubt it is always open to him to require tests on walls according to relevant codes of practice.

APPENDIX

5. Figures for profitability under Schemes I and II (Annex No. 2 and No. 3) have been used to give a fair comparison of profitability on Scheme II plus the second kiln and dryer. A figure of depreciation of 980350 or 49.02 Birr per 1,000 has been reduced to one-third or 16.4 Birr per 1,000. This then indicates a profit per 1,000 on the extra 20,000,000 output at 52.96 Birr per 1,000 which added to the 20.34 per 1,000 on the first 20,000,000 shows an average profit per 1,000 of 36.65 Birr against an average of 26.96 if a second Scheme I type works was erected.

In actual fact the savings on the second 20,000,000 would be in excess of this due to savings in staff.

Depreciation on Capital 30% of Original 16.40 Birr.

Profit on second 20,000,000, i.e. after second kiln and dryer built and two shift operation introduced using Table II with reduction of depreciation to 30%

Raw Materials	11.54
Fuel	49.04
Electric Power	4.19
Salaries	7.87
Charges	1.58
Depreciation	16.40
Sundries	12.32
	102.94
First cost	155.90
Profit	52.96

APPENDIX 5

TABLE

Annex No. 2

OF THE DESIGNED COST PRICE OF BRICKS AND TILES PRODUCTION IN THE CERAMIC PLANT "ALEM GENA" - ETHIOPIA

ALTERNATIVE I

DESIGNED COST PRICE IN BURRIES

EXPENSES	BRICKS			TILES			TOTAL/AVERAGE		
	for 15 mln nos	for 1000 nos	%	for 5 mln nos.	for 1000 nos	%	for 20 mln	for 1000 nos	%
RAW MATERIALS AND MATERIALS	100340	10.69	9.2.	70430	14.09	8.5	230770	11.54	8.9
FUEL	682610	54.51	39.1	298150	59.63	35.8	980760	49.04	38.0
EL.POWER	52840	3.52	3.0	30870	6.17	3.7	83710	4.19	3.2
SALARIES	83580	5.57	4.8	87300	17.46	10.5	170880	8.54	6.6
CHARGES	16740	1.12	1.0	17440	3.49	2.1	34180	1.71	1.3
DEPRECIATIONS	590910	39.39	33.8	253240	50.65	30.4	844150	42.21	32.7
SUNDRIES	158700	10.58	9.1	75740	15.14	9.1	234440	11.72	9.0
COMPLETE DESIGNED COST PRICE	1745720	116.38	100.0	833170	166.63	100.0	2578890	128.94	100.0
FIRST COST	2118000	141.20	-	1000000	200.00	-	318000	155.90	-
PROFIT	372280	24.82	-	166830	33.37	-	539110	26.96	-

APPENDIX 5

TABLE

Annex No.3

OF THE DESIGNED COST PRICE OF BRICKS AND TILES PRODUCTION IN THE CERAMIC PLANT "ALEM GENA" - ETHIOPIA

DE[illegible]

[illegible]	BR[illegible]			TILES			[illegible]		
	for 15 mln nos	for 1000 nos	%	for 5 mln nos.	for 1000 nos	%	for 20 mln	for 1000 nos	
AW MATERIALS AND MATERIALS	[illegible]	10.69	8.7	[illegible]	[illegible]	8.1	[illegible]	[illegible]	8.5
[illegible] "	682610	45.51	[illegible]	298150	59.63	34.3	980760	49.04	36.2
[illegible]	52940	3.53	2.9	30920	6.18	3.6	83860	4.19	3.1
[illegible]	76860	5.12	4.2	80580	16.12	9.3	157440	7.87	5.8
[illegible]	15410	1.03	0.8	16140	3.23	1.9	31550	1.58	1.2
[illegible]	686250	45.75	37.2	294100	58.82	33.8	980350	49.02	36.2
[illegible]	167440	11.16	9.1	79040	15.80	9.1	246480	12.32	9.1
[illegible] DESIGNED COST PRICE	1841850	122.79	100.0	869360	173.87	100.0	2711210	135.56	100.0
[illegible] COST	2118000	141.20	-	1000000	200.00	-	3118000	155.90	-
[illegible]	276150	18.41	-	130640	26.13	-	406790	20.34	-

APPENDIX

6. BRICK AND BLOCK QUALITY

I unde. .and from the Ethiopian Building Materials Corporation that there is an existing Ethiopian standard for bricks the British standard BS. 3921 Part 2 1969 (metric units) gives the following defirition for size and quality.

SIZES :

STANDARD BRICKS

Designation	Work sizes (mm)		
	Length	Width	Height
225 x 112.5 x 75 (i.e. Brick & Joint)	215	102.5	65

STANDARD BLOCKS

Designation	Work sizes (mm)		
	Length	Width	Height
300 x 62.5 x 225	290	62.5	215
300 x 75 x 225	290	75	215
300 x 100 x 225	290	100	215
300 x 150 x 225	290	150	215

In addition, half blocks 140 mm long and three-quarter blocks 215 mm long shall be available for bonding.

COMPLIANCE FOR DIMENSIONS (BRICKS)

DIMENSIONAL TOLERANCES (BRICKS)

Specified dimension (mm)	Overall measurement of 24 bricks (mm)
65	1560 + 60 / - 30
102.5	2460 ± 45
215	5160 ± 75

DIMENSIONAL TOLERANCES (BLOCKS)

Specified dimension (mm)	Tolerances for single units (mm)
less than 125	± 2.5
125 to 225	± 3.0
greater than 225	± 5.0

Bricks and block quality (ordinary)

a. Facing and common bricks and blocks of ordinary quality shall be well fired and shall be reasonably free from deep or extensive cracks and from damage to edges and corners, from pebbles and expansive particles of lime. They shall also, when a cut surface is examined, show a reasonably uniform texture.

b. Strength

The compressive strength of bricks of ordinary quality should not be less than 5.2 MN/m^2 and blocks of ordinary quality not less than 2.8 MN/m^2.

c. Soluble salt content

No requirements.

d. Liability to efflorescence

No sample shall develop efflorescence worse than moderate when tested in a laboratory.

STRENGTH AND ABSORPTION

Designation	Class	Average compressive strength MN/m^2 not less than	Average absorption boiling or vacuum per cent weight not greater than
Engineering brick	A B	69.0 48.5	4.5 7.0
Loadbearing brick	15 10 7 5 4 3 2 1	103.5 69.0 48.5 34.5 27.5 20.5 14.0 7.0	No Specific Requirements
Bricks for damp-proof courses	D.P.C.	As required	4.5

Bricks of crushing strength 5.2 MN/m^2 and blocks to 2.8 MN/m^2 can also be loadbearing eg. as used in one or two storey dwelling houses the 5.2 MN/m^2 brick is not limited to non-loadbearing uses.

APPENDIX 7

Hans Lingl
Anlagenbau und Verfahrenstechnik GmbH & Co.KG

LINGL

Hans Lingl · GmbH & Co. KG · Postfach 1829 · 7910 Neu-Ulm

Office and Factory I:
7910 Neu-Ulm, Albrecht-Berblinger-Str. 6
Tel. (0731) 70 81-1
Telex 712623
Telegrams: Linglmaschinen

Factory II:
8908 Krumbach, Nordstr. 2
Tel. (08282) 20 81
Telex 0539828

Building Materials Corporation
Ethiopia

Addis Abeba

ETHIOPIA

Your ref.:	Your letter dated:	Our ref.:	Date:
		4571/ bol/grb/kö	September 1, 1981

Quotation No. 4571 C

We thank you very much for your enquiry and take pleasure in submitting to you, without obligation, the following quotation in accordance with our General Business Terms:

LINGL TUNNEL KILN PLANT

for production of bricks and tiles

according to drawing 4571-I-2

Payment:

25 % cash down payment within 2 weeks after receipt of order
75 % against irrevocable and confirmed Letter of Credit

Validity of price for delivery in 1982

Delivery time:

Kiln building on completion of foundation work
Delivery of suspended flat roof approx. 3-4 months after receipt of order
Delivery of machines after completion of kiln
Setting machine: approx. 7 months after receipt or order

Terms: f.o.b. German seaport, taxes and duty unpaid

Packing: seaworthy

Neu-Ulm, September 1, 1981

Hans Lingl
Anlagenbau und Verfahrenstechnik GmbH & Co. KG

Agent:

Hans Lingl
Anlagenbau und Verfahrenstechnik GmbH & Co. KG

Verwaltung und Werk I:
D-7910 Neu-Ulm, Postf. 1820, Albr.-Berblinger-Str. 6
Tel. (07 31) 70 91-1, Telex 7 12 823

Werk II:
D-8908 Krumbach, Nordstr. 2
Tel. (0 82 82) 20 81, Telex 5 30 828

LINGL

QUOTATION NO.: 4571 C   September 1, 1981 kö

SUMMARY OF COST

page	LINGL SUPPLY		DM
	MACHINERY		
1-3	Automatic handling equipment for brick production line	263.368,00	
4-7	Kiln car loading with LINGL automatic setting machine for brick production line	901.423,00	
8-10	Automatic handling equipment for tile production line	290.623,00	
11-13	Kiln car loading with hand setting station for tile production line	276.913,00	
14	Transport equipment for chamber dryer	191.573,00	
15-17	Automatic pallet return equipment for brick production line	227.567,00	
18	Pallet return for tile production line	62.186,00	
19-23	Automatic kiln car transport equipment	369.792,00	
23	Control cabinet combination	165.165,00	
24-25	Automatic unloading equipment	261.920,00	
26-27	Automatic shrink wrapping system	302.775,00	3.313.305,00
	CHAMBER DRYER FOR BRICKS		
28-29	Fans	128.044,00	
29	Area ventilation	69.184,00	
30	Accessories for dryer	20.497,00	
	Indirect automatic air heater	172.119,00	
31	Doors	90.130,00	
	Electric control equipment	30.412,00	510.386,00
	CHAMBER DRYER FOR TILES		
32-33	Fans	112.892,00	
33	Area ventilation	69.184,00	
34	Accessories for dryer	20.497,00	
	Indirect automatic air heater	121.368,00	
35	Doors	90.130,00	
	Electric control equipment	30.412,00	444.483,00
	c/f.:	DM	4.268.174,00

Hans Lingl
Anlagenbau und Verfahrenstechnik GmbH & Co. KG

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Werk II:
D-8908 Krumbach, Nordstr. 2
Tel. (0 82 82) 30 81, Telex 5 38 826

LINGL

QUOTATION NO.: 4571 C September 1, 1981 kö

page			DM
	c/f.:	DM	4.268.174,00
	TUNNEL KILN		
36	Special shaped refractory bricks	4.522,00	
	Insulating material for tunnel kiln	77.321,00	
37	Tunnel kiln cars	543.660,00	
38	Doors and pushing machine	47.485,00	
39	Flat suspended roof, system LINGL	211.860,00	
	Roof beams and steel supports	44.198,00	
40	Kiln fittings	116.929,00	
41	Oil firing equipment	130.388,00	
42	Heating of heavy oil by hot air	32.050,00	
43	Oil supply equipment	213.057,00	
44	Fans	21.045,00	
45	Air supply unit	20.271,00	
46	Rapid cooling	11.317,00	
47	Air injection	16.350,00	
48	Automatic control equipment	94.610,00	1.585.063,00
	FURTHER DELIVERIES AND WORK		
49	Refractory material	192.700,00	
	Material for 78 kiln car decks	597.600,00	
	Material for tunnel kiln	160.600,00	
50	Additional equipment for dryer I and II	38.195,00	
	Metal pallets for dryer I and II	579.040,00	
	Additional equipment for the kiln	24.295,00	
51	Additional equipment for transport device	17.408,00	
	Air ductings	811.056,00	
	Platforms	33.000,00	
	Track material	198.585,00	
52	Electric installation	165.392,00	
	Spare parts	300.000,00	
	Building site lodgings	14.190,00	
	Auxiliary means	20.361,00	3.152.422,00
	c/f.:	DM	9.005.659,00

0063/3000/13

Rechtsform Kommanditgesellschaft.
Sitz Neu-Ulm, Reg.-Ger. Memmingen HRA 8701
Pers. haft. Gesellschafterin Lingl Verwaltungsges. mbH,
Sitz Neu-Ulm, Reg.-Ger. Memmingen HRB 8677.
Geschäftsführer Klaus Appel, Hans Lingl

Sparkasse Neu-Ulm Kto.-Nr. 4 386 BLZ 730 500 00
Dresdner Bank Ulm Kto.-Nr. 8 013 299 BLZ 630 800 15
Deutsche Bank Ulm Kto.-Nr. 239 707 BLZ 630 700 88
Bay. Vereinsbank Neu-Ulm Kto.-Nr. 2 705 540 BLZ 630 200 86
Postscheck München Kto.-Nr. 1844 74-808 BLZ 700 100 80

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LINGL

QUOTATION NO.: 4571 C September 1, 1981 kö

page			DM
	c/f.:	DM	9.005.659,00
52	Head masons's cost		136.100,00
	Supervision of construction		64.260,00
53	Planning cost		60.000,00
54	Erection of machinery and electric equipment as well as commissioning of machinery, dryers and kiln		835.100,00
	Total price:	DM	10.101.119,00

SOUTH GERMAN NET PURCHASE PRICES FOR
DELIVERIES AND WORK TO BE DONE LOCALLY

Foundation for tunnel kiln and preheater

445	m^3	to excavate pit for the foundations
220	m^3	to supply the gravel filtering layer
170	m^3	armoured concrete foundation
1.900	m^3	woven steel fabric
2,9	to	structural steel

Total price: DM 88.000,00

7.390 m^2 working hall, without hall floor and foundations budget price DM 1.847.500,00

Lighting for the hall budget price DM 30.000,00

HÄNDLE/RIETERWERKE Engineering Group
for the construction of ceramic plants

Building Materials Corp.,
Addis Abeba, Ethiopia

- 1 -
72/sch
3.8.1981

QUOTATION No. 81/465

for

a Brick and Tile Making Plant

acc. to project drawing no. 217 - 62 436

Output:	I. Stage - Bricks -		20.000.000 bricks/year effect.
		=	11.900 bricks/hour
		=	37,5 m³/h loose (incl. 10% reserve)
	II. Stage - Bricks -		15.000.000 bricks/year effect.
		=	8.950 bricks/hour
		=	28 m³/h loose (incl. 10% reserve)
	- Tiles -		5.000.000 tiles/year effect.
		=	3.000 tiles/hour
		=	12 m³/h loose (incl. 10% reserve)
Product:	Bricks reference size		250 x 120 x 60 mm
			2,85 kg fired weight
			25% perforation
	Tiles reference size		405 x 250 mm
			3,25 kg fired weight
Working Time:			1 shifts x 7 hours x
			5 days x 48 weeks
		=	1.680 hours/year

Any equipment or any work not specified individually in this quotation does not form part of our delivery.

HÄNDLE/RIETERWERKE Engineering Group
for the construction of ceramic plants

Building Materials Corp.,
Addis Abeba, Ethiopia

- 2 -
72/sch
5.8.1981

SUMMARY OF COSTS

			Stage I	Stage II
I	VEHICLES		DM 2.494.990,--	
	SPARE PARTS		DM 449.100,--	
II	PREPARATION		DM 2.146.350,--	
	SHAPING - bricks -		DM 1.236.700,--	
	SPARE PARTS		DM 676.610,--	
III	SHAPING - roof tiles -			DM 585.600,--
	SPARE PARTS			DM 117.120,--
IV	HOPPERS, CHUTES, etc.		DM 800.695,--	
	HOPPERS, CHUTES, etc.			DM 26.105,--
V	ASSEMBLY		DM 227.640,--	
	ASSEMBLY			DM 51.400,--
VI	SUPERVISOR	DM 19.000,-- per month		
VII	STATICS		DM 120.000,--	
			DM 8.152.085,--	DM 780.225,--
	TOTAL		DM 8.932.310,--	

HÄNDLE/RIETERWERKE Engineering Group
for the construction of ceramic plants

Building Materials Corp.,
Addis Abeba, Ethiopia

52/1a
17.8.1981

DESCRIPTION OF A BRICK PLANT

according to our project suggestion
No. 217 - 62 436

1. GENERAL REMARKS

Our project suggestion No. 217 - 62 436 represents a machine plant for the production of bricks of various kinds and sizes whereby there is the possibility of a production line to be joined in a second construction stage for manufacturing extruded tiles, Type "S-pan".

The conception of this plant is in the way that a material mixture of abt. 70 % tuff and 30 % plastic clay material can be processed. The capacity of the plant is designed in the first construction stage for 20 Mio. bricks, reference size 250 x 120 x 60 mm per year, and thus the plant entirely works as a brick plant.

Besides this reference size which is produced with a perforation range of 25 % other sizes can be manufactured e.g. big block bricks with a perforation range of up to 45 %, long hole bricks and ceiling bricks.

In a second construction stage a roof tile production line can be attached to in order to produce extruded tiles, Type "S-pan", as already mentioned before and stated in our quotation, paragraph 3.

On setting into operation of this roof tile production line the capacity of the brick plant would diminish to 15 Mio. bricks of standard size per year and in addition further 5 Mio. roof tiles per year would be produced.

The plant is designed in the way that afore mentioned capacities, i.e. either 20 Mio. bricks or 15 Mio. bricks and 5 Mio. roof tiles are manufactured in 1-shift-operation on 5 days, 48 weeks per year.

It has to be pointed out that with regard to the machines there is the possibility to double the capacity of the plant when operating at 2 shifts, however, dryer and kiln have to be designed according to this increased capacity, too.

HÄNDLE/RIETERWERKE Engineering Group
for the construction of ceramic plants

Building Materials Corp.,
Addis Abeba, Ethiopia

52/la
17.8.1981

2. PREPARATION

As two fundamentally different materials, namely tuff and clay, have to be mixed in the corresponding proportion 70:30 we designed our project in the manner that the tuff which is difficult to prepare and particularly is harder than the clay material is pre-crushed intensively.

Via wheel loader the tuff mined in the pit and stored on an intermediate heap comes into a Box Feeder, Item 1.

This Box Feeder works without paddle so that big-sized materials can be also fed without difficulties.

Via a Rubber Belt Conveyor, Item 2 the tuff material is conveyed to the Roller Crusher, Type WB 40, Item 4. The raw material fed into this Roller Crusher can be of abt. 600 x 400 x 500 mm in edge length which the machine breaks to an intermediate size of abt. 10 x 60 x 80 mm. A metal detecting device is installed between Box Feeder and Roller Crusher to eliminate possible metal parts in the material which eventually come from the mining machinery in the pit.

The material crushed by the Roller Crusher then comes via a Slat Belt Conveyor, Item 5 on a Disintegrator, Type WSL 450 B, Item 6. This disintegrator crushes the pre-broken tuff material to a final size of abt. 15 mm.

The tuff material crushed in this way is then transported via another Rubber Belt Conveyor, Item 7 into the Box Feeder, Item 8.

The clay material stored on an intermediate heap is now fed also via wheel loader into a further Box Feeder, Item 9.

Both Box Feeders Item 8 and Item 9 proportion the tuff and clay material in the corresponding ratio of mixture on a common Slat Belt Conveyor, Item 10.

The following Wet Grinding Pan, Type WO-S, Item 11 crushes, mixes and kneades the two materials while water is added at the same time and gives the material on a collecting plate beneath the Wet Grinding Pan and via a Rubber Belt Conveyor Item 12 on a preliminary Roller Mill, Type 1000 x 630 G, Item 14.

This preliminary Roller Mill crushes both materials up to a grain size of abt. 3 - 4 mm.

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Via another Rubber Belt Conveyor Item 15 which is equipped with a special material distributor, Item 16 to obtain a material strip of a uniform width the material is given on to a High-Capacity Fine Roller Mill, Type HW 800 x 1000, Item 17. By this Fine Roller Mill the material is crushed to its final size between 0,8 and 1,0 mm.

Behind the Fine Roller Mill a Double Shaft Mixer, Type MD 1030a, Item 19 was installed which is fed via a Rubber Belt Conveyor, Item 18, so that the material occurring in "flats" from the Fine Roller Mill is again homogenized and mixed and that there is the possibility to add further tempering water.

3. CLAY STORAGE

To make the preparation and shaping plant independent of each other and to overcome possible stoppages of machinery in this sector e.g. by maintenance works or difficulties with the material feed an intermediate storage in form of 2 large-capacity Box Feeders, Item 23 was installed between preparation and shaping. This material storage has a holding capacity of abt. 250 cu.m. and thus has a reserve of abt. 7 production hours.

The two large-capacity Box Feeders are fed via the Rubber Belt Conveyors, Item 20, 21 and 22. The arrangement we chose gives the possibility, in case of a roof tile production, to store in both box feeders different material mixtures and to give them independent of each other on the shaping line for bricks and roof tiles.

4. SHAPING BRICKS

The material mixture coming from the large-capacity Box Feeders is transported via the Rubber Belt Conveyor, Item 24 and Slat Belt Conveyor, Item 25 into the Circular Screen Feeder, Type SR 1900, Item 26.

In this Circular Screen Feeder again an intensive long mixing and homogenizing takes place, whereby, if necessary, the water content on extrusion can be corrected by adding again tempering water. There is the possibility to integrate, if necessary, additives e.g. in form of steam, porosity or colouring agents.

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Besides its mixing and homogenizing function the Circular Screen Feeder works at the same time as a proportioning machine onto the following De-Airing Extrusion Unit, Type VARIAT 600/560, Item 28.

This De-Airing Extrusion Unit with separate drive for vacuum shaft mixer and extruder is the shaping machine for bricks in the latest design available at present. By this de-airing extrusion unit all corresponding brick sizes are produced.

The evacuation of the material takes place in the spacicus vacuum chamber of the vacuum shaft mixer with the aid of the vaccum pump, Item 29.

The material column is cut to the required brick size by the following cutting system, as it proceeds from the extruder.

5. SHAPING ROOF TILES (2. construction stage)

The material mixture stored in the intermediate storages in form of large-capacity Box Feeder is fed for the production of roof tiles via the Rubber Belt Conveyor, Item 31 and the Slat Belt Conveyor, Item 32 to another, however, smaller Circular Screen Feeder, Type SR 1500, Item 33. Here the material is also mixed again intensively and homogenized, a fact which is especially necessary for the production of a high-quality roof tile.

The Circular Screen Feeder then gives the material via the Rubber Belt Conveyor Item 34 onto a de-airing extruder, Item 35. As the capacities for roof tile production are relatively small, this de-airing extruder is smaller than for the brick production. This extruder has a common drive for vacuum shaft mixer and extruder.

The clay column coming out of this extruder continuously is cut by means of a special cutting system to obtain the required roof tile shape and size.

Description of further plant please see Lingl project.

APPENDIX 8

LINGL

Anlagenbau und
Verfahrenstechnik KG
Neu-Ulm

July 08, 1981 LAB schw/eb

Laborbericht

LABORATORY TEST REPORT

Kunde: Firma
Customer — *Clark Ceramic Consultants*
Project Gademba - Ethiopia

Eingesandtes Material:
Material sent to us — *pit material*
clay, dark brown
tuff, 4 different samples, for reduction of plasticity

Prüfungsziel:
Aim of test — *suitable mixture (clay and tuff) for the production of common bricks and roofing tiles*

Prüfungsdurchführung:
Test performance — *DTA and Dilatometer curve of the individual raw materials, drying and firing tests with various mixtures, water consumption, grain analysis*

Zusammenstellung der Untersuchungsergebnisse
Summary of test results:

Clay:
The clay is an impured fire clay (see detailed report)

This clay cannot be used for brick production without admixing a plasticity reducing material. The clay has an extremely high drying shrinkage and is very sensitive on drying. It has a small sintering interval so that also on firing certain difficulties might occur.

In the Winkler Triangle the grain structure is still outside section III. This indicates that the material is very fine grained and that the above mentioned drying difficulties occur.

Tuff:
This is a medium hard, strongly weathered volcanic ash (trachyte) of light brown to white colour with many coloured inclusions and crystals (feldspar, iron, olivine). The 4 samples are almost the same. Tuff no. 4 was already sent to us in ground form.

Laboratory test report/Project Gademba, Ethiopia

The tuffs are free of lime, gypsum and quartz. They therefore are well suitable for reduction of plasticity.

The grain structure of the tuffs is in the right bottom corner of the Winkler Triangle. Not all of the tuffs were tested.

We also received iron concretions which had been separated from the clay. Under operating conditions in the plant, however, it will not be possible to separate them. Therefore it has to be taken care of them being fine-ground and admixed as homogenously as possible.

A mixture of

50 % clay and 50 % tuff

was proposed by the client. This mixture has a rather high plasticity and is very sensitive on drying. The drying shrinkage is almost 8 %. Therefore the bricks have to be dried with high air humidity in the beginning phase and with slowly increasing temperature. Asynchronous pre-drying (unilateral drying) has to be absolutely avoided.

In our laboratory a second mixture of

30 % clay and 70 % tuff

was tested. This mixture still has a rather high plasticity and is sensitive on drying, however much less than mixture 1. The drying shrinkage is only 6 %. This mixture also could be used for thin-walled products.

Drying has to be done very carefully in the beginning phase. In this respect the same as indicated for mixture 1 is valid.

The grain structure of both mixtures is in the centre of the Winkler Triangle. Such a material is suitable for the production of roofing tiles and hollow ware.

The firing behaviour did not show special difficulties in heating up and cooling. The Dilatometer curve shows in its lower area a short anomaly which indicates that heating-up must not be done too rapidly up to a temperature of 300 degrees C. A proportionally flat extension follows up to approx. 840 degrees. The anomaly at around 575 degrees which indicates the quartz conversion is so small that it can be neglected. The main firing shrinkage starts with the modification of structure around 840 degrees C and continues in a curve which at first is steep and then flat until the end of the firing process.

Due to the high content of iron the material can also be fired in reducing kiln atmosphere. This causes a blue-grey firing surface on the brick. In our laboratory we made tests in this respect.

For common bricks we recommend mixtu 2. The firing temperature should be 950 degrees C. The firing temperature for facing bricks should be approx. 1000 degrees.

Laboratory test report/Project Gademba, Ethiopia

For the production of roofing tiles we recommend mixture 1 or a mixture of 40 % clay and 60 % tuff. For this mixture we also recommend a firing temperature of approx. 1000 degrees C. For firing in reducing kiln atmosphere a firing temperature of 1020 degrees C would be necessary. Special attention has to be paid to the firing shrinkage which is rather high. If the fire is not exactly conducted this may lead to deformations.

For compensating the firing shrinkage part of the tuff could be replaced by brick grog.

Summary of the individual test results

Mixture	1	2 (average)
Drying shrinkage in climate room:	samples cracked, not evaluated	
Drying shrinkage at room temperature:	7,7 %	6,6 %
Firing shrinkage at 1000 degrees C:	2,0 %	1,2 %
Loss of weight on firing:	6,0 %	4,0 %
Water consumption:	12,0 %	13,0 %
Apparent solid volume:	1,93 g/cm³	1,89 g/cm³

The charasteristics of material described above only refer to the tested samples and were found under laboratory conditions. We cannot determine to which extent those samples are representative for the material which will be processed in the plant. For industrial production further features, especially with regard to the brick sizes which shall be produced and tne way of setting in the kiln have to be observed.

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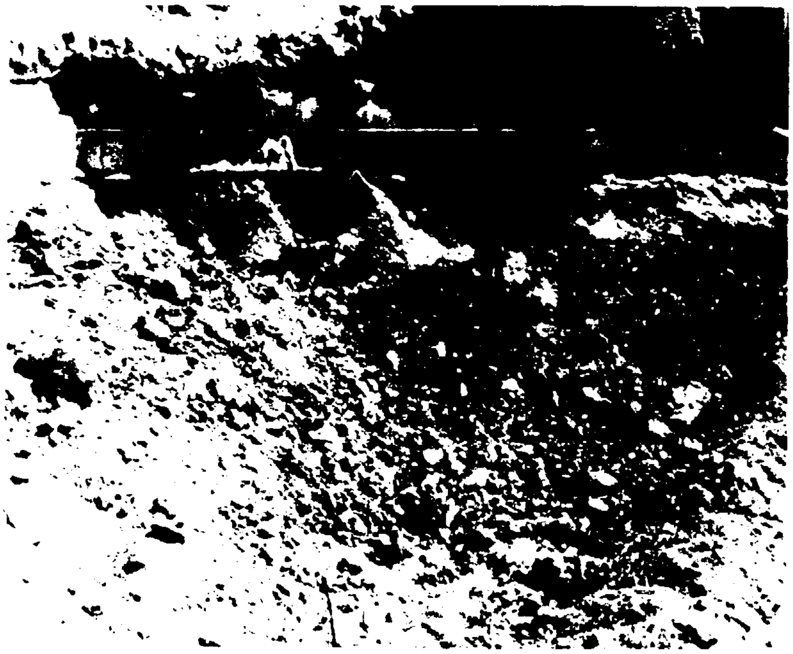
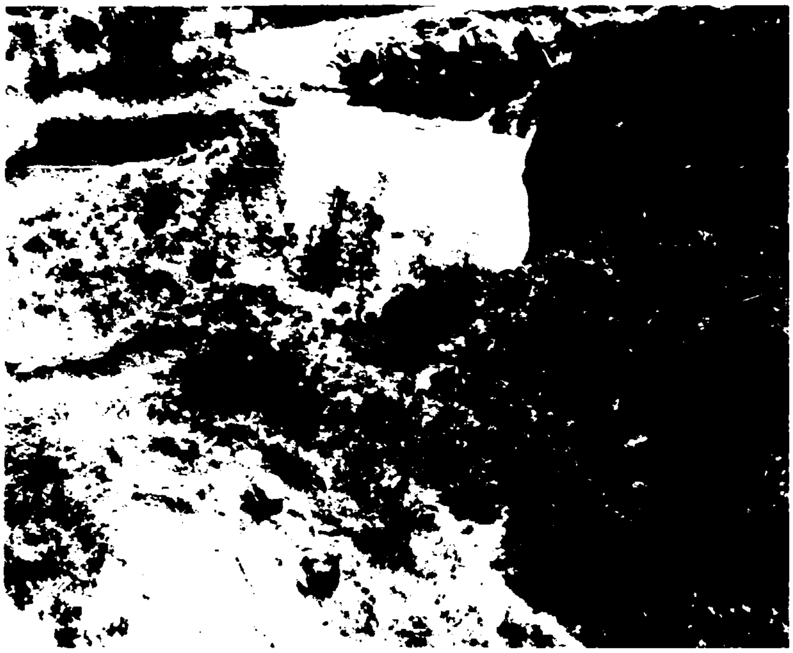


View of quarry at Stela Meda.

View of quarry for Tuff at Ceramical.

View of the Tuff face at Ceramical.

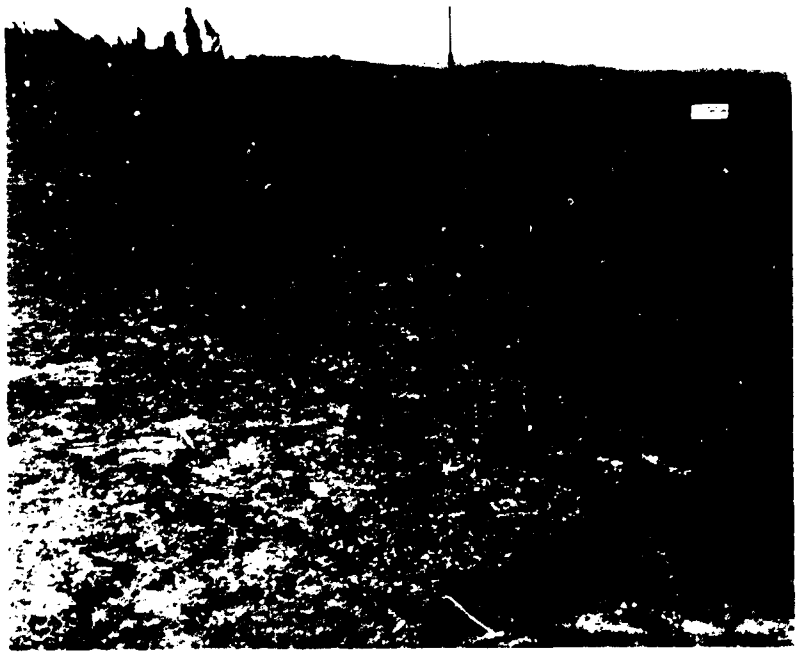


Tuff deposit at Gedamba.

Higher up the Gedamba deposit indicating the steep slope of the deposit which will require benching to work.

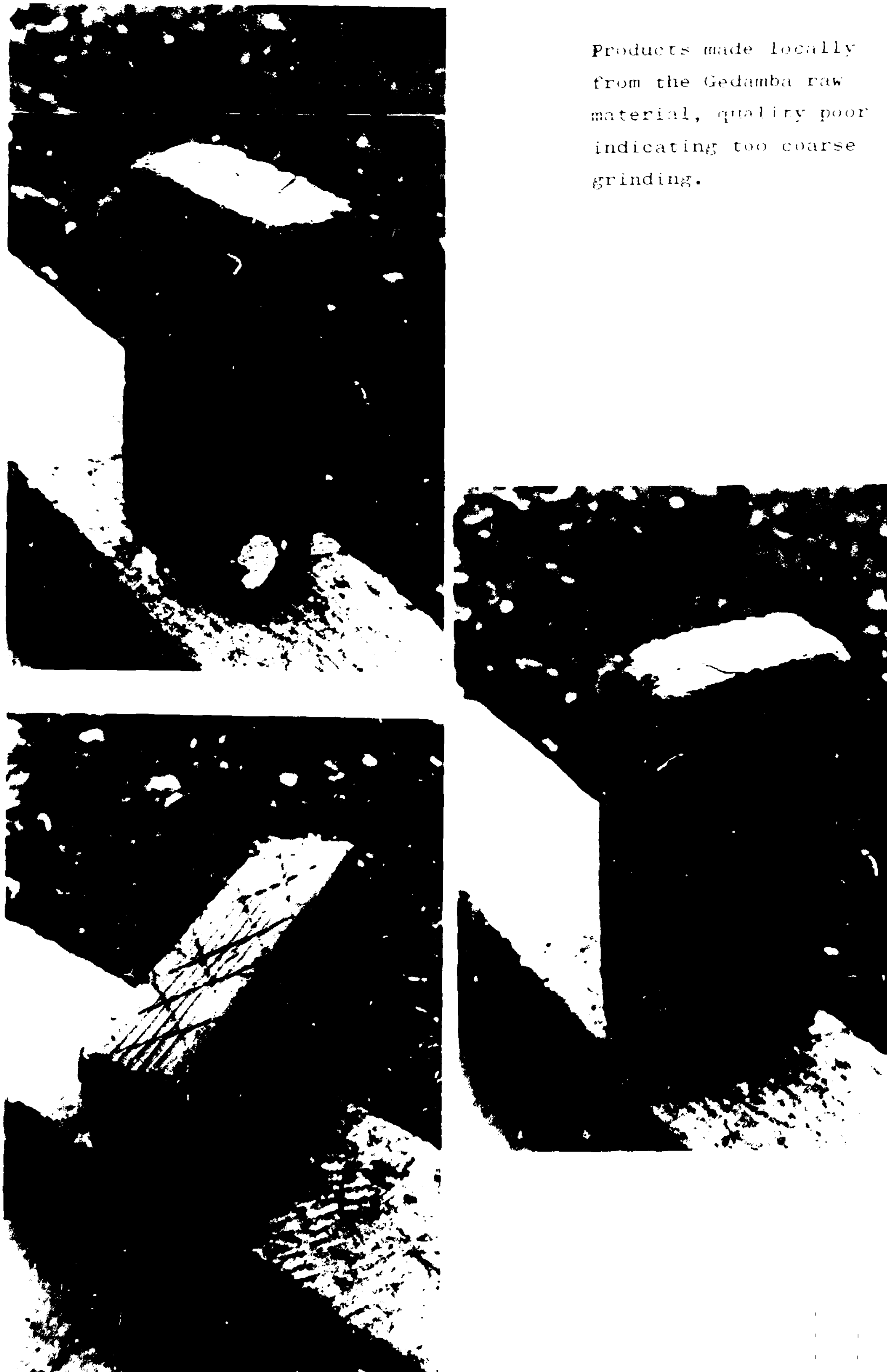
Another indication of the contour of the deposit.

Plastic clay deposit at Gedamba.

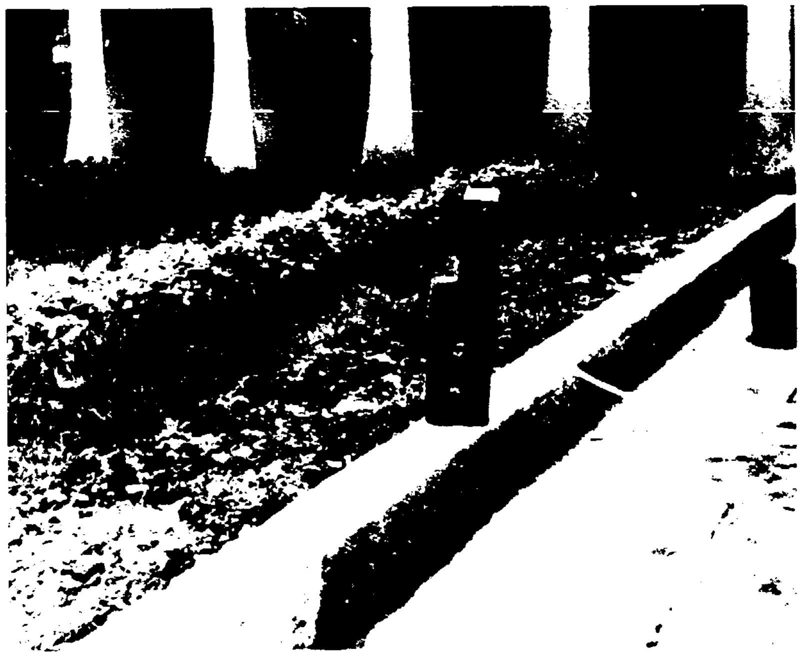


Site at Alemgena indicating the fairly level but slightly sloping site.

Checking the Alemgena site for possible load bearing qualities.



Products made locally from the Gedamba raw material, quality poor indicating too coarse grinding.

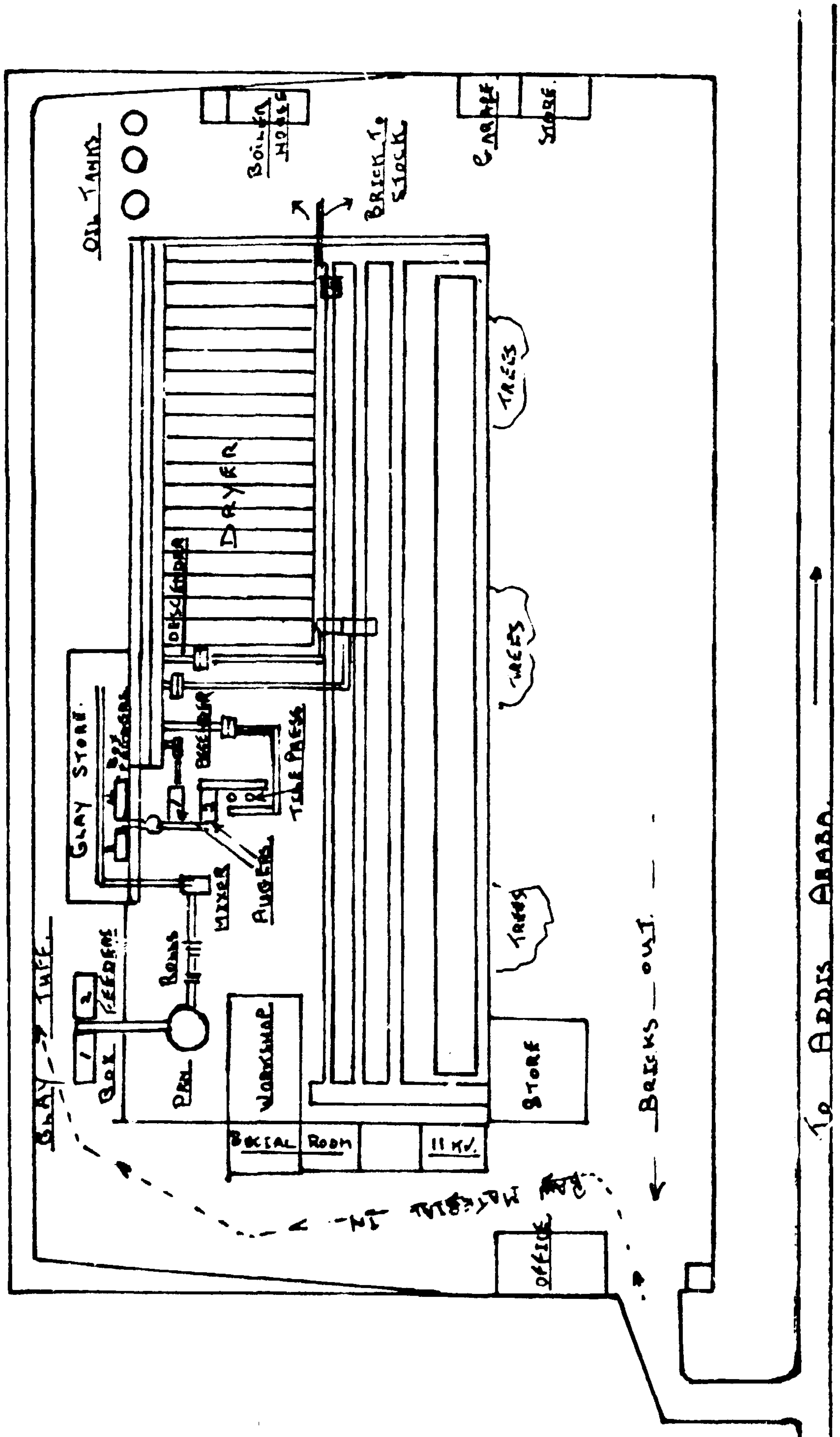


Products made locally from the Gedamba raw material, quality poor indicating too coarse grinding.

Samples produced by Lingl in Germany. Please note dark brown samples in foreground are the result of firing under reducing conditions, indicates possibility of producing natural through colour products in red and brown.

APPENDIX 10

TECHNO-EXPORT PROPOSED LAYOUT.



NOT TO SCALE.

APPENDIX 11

SUGGESTED MO.. GED LAYOUT.