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NATIONAL LABORATORY FOR THE DEVELOPMENT OF BUILDING MATERIALS INDUSTRY

DP/SOM/74/002

SOMALIA

TERMINAL REPORT

Prepared for the Government of Somalia by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization

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United Nations Development Programme

NATIONAL LABORATORY FOR THE DEVELOPMENT OF BUILDING MATERIALS INDUSTRY

DP/SOM/74/002

SOMALIA

Project findings and recommendations

Prepared for the Government of Somalia
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of A.V.R. Rao, building materials expert

United Nations Industrial Development Organization

Vienna, 1977

Explanatory notes

Reference to "tons" indicates metric tons, unless otherwise stated.

Reference to "dollars" ($) indicates United States dollars, unless otherwise stated.

In tables a dash (-) indicates that the amount is nil or negligible.

The monetary unit in Somalia is the Somali shilling (SoSh). During the period of the project, the value of the Somali shilling in relation to the United States dollar was $US 1 = SoSh 6.23.

The following abbreviations are used:

ASTM	American Society for Testing and Materials
LWA	light-weight aggregate
SCA	Somali Construction Agency

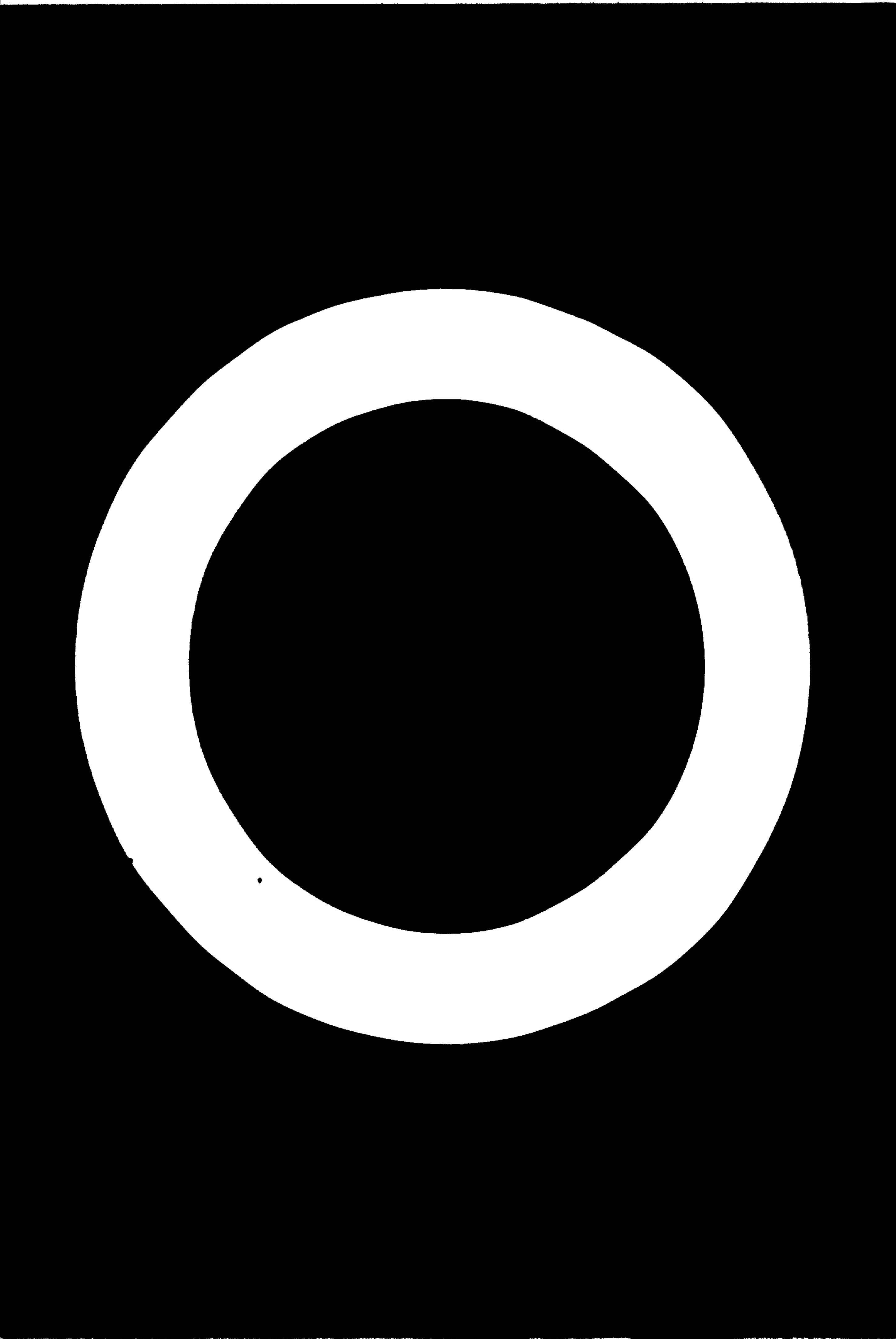
ABSTRACT

The project "National Laboratory for the Development of Building Materials Industry" (DP/SOM/74/002) of the United Nations Development Programme (UNDP) was carried out in response to a request from the Government of Somalia from 23 September 1975 to mid-October 1976 by the United Nations Industrial Development Organization (UNIDO) acting as executing agency for UNDP. The counterpart agency was the Somali Construction Agency. Although originally planned as a two-year project, it was terminated prematurely owing to financial difficulties.

UNDP contributed $47,350 for 13 man-months of expert services and equipment worth $3,777.

The long-term objective of the project was to assist the Government to develop building materials through the establishment of a national laboratory capable of carrying out testing and research on local raw materials and imported building materials.

The project was terminated just when it was beginning to show results.



CONTENTS

Chapter		Page
	INTRODUCTION	6
I.	PROJECT FINDINGS	8
	Testing facilities in Somalia	8
	Development of economical building materials for new settlements	9
	Training of local staff	38
II.	RECOMMENDATIONS	39

Annexes

I.	Building materials required for housing projects for drought-affected families in Somalia	43
II.	Data on building materials imported in 1974	45
III.	Project personnel	46
IV.	UNDP-financed supplies handed over to the Government	47
V.	Equipment required for the building materials laboratory	48
VI.	Books and technical publications requested for the National Laboratory for Development of Building Materials Industry, Mogadiscio	49
VII.	Scheme for production of 10,000 soil-stabilized blocks at Dujuma	52
VIII.	Requirements for production of 3 million bricks per year, or 20,000 bricks per day	55
IX.	Project proposal for lime plant at Mogadiscio	56
X.	Requirements for a sand-lime brick plant producing 20 million bricks per year	59
XI.	Ceramic plant for production of floor and wall tiles, household articles and low-tension insulators	61
XII.	Brick plant at Afgoi	63
XIII.	Additional equipment required by Afgoi brick plant	65
XIV.	Specifications of corrugated sheets manufactured by Light Roofings Ltd, Madras	66

Tables

1.	Particle-size analysis of sands and clays and plasticity index of clays used for soil stabilization	10
2.	Chemical analysis of samples of silica sands collected for feasibility studies	22

Figures

I.	View of simple kiln with permanent walls as it appears when completed	12
II.	Transverse cross-section of kiln showing how the bricks are stacked alternately with space left between each two bricks	12
III.	Longitudinal cross-section of kiln at one of the fire openings	13
IV.	Method in which bricks are stacked to form the front and rear walls of the kiln	14
V.	Bulls trench kiln used in West Bengal	16
VI.	Loaded bricks in kiln, front elevation	17
VII.	Loaded bricks in kiln, longitudinal elevation	18
VIII.	Layout for sand-lime brick factory	23
IX.	Flow diagram of production process used in sand-lime brick factory	24

INTRODUCTION

Construction is a major sector of development, representing 45-60 per cent of capital formation. Building materials and components constitute 50-60 per cent of the total value of construction output. The building materials industry is therefore closely connected with the development of any country. The current five-year development plan of Somalia (1974-1978) envisages an investment of SoSh 3,863 million, about 55 per cent of which is allocated for transport and communications, industry, health, and housing - sectors that mainly depend on the availability of building materials for achieving the targets of the plan.

It is estimated that about 54,650 dwellings are immediately required for the homeless and those living in substandard housing in 18 major townships in the country. In Mogadiscio the housing shortage is acute. About half the dwellings needed in Somalia are needed in this city. The Government is proposing to invest SoSh 156.6 million for construction of 13,650 new dwellings in the urban areas. The balance of the housing requirements is to be met by the private sector with the support of government agencies and banking institutions. In addition to urban development, about 30,000 drought-affected families are being settled in the agricultural areas. The cost of the minimum requirements for materials, excluding local materials, for constructing low-cost housing in these settlements has been estimated at SoSh 100 million (see annex I).

The tempo of construction has been increasing rapidly in recent years in Somalia. The Somali Construction Agency (SCA), the principal construction agency in the public sector, carried out projects worth SoSh 80 million in 1974 and SoSh 105 million in 1975; it envisages a larger construction programme in 1976. However, it constructed mainly office, factory and commercial buildings and very little housing.

Eighty-five per cent of building materials are imported at an increasingly high cost. This cost is a major element in the cost of construction (SoSh 1,200/m^2) for housing in urban areas. With the increasing urbanization, the cost of imports of building materials has risen as follows (million SoSh): in 1970, 19; in 1972, 30; and in 1974, 80. The data for 1974 do not, however, include the cost of cement imported. Annex II gives data on the building materials imported in 1974.

The Government envisages a large programme to develop the local building materials industry to satisfy the need for building materials and to reduce imports.

The current development plan provides for the establishment of plants to produce cement, asbestos-cement roofing sheets, terrazzo tiles, ceramic tiles, sanitary ceramics and a pilot gypsum plant.

Limestone, silica sands, gypsum, kaolin, feldspar, quartz, talc, nepheline, syenite and bentonite are available in the country for the production of building materials. However, detailed geological and technological surveys have not been carried out so far. The Ministry of Mining and Water Resources plans to undertake a geological survey of some of the raw materials, but no facilities exist for evaluating them.

During 1973/74, a UNIDO expert, who surveyed some of the silicate raw materials, suggested the establishment of a national laboratory for the building materials industry that would test the quality of both imported and locally produced building materials. The Government accepted the proposal, and the UNDP project document was signed on 13 May 1975.

The project "National Laboratory for the Development of Building Materials Industry" (DP/SOM/74/002) of the United Nations Development Programme (UNDP) was carried out in response to a request from the Government of Somalia from 23 September 1975 to mid-October 1976 by the United Nations Industrial Development Organization (UNIDO) acting as executing agency for UNDP. The counterpart agency was the SCA. Although originally planned as a two-year project, it was terminated prematurely owing to financial difficulties. Project personnel is listed in annex III.

The long-term objective of the project was to assist the Government to develop building materials through the establishment of a national laboratory capable of carrying out testing and research on local raw materials and building materials, to satisfy local needs and ensure a better utilization of the local deposits of silicate raw materials. The immediate objectives were:

(a) To provide facilities for testing local silicate raw materials;

(b) To test both local and imported building materials and recommend standards and specifications;

(c) To initiate applied research for the manufacture of various building materials from local raw materials, such as ceramic tiles, sanitary ceramics, asbestos roofing sheets and pipes and insulating materials;

(d) To provide the necessary technological data for the establishment of the building materials industry.

(e) To train national counterpart staff on the job and through fellowships.

I. PROJECT FINDINGS

The preparation, including procurement of UNDP-financed equipment and construction of the required building, was not completed. The project was located in the existing Highway Laboratory, which has an area of about 400 m^2 on the ground floor of the 3-storey building of the Civil Engineering Department. Three rooms with a total area of 46 m^2 had been reserved for the project. The counterparts - project director, engineer/technologist - were assigned for the project from November 1975. However, the project was without a counterpart project director from February 1976 on.

Testing facilities in Somalia

The equipment available in laboratories in Somalia was studied, and a revised list of equipment required for the project was prepared to suit the needs of the project; priorities were set according to the finances available. The laboratories of the Highway Department, the new port at Mogadiscio and the Highway Laboratory at Hargeisa have facilities for testing only concrete and soil. The Department of Mines is equipped to carry out chemical analysis and petrographic examination of minerals. The foundry and workshop of the Ministry of Industry also has a laboratory with limited facilities for casting steel. Owing to lack of funds, only $5,000 worth of UNDP-financed equipment was received. A list of equipment received and handed over to the Government is given in annex IV. The universal ball mill, however, is still under customs clearance, but the rest of the equipment has been installed and is in working condition. The essential equipment, without which it is difficult to carry out developmental work on silicate raw materials, has not been received; it is listed in annex V. No technical literature on building materials is available in Somalia, and no standards for them exist. A list of technical books, publications and standards that have been requested but not received is given in annex VI. Separate space has been provided for the library in the first floor of the building.

With the existing facility, imported and local building materials were tested routinely, and the counterparts were trained. The building materials produced in Somalia - bricks and blocks from the Afgoi brick plant, sandcrete blocks from the existing units from Mogadiscio and lime from the small units producing lime at Mogadiscio and Merca - were tested from time to time. The soil, sand and aggregate were tested for their quality. Detailed investigations of locally available aggregate for use in concrete were carried out to determine the minimum quantity of cement required to obtain the desired strength for various types of concrete for the Gezira power station, university projects etc., undertaken by SCA. These investigations have resulted in reducing the quantity of cement needed for the concrete required for these projects.

Development of economical building materials for new settlements

By 1980, it is planned to settle 30,000 families in the agricultural areas of Kurthanwary, Sablaale and Dujuma. An integrated system of grid and radial planning with linear development along the rivers has been adopted for the settlements. It is proposed to provide a house site of 100 m^2 with a covered area of 40 m^2 for each family in the settlement. More information is given in annex I. The project manager was asked to include in the project an investigation of economical building materials on a priority basis.

Soil-stabilized blocks

The soil at Kurthanwary, Sablaale and Dujuma were tested in a laboratory. The soils from Kurthanwala and Sablaale are highly plastic and difficult to dry without adding any sand or non-plastics. The soils from Dujuma are highly sandy. Table 1 gives the particle-size analysis of sands and clays and plasticity index of the clays used for soil stabilization.

Tests were carried out in the laboratory for producing soil-stabilizing blocks by using lime and/or cement as stabilizing agent. Soil stabilization by asphalt is generally recommended for highly plastic soils such as those at Kurthanwary and Sablaale. Since asphalt must be imported and is costly, tests were carried out for producing lime-stabilized blocks using looal clay with lime and sand. The clay and sand proportions were fixed at 1:1 ratio, and addition of lime and cement was varied from 0 to 10 per cent. Water added was also varied from 10 to 15 per cent of the mixture and it was compacted by hand. The densities of the samples of Kurthanwary and Sablaale clays were 1.58 and 1.65, respectively. The results of the tests indicated that clay and sand alone gave a strength of 20 kg/om^2, but the bricks disintegrated when in oontact with water. Addition of lime alone did not give any strength to the brick because of the poor quality of the lime available in Merca, but the brick withstood the penetration of water.

Addition of cement up to 4.5 per cent improved the strength considerably, and coarse sand (Merca) gave better strength than the fine sand (Shalamboot). Soil-stabilized blocks having a strength of 30 kg/cm^2 and resistant to water penetration were successfully produced using 4.5 per cent cement and 4.5 per cent lime.

Table 1. Particle-size analysis of sands and clays and plasticity index of clays used for soil stabilization

A. Particle-size analysis

	Percentage retained					
ASTM sieve	I	II	III	IV	V	VI
10 mesh (2 mm)	1.0	0.5	1.6	3.8	1.8	1.0
20 mesh	1.6	0.5	1.8	1.2	1.6	1.0
40 mesh	1.8	0.2	19.10	2.2	90.9	55.2
60 mesh	1.8	0.2	17.6	13.2	5.3	23.2
140 mesh	8.0	0.8	19.3	75.6	0.3	18.0
200 mesh	1.0	0.3	1.9	2.8	0.1	1.2
Smaller than 200 mesh	84.8	97.5	38.7	1.2	0.0	0.4

B. Plasticity analysis

	Water content (percentage)		
	I	II	III
Liquid limit	57.2	41.2	22.8
Plastic limit	29.8	22.9	13.9
Plasticity index	22.0	18.3	8.3

Note: I Kurthanwary clay; II Sablaale clay; III Dujuma clay; IV Shalamboot fine sand; V Merca sand; VI Brava sand

Field trials were successfully carried out at Kurthanwary by installing two hand-operated compression machines (CINVARAM presses). Soil-stabilized blocks of 29 x 14 x 9 cm were produced using soil from Kurthanwary, sand and lime from Merca and cement. The blocks produced had a strength of 40 kg/cm^2. The local workers were adequately trained. Mixing the ingredients and addition of the optimum moisture are important in producing soil-stabilized blocks. For the foundations and walls of the houses at Kurthanwary, 5,000 blocks were manufactured.

The estimated cost of blocks at Kurthanwary is SoSh 30 per 100 blocks. Because of the successful results obtained, the United Nations Children's Fund (UNICEF) imported 30 CINVARAM presses for this purpose.

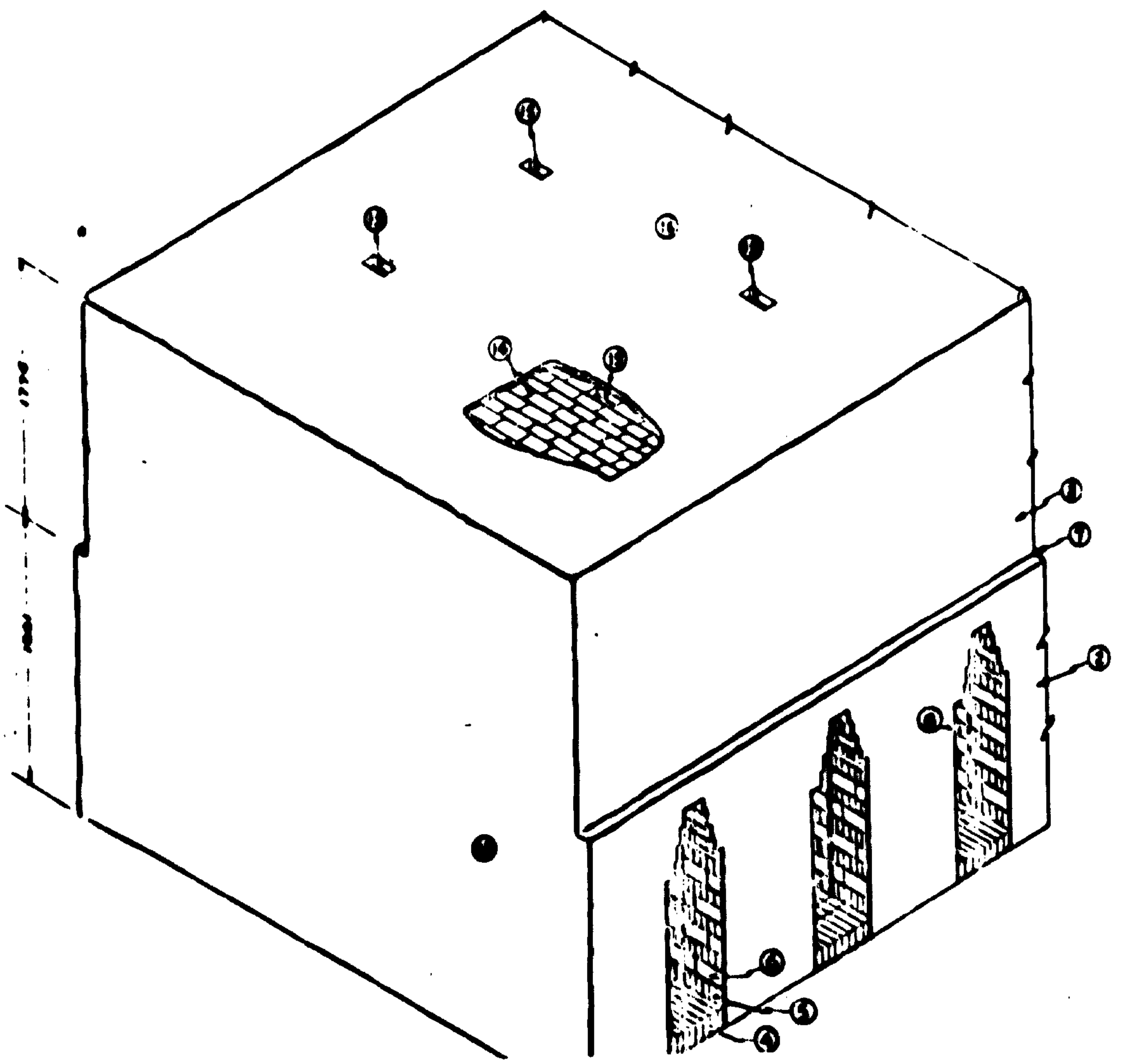
The soil from Sablaale is better suited for soil stabilization, but the soil from Dujuma is the best because it is sandy. A scheme giving work programme, materials and buildings requirements and the step-by-step process for production of 10,000 blocks per day at Dujuma was submitted to the Ministry of Interior for execution (annex VII). A manual for soil stabilization was also prepared. The Somali counterpart technologist is now well trained to produce soil-stabilized blocks and is able to judge the quality of the soil and vary the quantity of water, cement and lime to be added to the soil.

Clay bricks

As an alternative to producing soil-stabilized blocks, tests were carried out for producing clay bricks, since cement is a costly imported material required for the soil-stabilized blocks. Since the clays from Kurthanwary and Sablaale are highly plastic, addition of sand or non-plastic material is essential in brick production to avoid drying cracks. Sand from the dunes near Kurthanwary (Shalamboot) and Sablaale (Mudal) were used. Tests were also carried out using no sand but calcining the local clay at a low temperature (600°C) and adding the calcined clay as a replacement for sand. Good-quality bricks of 50 kg/cm were produced from Kurthanwary and Sablaale soils. It was proposed that field trials at Kurthanwary be carried out by burning the bricks using wood as a fuel; the kilns suggested for this purpose are shown in figures I-IV.

The results of the laboratory tests, however, could not be taken to the field because the project was terminated prematurely and the local people were also carrying out independently trial production of clay bricks. The quality of bricks they produced, however, was poor, and considerable drying and firing losses occurred. Another main problem they face is lack of wood for burning. After discussing this problem with the Ministry of Agriculture and Forestry and the Food and Agriculture Organization of the United Nations (FAO) experts, the expert concluded that too little wood would be available for brick burning, and alternative economical fuel would have to be found for that purpose. Since the settlements must be [illegible] in the next few years, coal should be imported either from India or Mala[illegible].

Figure I. View of simple kiln with permanent walls as it appears when completed



II. Transverse cross-section of kiln showing how the bricks are stacked alternately with space left between each two bricks

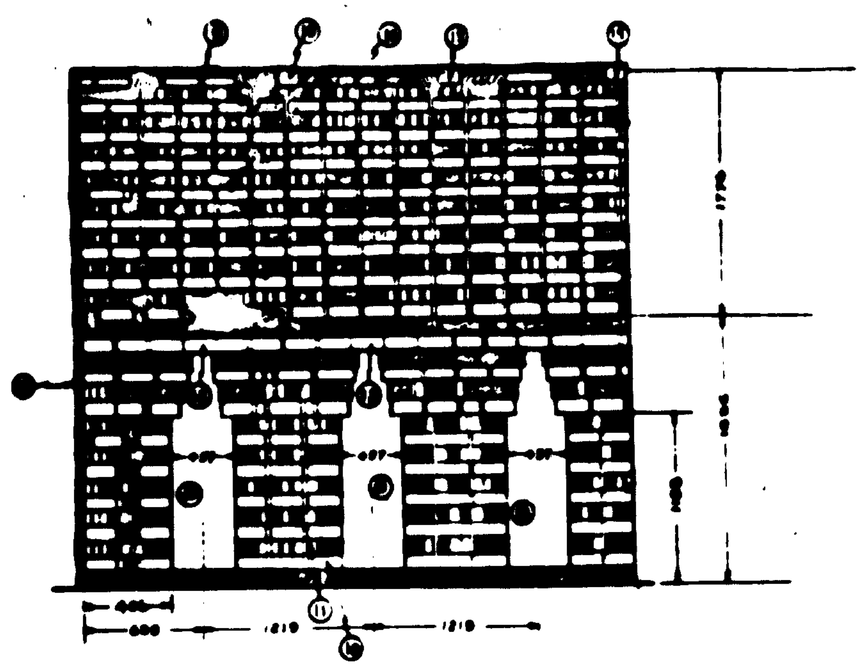
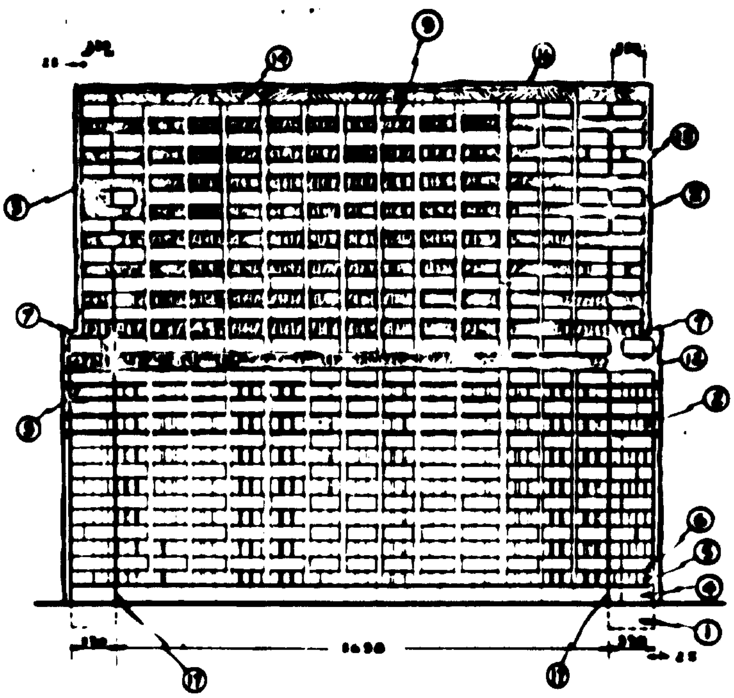


Figure III. Longitudinal cross-section of kiln at one of the fire openings



Legend (figures I-III)

(1) Foundation wall.

(2) Permanent front wall of kiln. This wall is 330 mm thick up to a height of 1,836 m The remainder of the wall is 230 mm thick.

(3) Permanent back wall of kiln. This wall is 330 mm thick up to a height of 1,836 mm The remainder of the wall is 230 mm thick.

(4) First layer of bricks in the wall.

(5) Second layer of bricks in the wall.

(6) Third layer of the bricks in the wall.

(7) Point in wall of kiln at which the thickness is reduced to 230 mm.

(8) Opening in front and rear walls of kiln through which fuel for fire is passed into interior of kiln.

(9) One of the piles of bricks that are placed in the interior of the kiln.

(10) First layer of bricks in piles in interior of kiln.

(11) Second layer of bricks in piles in interior of kiln.

(12) Layer of bricks laid close together to form a solid roof to the fire chamber.

(13) Stiff clay used as covering for the walls of the kiln.

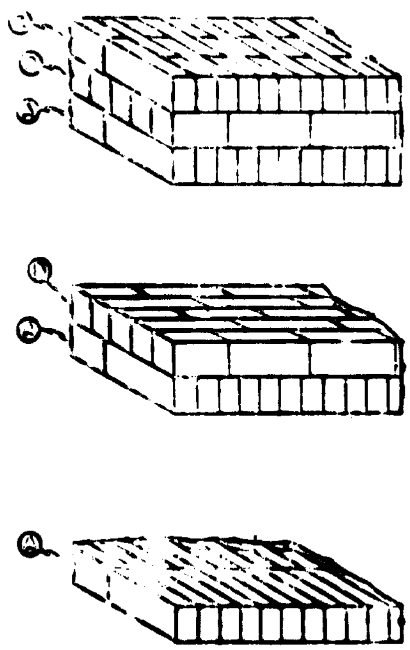
(14) Bricks placed close together to form a roof to the kiln.

(15) Openings left in roof for draft.

(16) Clay surface of the permanent wall.

(17) Inside surface of the permanent wall.

Figure IV. Method in which bricks are stacked to form the front and rear walls of the kiln



A. First layer of bricks. The bricks are placed on edge with the ends of the bricks towards the outer surface of the walls.

B. Second layer of bricks. The bricks are placed on edge with the flat side of the bricks parallel with the front of the wall.

C. Third layer of bricks. The bricks are laid as follows: a whole brick is placed on edge with its end facing the outside of the wall. Behind it a half brick is laid with its smooth end facing the inside of the kiln and its rough or broken end facing the end of the whole brick. The next brick laid is a half brick laid on edge along the side of the whole brick. Then behind the half brick a whole brick is placed on edge.

For burning bricks by coal, Bulls trench kilns are popular in India and Pakistan, where clay brick is the main masonry material used for construction. A typical Bulls trench kiln and setting up of bricks adopted for burning in West Bengal (India) is given in figures V-VII. The kiln is an oval trench in which bricks are set in such a way that natural flues are formed for passage of flue gases (figures VI and VII). The coal is fed from the feed holes left at the top, and an iron chimney (figure VI) moves over the bricks to create the draught. It is a continuous kiln similar to the Hoffman kiln except that it has no roof and permanent structure. The waste heat from the flue gases is efficiently used for preheating the bricks. About 10,000 such kilns are spread throughout India, even in villages, for producing bricks economically. A scheme for producing 3 million bricks using coal for burning in open trench kilns is given in annex VIII. The process is labour oriented. The investment of SoSh 126,000 is mainly for the coal. The estimated cost of production of such bricks (23 x 11.5 x 7.5 cm), excluding labour cost, is $0.06 per brick as compared with $0.40 per brick produced by the Afgoi brick plant.

<u>Lime</u>

Somalia is very rich in limestone deposits and lime should be the basic raw material for the building materials industry to be set up in Somalia. Lime is already produced at Mogadiscio, Merca, Kismayu and Berbera. At Mogadiscio, 25 limekilns with a capacity of 0.5-1 ton per day exist near the limestone quarries. Soft limestone, which occurs between layers of sand, is quarried manually.

The limestone is burnt using either wood or charcoal. In the former case, logs and limestone are stacked in layers and built in the form of clamps; flues are provided for the escape of gases. Once the fire is lit, it takes 15 days to complete the burning. There is no absolute control of the burning operation. After cooling, water is sprinkled on the burnt lime for hydration. The other process is slightly more scientific. Limestone is burnt in a shaft kiln 4 m high and 1 m in diameter. Charcoal and limestone (over 5 cm in size) are fed in layers, and the burnt lime is drawn from the outlet at the bottom every hour during the day. Hydration is the same as in the other process. A large quantity of charcoal is consumed: one ton of charcoal per ton of lime produced. There is no quality control at any stage of the process. The lime produced is used for mortars and

Figure V. Bulls trench kiln used in West Bengal

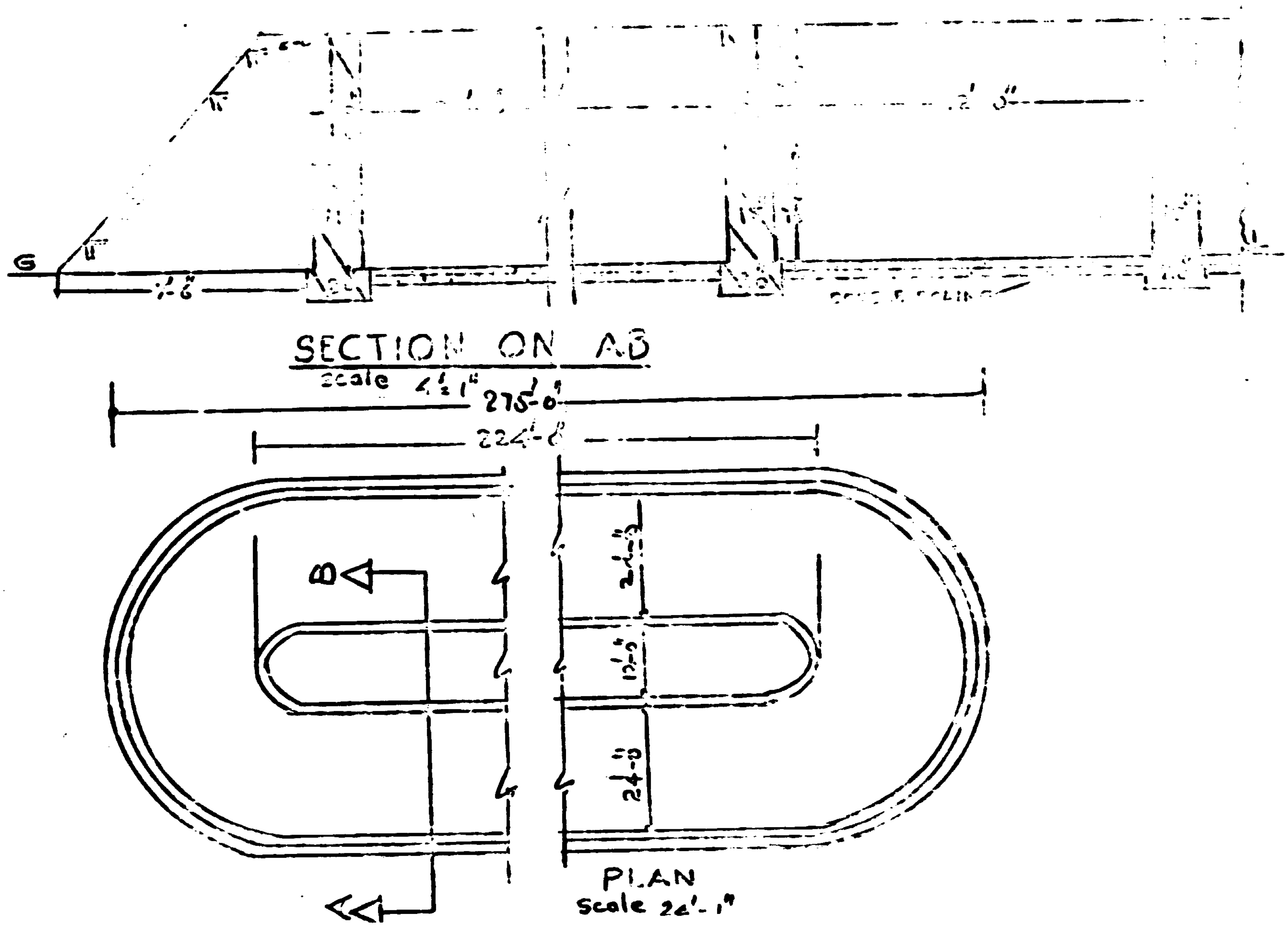
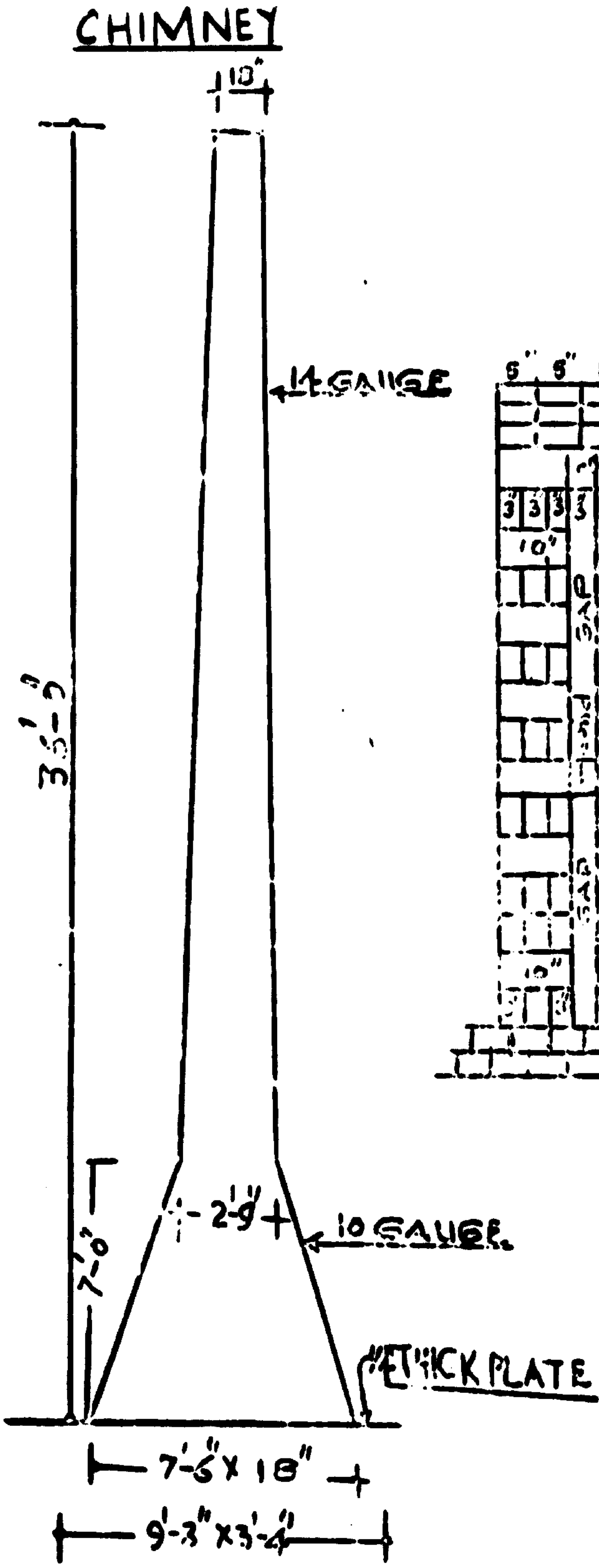


Figure VI. Loaded bricks in kiln, front elevation



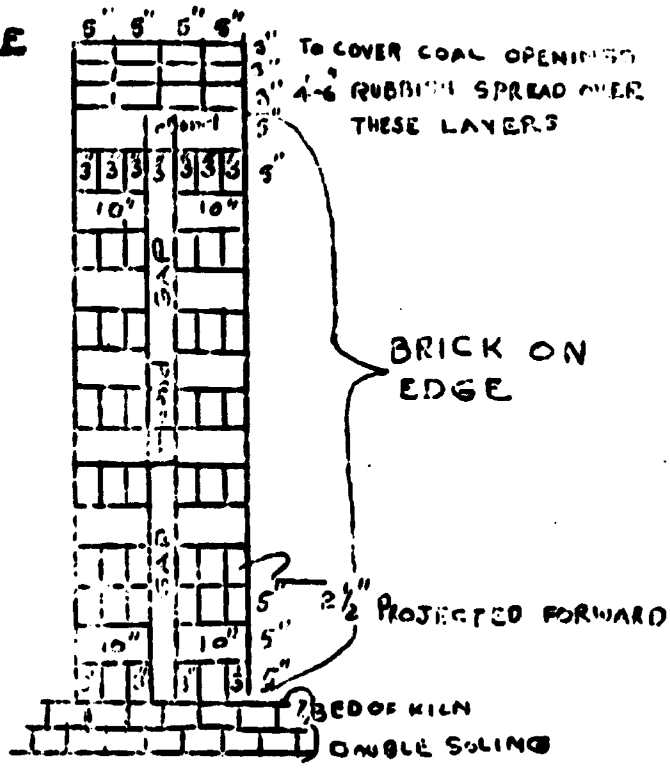
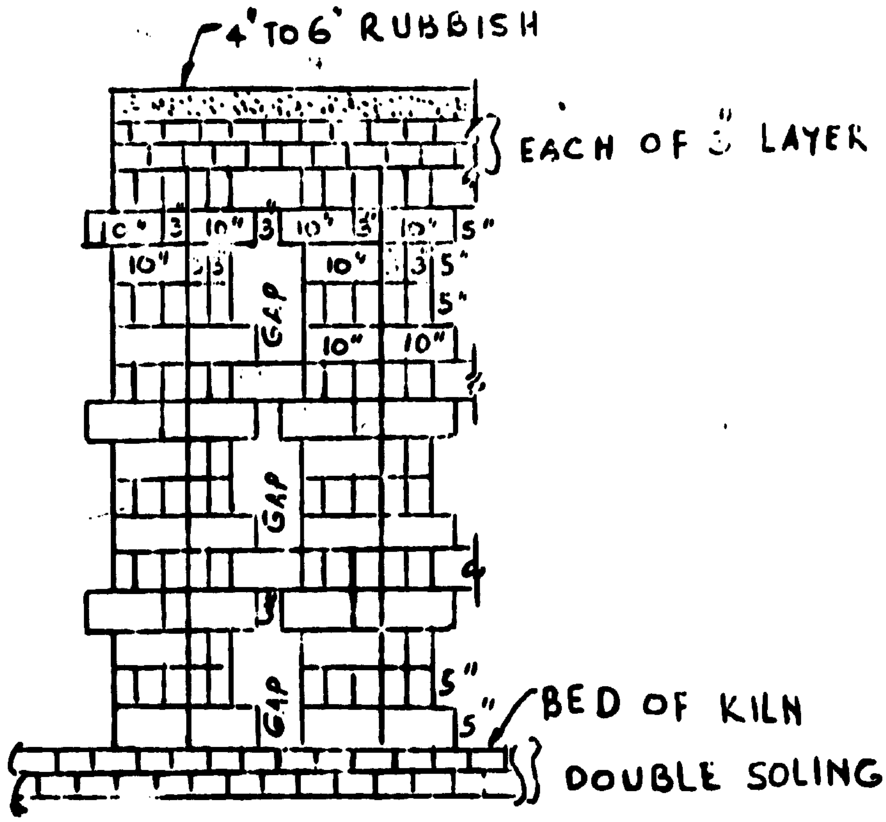


Figure VII. Loaded bricks in kiln, longitudinal elevation



white washing. Samples of limestone and lime produced in the Mogadiscio and Merca areas were tested at the mining laboratory. The available CaO (free CaO) varied from 17 to 36 per cent in the lime produced, indicating its poor quality. The limestone, however, is of good quality, containing 49-51 per cent CaO and less than 6 per cent silica and having a loss on ignition of about 41 per cent.

The total quantity of lime produced in Somalia is about 20,000 tons. If quality lime is available, the demand for lime will increase fourfold for building applications. It can be used as a partial or total replacement for cement and is also an important material for sand-lime brick production, sugar refining, leather tanning, and soil stabilization. About 30,000 tons of lime alone are required for constructing the Gelib-Golwein road. There is an urgent need to modernize lime production in Somalia.

Lime can be produced in smaller capacities more economically than cement. It is feasible to set up a commercial plant with a minimum capacity of 60 tons of lime per day and 35 tons of hydrated lime. Half of the 60 tons of lime produced, will be used for hydration and half will be ground and sold as it is in tin containers. Quotations were invited for such a plant from lime manufacturers in the Federal Republic of Germany, India, the United Kingdom of Great Britain and Northern Ireland and the United States of America. The prices quoted for the plant and equipment of the capacity mentioned above varied from $700,000 to $3,000,000. The lowest quotation was from India for mixed feed kilns and hydrator.

Because of the low investment, economic operation and labour-oriented process, it was considered best to establish a plant in Somalia based on the mixed feed kilns used in developing countries. An investment of SoSh 5 million is required for such a plant. The manufacturing process for dry hydrated lime is outlined below.

Limestone 7-10 cm in size and coal 5 cm in size mixed in a proportion of about 6:1 is fed to the top of the vertical shaft kiln about 15 m in height and with an interior diameter of 4 m by means of a skip hoist. The inside of the kiln is lined with 22-cm-thick refractory bricks, and the maximum temperature attained in the kiln is 1,100°C. The kiln operates continuously for 24 hours, and calcined material is drawn from the bottom of the kiln at regular intervals. The limestone fed at the top of the kiln takes 72 hours to reach the bottom, during which period it is completely calcined. The calcined limestone is screened to separate ash and uncalcined lumps. The calcined lime is then transported to the hydration plant. The hydration plant consists of three-tier double-shafted mixers. The calcined lime is fed to the top of the hydrator, which is installed at the height of about 6.5 m. Water is added to the quicklime, and the steam generated during the process is utilized in preheating the water used for hydration. The partially hydrated lime moves forward to the second hydrator. By the time it reaches the third hydrator, the lime has been completely hydrated and is in dry, powdered form. It is then further ground in a pulversizer fitted with a cyclone separator and is subsequently bagged.

To determine the location of the plant, limestone at Mogadiscio and Merca was studied in detail. The quality of limestone at Merca is better than at Mogadiscio. However, because of its market facilities and larger limestone deposits, Mogadiscio was selected as the site of the first plant to be set up in Somalia. The suggested location of the plant is by the Gezira power station, where limestone of good quality and suitable for burning in lime shaft kilns is abundant. It is estimated that 15 million tons of limestone reserves exist in this area. The quarrying of the limestone is simple because the hard limestone occurs in layers with sand. A limestone quarry for producing aggregate already exists where the mining operation is carried out manually. Only a bulldozer is used for quarrying and transporting the material to the stone crusher. Since stone-crushing equipment is already in the area and quarrying is simple, there is no need for any quarrying equipment and therefore none is included in the project proposal (annex IX). Limestone lumps 7-10 cm in size can be taken from the crushers, since the size of the aggregate required for the concrete and other applications is less than 5 cm.

Coal can be used as a fuel for the limekiln because coal has higher fuel parity as compared with fuel oil if the cost and the quantity required per ton of lime produced are considered. The coal can be obtained from India or Madagascar at c.i.f. Mogadiscio SoSh 160 per ton for good-quality coal of calorific value 7,000 kcal per kg. The present rate of fuel oil is over SoSh 1,000 per ton. Even after a refinery is set up at Mogadiscio and heavy furnace oil is available, it will cost about SoSh 700 per ton. The requirement of coal is about 80 per cent more than that of oil.

In view of the initial investment and the operating cost, it is advisable to set up a limekiln with a capacity of 60 tons per day based on intermediate technology suitable to developing countries having no local oil resources. The estimated cost of production of lime is SoSh 128 per ton excluding bagging charges. The sale price of ground lime and hydrated lime (excluding packing) could be SoSh 150 and SoSh 200 per ton, respectively, which would bring a return of 20 per cent on capital investment. A short-term consultant would be needed for this project.

Sand-lime bricks (calcium silicate bricks)

If lime of good quality is available, the next important building materials industry that has great scope for development and is based on local raw materials is the sand-lime brick industry. The sand dunes occurring 70 km from Mogadiscio and at Shalamboot for which no use has been found so far could be profitably utilized for producing sand-lime bricks.

The feasibility studies for the establishment of a glass factory in Somalia carried out by the Italian firm Gruppo Perotti indicate that silica sands occur 70 km from Mogadiscio, Shalamboot and Hargeisa. Table 2 gives the chemical analysis and petrographic examination of the samples collected.

Samples I, II and III are yellow and contain round, transparent quartz grains. They indicate alluvial formation. Sample IV contains only a few opaque quartz grains. Sample V is white containing mainly quartz grains.

The investigation indicated that the sandy deposits occurring 70 km from Mogadiscio and at Shalamboot and Hargeisa are suitable for sand-lime brick manufacture, although the particles are fine and round. Since the main consuming centre for sand-lime bricks is Mogadiscio, only deposits I and II were considered for the location of the sand-lime brick factory.

Sand-lime brick is a good structural material for buildings, as are clay bricks, and are more economical than the cement-sand blocks. The manufacturing process for sand-lime bricks consists of mixing the sand and lime in the required ratio (1:10) in a mixer. After the mixture has been kept in a reactor for 10-12 hours, it is pressed into bricks by a 200-ton capacity press and automatically transferred into trolleys and then transported to autoclaves. The sand-lime bricks are cured in the autoclaves under steam pressure of 16 atm and temperature of 195°C for 6-8 hours, after which they are ready to be used. A strength as high as 400 kg/cm^2 can be obtained for these bricks. An investment of about SoSh 10 million is required for setting up a plant with a capacity of 20 million sand-lime bricks per year. The cost of production of sand-lime bricks of 19 x 9 x 9 cm or any other standard dimensions will be SoSh 150-200 per thousand. The plant and equipment required are listed in annex X. Figure VIII shows the factory layout and figure IX a flow diagram of the process.

Table 2. Chemical analysis of samples of silica sands collected for feasibility studies (Percentage)

Component	I	II	III	IV	V
A. Chemical analysis					
SiO_2	92.6	91.7	93.12	34.19	98.80
CaO and MgO	0.27	0.49	0.30	22.0	0.03
Iron oxide	0.29	0.49	0.35	0.21	0.06
Al_2O_3 and TiO_2	4.01	6.65	3.58	2.83	0.77
Alkalies	2.4	2.89	-	-	0.03
Loss on ignition	0.26	0.33	0.32	27.33	0.31
B. Sieve analysis					
Particle size (mm)	I	II	III	IV	V
0.4	2.0	1.0	15.6	-	1.2
0.3	10.8	4.5	19.2	Traces	7.6
0.2	33.3	25.0	27.0	2.4	53.4
0.1	51.8	67.5	35.8	96.4	36.2
Less than 0.075	1.1	0.6	1.0	0.8	0.2

<u>Note</u>: I Collected from dunes 70 km from Mogadiscio on the Mogadiscio Merca road

II Collected at Shalamboot

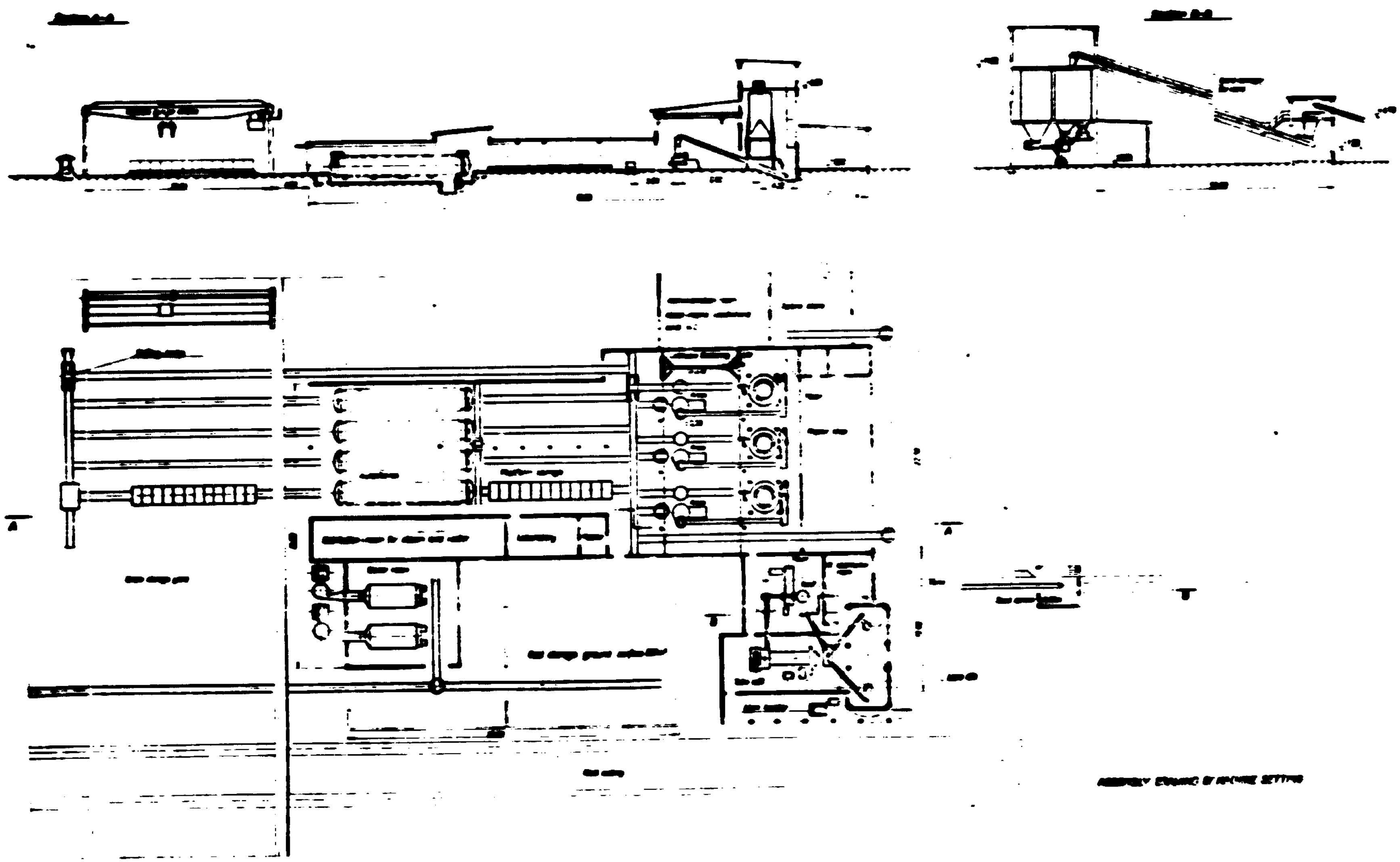
III Near Regional Government Office, Shalamboot

IV Near Lido, Mogadiscio

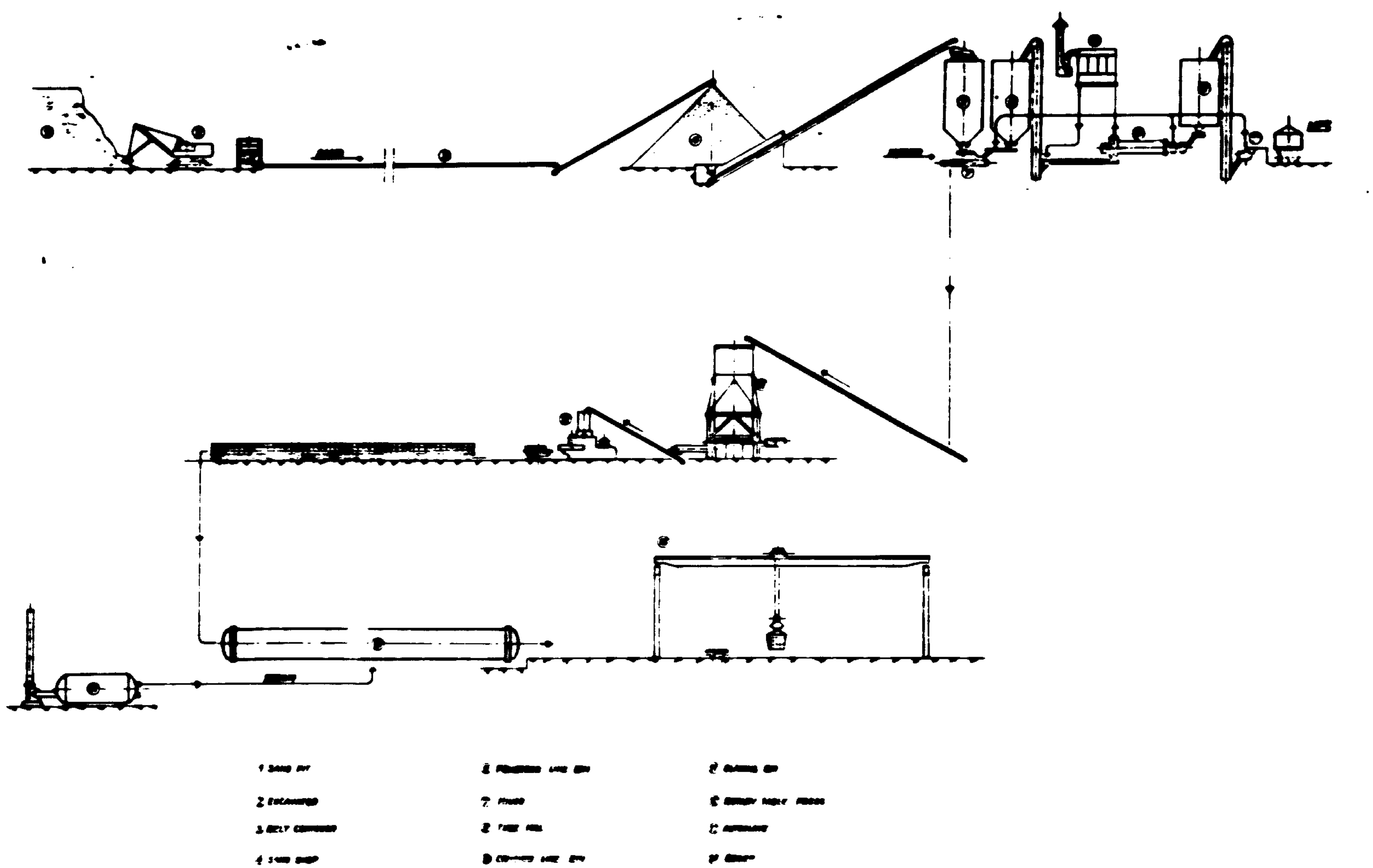
V Sample supplied by the Department of Mines, Hargeisa

The detailed data required for the feasibility study has, however, to be collected. The sand-lime bricks could be used for load-bearing purposes in the construction of multistorey buildings. The mortar used with these bricks is the common lime-sand mortar (1:2 ratio) for ordinary construction where the safe permissible load is less than 6 tons. For masonry in multistorey buildings a cement-lime-sand mortar with a ratio of 1:3:12 is recommended. No external

VIII. Layout for sand-lime brick factory



IX. Flow diagram of production process used in sand-lime brick factory



plaster is required for walls built with these bricks. Sand-lime bricks, however, have a higher coefficient of expansion than the clay bricks, as do sandcrete block and cement concrete products. This aspect has to be taken into consideration when using these bricks in building construction. Sand-lime bricks can be manufactured in several colours and having a strength of 150-400 kg/cm^2 depending upon the particle size of the sand used and the quantity of the lime added.

Light-weight aggregate (pumice)

Deposits of light-weight aggregate (LWA) are located 18 km south-west of Brava. LWA occurs over a 10-km length of the beach and over a width of 300 m. The aggregate's size range is 2-100 mm. It is found mixed with fine sand. The local workers dig to a depth of 1 m and take out the sand mixed with aggregate and dry it in the sun. After drying, the sand is sieved from aggregate through a 2-mm mesh. The aggregate is collected in gunny bags, which are transported to Brava by camel or lorries. Each bag sells for SoSh 3.50. Fifteen to 20 workers work the first km of the deposits. There is no proper approach road to the deposits.

The aggregate is used for the production of cement-sand LWA blocks used for walling material for single-storey construction at Brava. LWA is also transported to Mogadiscio and used for production of blocks meant to be used in the third or fourth storey of a building so as to reduce the dead load of the building. A detailed investigation of possibilities for developing a LWA building blocks industry using lime and LWA from Brava if quality lime is available is needed. The pumice (LWA) being a pozzolanic material, no cement would be required. The LWA blocks not only decrease the dead load when used in multistorey construction, which saves a considerable amount of cement and steel, but also have much better thermal insulation properties.

Support to geological survey of silicate raw materials

One of the main activities of the project was assisting in a survey of silicate raw materials. Detailed discussions were held with officials of the Department of Geology (Ministry of Mining and Water Resources) on the geological surveys of the silicate raw materials and the results obtained. The Ministry of Mining has given priority to the carrying out of a detailed survey of the kaolin, feldspar, and glass sand deposits during 1976. Survey teams have been posted in the Hargeisa area because the work carried out so far has given encouraging results about the quality and quantity of the deposits, and there are prospects of commercial exploitation. Reports on the preliminary geological survey on nepheline-syenite and cyanite minerals indicate that the deposits do not justify commercial exploitation. Detailed exploration of the asbestos mineral deposits is also important because asbestos is one of the major raw materials used for the asbestos-cement-roofing plant being set up in Berbera, and it accounts for approximately half the cost of the product. However, it is understood from the Ministry of Mining that low priority has been given to this work, since earlier work has not indicated any occurrence of sizable deposits except for some minor pockets. Along with the geologist of the Mining Department, the expert visited deposits of kaolin, feldspar, and quartz occurring in the Hargeisa area to collect mineral samples.

Kaolin

Kaolin deposits occur 50 km from Hargeisa on the Berbera road. The outcrop is located 250 m north of the road. The kaolin is of residual nature, and the disintegration products of the parent rock - quartz and mica - could be seen with kaolin. The pits dug at the outcrop show that kaolin is present at least to a depth of 3 m. The geologist reports that kaolin occurs over a length of 20 km along the contact. Samples of kaolin were collected at the outcrop and tested in the laboratory. Although the equipment for beneficiation of silicate raw materials, such as clay-washing plant, was not ordered owing to the cut in the UNDP budget for equipment, work was carried out with the facilities available. The yield of kaolin from the parent rock was as high as 60 per cent. The washed kaolin has plasticity - Pfefferkorn coefficient of 32 - and burns white at 1,000°C. It was further planned to collect bulk samples with the assistance of the Mining Department and to evaluate them to obtain confirmatory results, but the plan had to be abandoned. There is good scope for setting up a kaolin-washing plant with a capacity of 20 tons per day as an adjunct to the ceramic plant suggested below. Kaolin is the primary raw material the ceramic industry uses for producing tiles, sanitary ware and household articles. The paper, paint, and rubber industries also use it. Good-quality kaolin has an export market.

Occurrence of pegmatite containing feldspar and quartz is reported in the Lafa Rug - Hudiso area. Feldspar deposits near Hamas, which is 112 km from

Hargeisa on the Hargeisa-Berbera road, were visited. Large quantities of good-quality feldspar can be seen. Considerable exploitation of feldspar was carried out by a British firm long ago. Water is available in this area. Numerous large quartz boulders are also to be seen. The Mining Department is carrying out a detailed survey of these deposits. Samples of feldspar and quartz were collected for evaluation. These deposits offer the ceramic industries good scope for commercial exploitation. Detailed studies could not be carried out, since the laboratory equipment, crushing and grinding equipment (jaw crusher and ball mill) and thermal gradient kiln required were not received. This important activity, which started gaining momentum, had to be abandoned just when fruitful results were expected.

The Government is interested in setting up ceramic industries for the production of ceramic tile, ceramic sanitary ware and household articles. An Italian firm, Technical Consulting Engineers, submitted a project proposal for establishing a plant producing 750 m^2 of floor tiles per day, 1,250 m^2 of wall tiles per day and 500 tons of crockery per annum in the first phase and production of sanitary ware in the second phase. The investment was estimated at over SoSh 42 million for the first phase. Although possibilities for setting up a plant producing the above-mentioned building materials are good, the capacity suggested was very high. If the market potential in Somalia and the neighbouring countries is taken into account, a plant with a capacity of 1,200 tons per year would be appropriate. Suggested annual production would be 70,000 m^2 of floor and wall tiles and 250 tons of various products, such as household articles and low-tension insulators, to meet the present requirements and increased demand for the next 10 years. A 20 per cent spare capacity for export is allowed. The plant could be extended to produce annually 200 tons of sanitary ware. It would form the nucleus for future development of other ceramic industries, e.g. refractories from local materials - fire-clays or cyanite etc. An investment of SoSh 6 million is required (see annex XI). Further technical evaluation of the raw material is necessary for working out the detailed feasibility report. The Ministry of Mining is also carrying out a survey of raw materials in the Bur-Acaba area, where kaolin, feldspar and quartz etc. are reported to exist. Further investigations are necessary to consider setting up a plant at Mogadiscio using these raw materials on a small scale. First preference should be given to the ceramic industry in the Hargeisa area.

Mechanized brick plant at Afgoi

A modern brick plant has been set up at Afgoi, about 30 km from Mogadiscio. The plant has an installed capacity of 50,000 bricks per day and is producing perforated bricks with dimensions of 25 x 12.5 x 6.5 cm and 25 x 12.5 x 12.5 cm and hollow clay blocks with dimensions of 23 x 19.5 x 18.5 cm and 39 x 28 x 24 cm which are sold at SoSh 0.40, 0.90, 2.50, and 3.60, respectively. The plant has been financed by the Somali Development Bank. An investment of SoSh 9 million was made in 1973 for the purchase and installation of complete plant and equipment for production of bricks. More information about the plant is given in annex XII. The expert visited the brick plant several times. Samples of the products were tested from time to time. The results indicated that no proper quality control was carried out on production, since the compressive strength of the bricks varied from 80 kg/cm^2 to 190 kg/cm^2. The hollow blocks were of poor quality, having strength ranging from 50 to 60 kg/cm^2. Most of the hollow blocks had hair cracks and defects caused by lime modules (lime blowing).

In spite of the high selling price of the products, the plant is running at a deficit. The major problems it faces are as follows:

(a) Quality control of the raw materials (clay) at various stages of production is not exercised, since no laboratory exists in the plant;

(b) Each load of clay supplied to the plant varies in quality, since the bulldozer is used for winning the clay, and it cuts or digs the earth layer by layer instead of excavating all the layers from bottom to top and mixing the materials as an excavator does;

(c) Lime modules and organic roots are present in the clay;

(d) The capacity of some of the equipment installed (particularly the double-shafted mixer and kiln) does not match the capacity of the main production equipment;

(e) Only one line of production exists. If a breakdown occurs in any piece of equipment, the whole plant has to be shut down until it has been repaired. Such a procedure is uneconomical, since the drier and the kiln, which operate around the clock, must be fed continuously with wet and dried bricks;

(f) Demand is limited, owing to the high cost of production and the unawareness of the various construction agencies of the advantages of using these bricks.

The management of the brick plant approached the expert for assistance; but he could not do much, since the plant was closed most of the period of his assignment in Somalia. By the time work was taken up the project was prematurely terminated.

There is an urgent need to install a few machines, including an extruder and a roofing-tile press, matching the capacity of the main equipment. In this way the full capacity of the plant could be utilized, the goal being to make the plant economically viable. A further investment of SoSh 2 million is required. The plant and equipment required is listed in annex XIII. However, further details must be worked out.

Although the products of the Afgoi brick plant vary in quality, the perforated bricks produced have a minimum strength of 80 kg/cm^2 and can be used for construction of four- or five-storey buildings and factory buildings with load-bearing brick walls without using the costly reinforced concrete frame structure. The use of bricks for load-bearing purposes in such cases would result in a saving of 40 per cent of steel and a further saving of 20 per cent of steel in building construction and bring down the total cost. These bricks at present are only being used as filler blocks and facing bricks. The hollow clay blocks are, however, being tried for composite roofing slabs. There is need for a short-term consultant who could explain how the Afgoi bricks and the new items produced should be applied and train the local technicians to use building materials rationally to achieve economy in construction. Fellowships for training are also necessary in this field.

Sewage pipes

Drainage and sewer systems do not exist at present. The Government, however, has planned to set up a sewerage system for which detailed project proposals are being prepared. The consultants MacDonald and Partners estimate that for drainage purposes alone the initial requirement would be 400 km of pipes and a total demand of 1,600 km over a five-year period. It is expected that 75 per cent of the pipes would have a length of 1 m and the remainder a length of 1.25 m. At present, concrete pipes are produced to a very limited extent; clay pipes and PVC pipes are imported.

The clay pipe has been in use for 2,000 years in many countries. Clay pipes are superior in many respects, particularly because they are resistant to attack of natural chemicals present in the sewage and they can be produced from local raw materials. It may be possible to set up a clay-pipe manufacturing unit in the Afgoi area because suitable clay may exist there. Detailed investigation of the clay was planned, but it had to be abandoned owing to the premature termination of the project.

It is not advisable to diverse the production of the existing Afgoi brick plant by adding production of clay pipes, since the costly deairing extrusion machine (auger press) available is not suitable. A different one would have to be installed and additional capacities for mixing, drying and burning created. It is, therefore, suggested that if clays in Afgoi are found to be suitable after detailed investigation, a separate unit for manufacturing clay pipes should be set up adjacent to the existing brick plant.

Gypsum

Over 7 million tons of good-quality gypsum and anhydrate exist in Suriah Malableh, which is about 15 km south of the port of Berbera. The utilization of gypsum has been studied by various experts and consultants. A UNIDO expert suggested a step-by-step development programme beginning with a pilot scale processing plant for production of plaster of Paris (calcined gypsum), school chalk, medical plaster, plaster boards and panels. There is also scope for manufacturing fibrous plaster board, which is a thin board of plaster reinforced with sisal fibre. Based on the reports of UNIDO experts, UNDP has planned an integrated gypsum pilot project for the utilization of gypsum during 1977. It envisages the quarrying of 3,750 tons of gypsum per year and the establishment of a calcination plant of 300 tons per year to produce chalk-reinforced plaster, fibreboard and panels etc. The project could be enlarged so that annually 20,000 tons of gypsum would be quarried and 10,000 tons of calcined gypsum produced for ready-mixed mortars and plasters (lime, pozzolana, gypsum, sand), gypsum concrete blocks (calcined gypsum and pumice), and the moulds required for the ceramic industries already suggested and for foundries. Of the 20,000 tons of gypsum quarried, 5,000 tons will be consumed by the cement plant being installed at Berbera. There is also great scope for exporting calcined gypsum to Kenya, Kuwait and Uganda, where gypsum products are in great demand.

The Government was also considering the production of sulphuric acid and cement from gypsum as suggested by a United Nations expert in 1968. The minimum capacity of plant suggested was 100,000 tons of sulphuric acid per year, which would have required, in 1968, an investment of $20 million. The present cost would be much higher, and the project is not a feasible proposition, since there is not much demand for sulphuric acid in Somalia and in the neighbouring countries. Gypsum can be produced much more cheaply by using elemental sulphur, or, next best, iron pyrites. In the expert's opinion, the Somali Government will not take up this venture for some time to come.

Economic roofing materials

Roofing is one of the major problems of low-cost housing and buildings in Somalia. The traditional type of dwelling in farming villages on the Juba and Scebeli rivers, the mundal, consists of cylindrical walls covered with a conic roof resting on a wooden pole set in the middle of the house. Grass roofing on the wooden sticks is the basis of the roof, which is frequently renewed. In the arish type of house in urban areas, the roofing material is produced from palm trees and also needs to be replaced frequently.

In the slightly better type of house in urban areas, galvanized iron sheets and asbestos-cement sheets are used for roofing, which are very expensive (SoSh 60-70/m^2). Since the galvanized iron sheets are affected by weather and corrode badly, they need protective coating. The asbestos sheets are often damaged in transit if they have to be transported long distances.

Corrugated roofing sheets are made from asphalt and paper felt and are used in Argentina, Brazil, Mexico and other Latin American countries and India. They are also produced and used in Belgium, France and the Union of Soviet Socialist Republics. These sheets have proved to be a satisfactory roofing material in areas where temperature in the shade does not exceed 48°C. Asphaltic roofing sheets are light-weight and waterproof; they are not attacked by fungi and vermin as thatch or grass roofing is and provide better thermal comfort than asbestos-cement sheets and galvanized iron sheets. The roofing sheets are not brittle like asbestos roofing sheets, and there is little breakage during transport. Comparative thermal installation values of different roofing materials are given below.

Roofing material	Insulation value
Aluminium sheet	0.
Asphaltic shingle	0.15
Reinforced cement concrete, 200 mm thick	1.71
100 mm thick	0.71
Asbestos-cement sheet	0.21
Corrugated asphalt sheet	0.44

Asphaltic corrugated roofing sheets have become popular in India because the price of the material is one fifth that of galvanized iron sheets (SoSh 6/m^2). Five plants have been installed in India during the last five years. The process is mainly labour-oriented. About 200 workers in the plant produce 2 million m^2 of roofing sheets with a capital investment of SoSh 2 million. The specification for the corrugated roofing sheets manufactured by Light Roofing Ltd, Madras, India, is given in annex XIV.

Corrugated asphaltic roofing sheets consist essentially of "felt" or board impregnated with a suitable asphaltic medium and protected by a surfacing material The principal felt or board is generally manufactured out of scrap paper, cotton rags and lint. The organic fibres in combination with other materials that can be used in the production of felt are sawdust, straw, bagasse and coconut fibres. The second basic raw material used as an asphaltic impregnating medium is standard grade paving asphalt. Mineral granules, aluminium foil, and aluminium paint are used to protect the surface of the roofing sheets.

The process may be described briefly. The waste paper and other fibrous materials are soaked overnight in water in a soaking pit. The soaked paper is then fed to a hammer mill from which the pulp flows by gravity into a tank at the ground level. The pulp is then lifted by a pump to an overhead tank and then passes through a series of baffles and is fed to a finer hammer mill. It again passes through a series of baffles and through a feeding chute to tanks feeding the forming machines. The board, when formed of the required thickness, is stripped off and stacked on pallets and dried in the drying chamber or in the sun. The dry sheets are wetted, trimmed, corrugated and impregnated with an asphalt bath maintained at a temperature of 55°C. After curing, the sheets are dipped in aluminium paint.

There is good scope for producing asphaltic roofing sheets at Mogadiscio, since the refinery is in the process of being established at Mogadiscio and considerable spare capacity of the corrugated board industry set up at Kismayu is available. Detailed studies, however, must be carried out in this field.

Asbestos-cement roofing plant

The asbestos-cement roofing plant is located 12 km from Berbera on the Berbera-Burao road. The plant has a capacity of 60 tons of roofing sheets per day based on three shifts of 8 hours, or 1.8 million m^2 of roofing sheets per year. The estimated investment is SoSh 9.97. The expert visited the plant, which is under erection, in March 1976. His findings and suggestions were conveyed to the Ministry of Industry. The situation, described below, has not changed since then.

The plant and equipment are being supplied by Interasbest-Zement Anlagen, Austria, at a cost of S 14,560,000 ($780,000), which includes the cost of steel structures for factory buildings, electric generators, erection and supervision, and training of technicians. The agreement was signed in July 1974 for the supply of equipment. The dimensions of the land acquired for the factory are 200 x 75 m. The civil works, including foundations for the machinery, is being carried out by the Somali Construction Agency at an estimated cost of SoSh 2.45 million. The construction costs are higher in the area than in Mogadiscio because most of the building materials have to be imported, water is scarce and skilled workers - masons, carpenters, welders etc. - cannot be obtained locally. At the time of the visit the factory shed (140 x 20 x 7 m) had been completed. The imported steel strusses for the roof had arrived in bad condition, which had caused difficulties in erecting the roof. The office, canteen, electric sub-station, water storage tank and silos had still to be completed.

Almost all the machinery except the piping had been received and was under erection. The construction of the agitator, which was supposed to be made of reinforced concrete by Somali engineers, had not been started. Importing an agitator made of steel was being considered. The procurement of the agitator, special piping and the electrical cables etc. would cause a delay in completing the erection of the plant and quipment.

Raw materials

The major raw materials required in the production of roofing sheets are Portland cement and asbestos fibre. The ratio of fibre to cement (by weight) is 1:7. The machinery suppliers who have guaranteed the production have insisted that the Portland cement should conform to British standard (B.S.) 12/1958 and that it should not contain any free lime (CaO). The cement without any free lime is rather difficult to obtain. The B.S. and ASTM specifications for Portland cement do not specify total absence of free lime. These specifications, however, include a "soundness" test, which only limits the presence of free lime. Therefore, this matter should be clarified with Interasbest-Zement.

The decision to locate the asbestos-cement roofing plant was based on the assumption that a cement plant would already be established at Berbera and on the reported occurrence of asbestos fibre of good quality in the neighbourhood. The cement plant is now in the initial stages of erection, but it may take another two years to start the production and market it. Although asbestos forms only 12-14 per cent of the batch composition, its cost constitutes 50-60 per cent of the cost of the asbestos-cement products. So far, asbestos deposits in sufficient quantity to be economically exploited have not been found. The production of roofing sheets will depend on imported cement and asbestos for the next two years at least.

About 360 tons of asbestos of three types - P-5-65 (5 M), P-4-20 (4) and P-3-60 (4 T) - have been imported from the USSR. The blue asbestos Canadian fibre has not been received so far. The proportions of various types of asbestos fibres for production of roofing sheets indicated by the machinery suppliers are (per cent):

Grade 4 T	55
Grade 5 M	35
Blue asbestos	10

For approximately 60 days of production, 500 tons of asbestos, including 140 tons still to be received, would suffice. The water and power requirements are 12-15 m^3 per day and 200 kW, respectively.

Process

The process adopted in the plant may be described briefly.

The asbestos is ground in an edge runner to loosen the fibres. A weighed quantity of ground asbestos is fed to the mixer, a concrete cylindrical vat where a sufficient quantity of water and the required quantity of cement are added and mixed. The slurry containing asbestos-cement water passes to the agitator, which serves as a storage tank and homogenizer. The prepared slurry is led to two filters with special valves and vacuum pumps. At this stage the slurry is fed to drums with perforations (sieve cylinder) rotating in a cylindrical vat, and it forms a thin layer around the drums. The layer of the asbestos cement is then transferred to the sheet-making machine by special rollers installed and to an endless belt, which passes through the suction chamber, where part of the water is removed by vacuum pump. The thin sheet of asbestos-cement from the belt rolls itself on the forming roller. The asbestos-cement sheet then passes to the trimming, corrugating and piling plant.

All the operations up to this stage - preparation, filtering and pumping, suction and sheet making, trimming, corrugating and piling including recirculation of waste water from filters and depulping - can be automated. In the last stage of production, the roofing sheets are handled manually, and no provision has been made for proper curing under controlled humidity and temperature. This decision was probably taken to reduce the investment in the plant.

Curing is an important operation for producing a product of good quality. In Berbera the temperature reaches 45°C and humidity is low in the summer, which could cause a serious problem and result in considerable production losses. An inexpensive method of curing is to pass the corrugated sheets from the trimming and corrugating plants through a tunnel where high humidity is maintained for the first 24 hours.

The following suggestions were made:

(a) The specifications of Portland cement regarding free lime should be ascertained from Interasbest-Zement;

(b) Long-term arrangements should be made for the supply of asbestos fibre, since the price of asbestos in the international market has been increasing considerably during the last three years;

(c) A curing chamber is essential and should be designed and constructed for production of products of good quality;

(d) A production manager, preferably a chemical engineer, and two foremen (mechanical, electrical) should be appointed immediately so as to be associated with all stages of erection, trial production and regular operation and trained to take over the plant from the experts of Interasbest-Zement;

(e) Diversification of products - manufacture of low-pressure and high-pressure pipes, rainwater drainage pipes etc. - should be undertaken to reduce imports of asbestos to meet the local requirements. Low-quality, short-fibre asbestos (amphibole variety) could be advantageously used with a mixture of long-fibre asbestos. Occurrence of the amphibole variety of asbestos has been reported in the Dohl, Mora and Bawa areas and there is scope for their exploitation.

Cement plant at Berbera

The expert visited the cement plant at Berbera, which is under construction, in March 1976. The findings and suggestions for the implementation of the project were submitted to the Ministry of Industry and are given below. SoSh 68.4 million has been allocated for this project.

The cement plant is being constructed 700 m from the asbestos-cement roofing plant in an area of 200 x 200 m. The plant has a capacity of 100,000 tons per year and is being established with the assistance of the Democratic People's Republic of Korea, which has assumed responsibility for civil works and machinery and their erection and operation. Thirty-six experts from that country are on the job. Work on the project was started in October 1975; the erection of the plant is expected to be completed by the middle of 1977. The stores, office, and canteen buildings are under construction. The major building materials - cement, steel and roofing sheets etc. - are supplied by the Democratic People's Republic of Korea.

The major deposits of the raw materials - limestone, clay and gypsum - which are sufficient to meet the plant requirements for 30 years, are located in the adjacent hillocks 3-4 km from the factory. The wet process has been adopted for cement manufacture reportedly because dry-process equipment for this capacity is not manufactured at present in the Democratic People's Republic of Korea or in Romania, which is the supplier.

The major problem anticipated with the wet process is meeting the water requirements, about 3,000 m^3 per day. The town's water supply at present is only 300 m^3 per day. Not enough water sources have been located so far.

The expert visited the following three sites of water supply:

(a) About 15 km from the cement plant. The seepage water from the adjacent hillocks is collected in a shallow pond 0.5 m in depth. Approximately 200 m^3 of water per day is available from this source;

(b) Water supply station for Berbera. The seepage water from the surrounding hills is collected in 16 wells located on inclined ground at the base of the hills. The wells are connected by cast-iron pipes, and the water from these wells is supplied to the town by the flow of gravity;

(c) Hot sulphur springs located 50 km from Berbera. A shallow stream of hot water flows from a canyon into the plains. The water is hotter higher up the stream. This water is not likely to be suitable owing to its acidity caused by reaction with the sulphur-bearing minerals.

In localities where the supply of potable water is scarce, the dry process is generally adopted for cement manufacture. The consumption of water in the dry process is less than half of that in the wet process. In addition, the consumption of fuel is 40 per cent less and the cost of production is lower. Because of these economies, new cement plants set up in developing countries and in industrially advanced countries use the dry process and have large capacities.

Consumption of cement in Somalia has risen considerably and is now about 120,000 tons per year. Setting up a larger plant is justified, since cement is a versatile construction material. The more cement is produced the more is consumed. It is considered an economic indicator in developing countries.

Therefore, large-capacity plants can be recommended for cement manufacture by dry process at Berbera. Since the consumption of cement in Berbera is much lower than it is in Mogadiscio, the plant at Berbera could produce mainly clinker. The clinker would then be transported to the major consuming centres like Mogadiscio, where it would be ground with gypsum in clinker-grinding plants that would be set up. This method would reduce the transport losses and transport costs because the clinker could be transported and stored in the open. The clinker does not deteriorate in storage even if stored for over a year. Cement has to be transported in bags, stored free from moisture and used within six months of production.

If plans can be revised, a plant with a capacity of 2000,000 tons or more of clinker per year by dry process should be installed at Berbera instead of the planned 100,000 ton-per-year plant using the wet process. A second plant should be set up at Mogadiscio.

The clinker-grinding capacity at Berbera may be limited to meeting the cement requirements in Hargeisa and vicinity up to the distance cement could be transported economically.

A clinker-grinding unit with a capacity of 100,000 tons per year should be set up at Mogadiscio to meet the cement requirements in the area.

A smaller-capacity clinker grinding plant should be set up at Kismayu later, depending upon the requirements.

Any clinker remaining could be exported to neighbouring countries, such as the United Republic of Tanzania, where a cement shortage still exists.

The present position is that most of the machinery has arrived at the site, but the project implementation has been stopped until the water supply has been assured.

<u>Timber</u>

Timber is one of the major elements of housing and buildings. Most of the timber required is imported. During 1974, timber worth SoSh 27 million was imported. The price of the timber has skyrocketed to SoSh 1,800-2,000 per m^3 (SoSh 1,200 per m^3 in 1975). Therefore, the cost of imported timber also contributes to the high cost of building construction in Somalia. The timber resources in the Erigavo/Mait area, Kismayu and other places are not properly exploited. It is essential to develop and use local timber to cut the import bill. A wood technologist is needed to carry out studies in this field.

Training of local staff

Very few facilities exist for training local staff to develop and use properly the new and improved materials suggested in this report. Although two fellowships were included in the project document, they were not awarded because of the financial constraints. Provision of fellowships in this field is absolutely necessary. During the period of the expert's assignment, the counterpart project director worked on the project for a period of only two months. The second counterpart, a chemist, was very co-operative. He was trained to test and carry out quality control of the imported and the locally produced materials and to evaluate raw materials using the available facilities.

II. RECOMMENDATIONS

1. Production of 10,000 soil-stabilized blocks per day should be started at Dujuma immediately by installing 10 CINVARAM presses (annex VII), since no alternative building materials for walls can be produced from local soils because they are very sandy.

2. Production of clay bricks should be undertaken by using coal for burning the bricks in the open trench kilns (annex VIII). The production of bricks by this method is most economical. A short-term consultant should be provided for this work.

3. One commercial-scale production plant with a capacity of 60 tons of lime per day should be set up at Mogadiscio next to the Gezira Power Station for the production of lime and hydrated lime. It would serve as a production-cum-training centre for setting up similar plants in other areas. A short-term consultant would be necessary for this project.

4. A detailed feasibility study for setting up a sand-lime brick plant with a capacity of 20 million bricks per year should be carried out, since there is great potential for this industry, based on local sand from the dunes occurring 70 km from Mogadiscio and at Shalamboot.

5. Systematic production of blocks made of light-weight aggregate (LWA) using lime and pumice available at Brava should be undertaken, since these blocks are an economical building material for single-storey construction at Brava and a useful material for insulation and for reducing the dead weight in the multistorey construction at Mogadiscio.

6. Greater emphasis should be given to technological investigation of silicate raw material as a support to the geological survey being carried out by the Department of Mines. There is good scope for commercial exploitation of kaolin, feldspar, quartz and gypsum in the immediate future. A 20-ton kaolin washing plant should be set up at Hargeisa as an adjunct to the ceramic industry.

7. A ceramic plant with a modest capacity of 1,200 tons per year should be set up to produce annually 70,000 m^2 of wall and floor tiles and 250 tons of various ceramic products - household articles and low-tension insulators - to meet the present requirements as well as future demand. Later the plant could be extended to produce 200 tons of ceramic sanitary ware. It should form the base for future

development of other ceramic industries in Somalia. Further technical evaluation of the raw materials is necessary for working out the detailed feasibility report.

8. The establishment of a laboratory for quality control and for diversification of the Afgoi brick plant should be given high priority. The equipment listed in annex XIII should be installed.

If the plant begins to produce roofing tiles, its full capacity will be used and it will be economically viable.

9. Training of engineers and technicians in the proper use of new and improved building materials should be introduced with a view to achieving economy in building construction.

10. Detailed feasibility studies should be carried out with a view to setting up clay pipe manufacturing units adjacent to the Afgoi brick plant.

11. A project for quarrying 20,000 tons of gypsum and for producing 10,000 tons of calcined gypsum per year should be set up for use as ready-mixed mortars and plasters, gypsum concrete blocks etc.

12. Since there is scope for producing economical roofing material - asphaltic corrugated roofing sheets - at Mogadiscio from asphalt from the proposed refinery and corrugated board from Kismayu, a detailed study on production should be undertaken immediately.

13. A curing chamber should be installed in the asbestos-cement plant under construction at Berbera to avoid production losses. Diversification of production, i.e. pipes for the water supply or rain-water drainage could be considered to utilize the low-quality asbestos available in the country.

14. A cement clinker plant with a capacity of 250,000 tons per year based on the dry process should be set up at Berbera, and clinker should be transported to major consuming centres like Mogadiscio, Kismayu, where clinker-grinding plants should be installed.

15. A programme should be initiated with the goal of better utilizing the local timber available. An integrated plant for seasoning, treatment and joinery for production of doors and windows should be established in Mogadiscio.

To implement these recommendations, it is essential that the Government be provided with a certain amount of technical assistance. The volume and duration of such assistance will depend on the extent to which the Government wishes to implement the proposed programme and on the amount of funds available. The following should therefore be taken only as a tentative guide to the future assistance recommended by UNIDO:

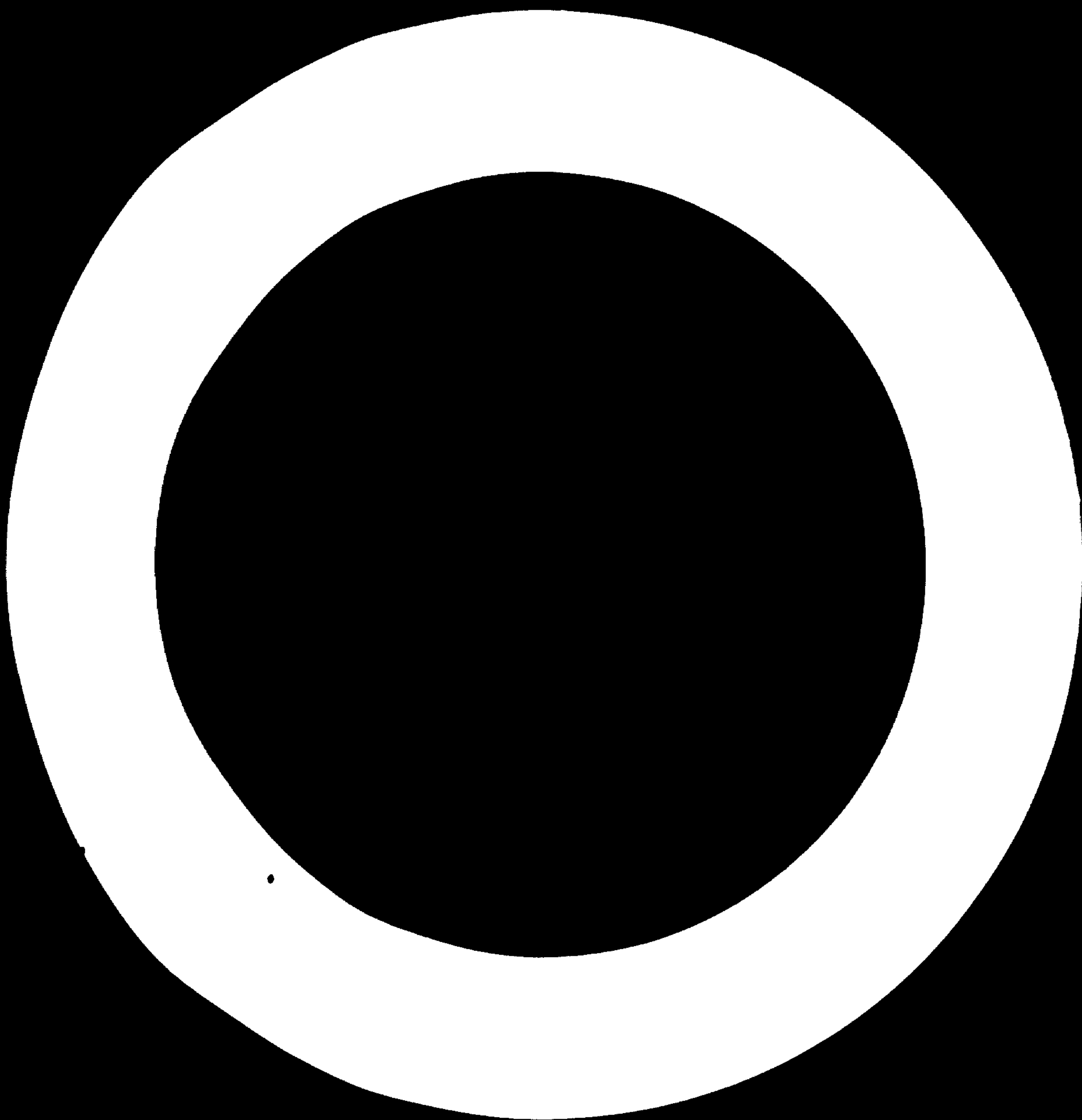
Project title: Development of an integrated national building materials industry

Duration: Three years

Objective: To implement part or all of the above-listed recommendations and particularly to assist in all aspects of the planning and establishment of a range of building materials industries based as far as possible on local raw materials.

UNDP input:

	Item	Duration (man-months)	Cost (thousand dollars)
11-01	Project co-ordinator, building materials expert	36	144
11-02	Ceramics expert	12	48
11-03	Gypsum expert	12	48
11-04	Clay-brick expert	3	12
11-05	Lime expert	6	24
11-06	Construction expert	3	12
11-07	Consultants	6	24
13	Local support personnel		15
15	Local travel		10.8
16	Staff member travel		4
19	Component total		341.8
21	Subcontracting (testing)		30
39	Fellowships (total)	24	26.4
42	Equipment as per annex V plus four-wheel drive vehicle		50
59	Miscellaneous		10
99	Grand total		457.2



Annex I

BUILDING MATERIALS REQUIRED FOR HOUSING PROJECTS FOR DROUGHT-AFFECTED FAMILIES IN SOMALIA

The drought in Somalia is the latest in a series of droughts that has spread across Africa in recent years. In December 1974, the Government evaluated the assistance needed and organized relief camps for 200,000 persons affected. Settlements are planned in the agricultural areas of Kurthanwary, Sablaale and Dujuma, which are located near the Shebeli and Juba rivers. Settlements at Brava, Adale and Eil are also planned in the fisheries sector. These are linked with the development of fisheries.

It is proposed to provide each family with a house site 100 m^2 in area. The house will have one bedroom (16 m^2) and one multipurpose room (36 m^2) with a front verandah 1 m wide. Each 10 houses will form a cluster in an area of 1,800 m^2 and will be provided with common facilities. Five such clusters will form a compact unit. A community centre is planned for each 800 families. Model houses have been evolved, and maximum stress is laid on the use of locally available building materials such as soil, coral stones, sand and lime, and the construction is to be carried out by self-help labour in the settlements. Soil-cement/lime-stabilized blocks and burnt-clay bricks using local soils have been developed as masonary material.

The settlements cannot be established unless adequate housing is provided. The constraints have been lack of an adequate supply of wood for brick burning, cement for soil-stabilized blocks, timber for doors and windows and roof structure, galvanized iron sheets, asbestos-cement sheets, building hardware etc. Data on the materials that must be imported for building 30,000 houses for the settlements are given below.

Imported materials required	Quantity	Cost (SoSh)
Coal for brick burning	35,000 tons	5,250,000
Iron sheets 8-16 gauge for chimneys for brick burning	150 tons	375,000
Cement for producing soil-stabilized blocks, mortar etc.	20,000 tons	15,000,000
Timber for roof structure	30,000 m^3	36,000,000

Imported materials required	Quantity	Cost (SoSh)
Timber for doors and windows	7,500 m^3	9,000,000
Galvanized iron, asbestos-cement roofing sheets	1.6 million m^2	33,000,000
Round mild steel bars, for RCC plates for rural lavatories etc.	500 tons	1,250,000
Binding wire	100 tons	300,000
Galvanized iron pipes and fittings	50 tons	250,000
Hardboards	500,000 m^2	5,000,000
Paint and varnishes	50 tons	200,000
		108,575,000

Annex II

DATA ON BUILDING MATERIALS IMPORTED IN 1974

Type of material	Quantity	c.i.f. cost (SoSh)
Timber	22,429 m^3	24,748,732
Plywood	147 tons	452,427
Hardboards	743 tons	1,426,051
Mild steel round bars	11,821 tons	26,503,628
Galvanized corrugated iron sheets	2,845 tons	7,638,052
Binding wire	600 tons	1,897,964
Iron wire netting	16 tons	254,220
Nails	1,268 tons	3,578,485
Tiles	75,432 m^2	2,679,274
Hardware	245 tons	3,199,871
Paints	876 tons	5,289,218
Iron pipes	1,269 tons	3,594,860
Pipe fittings	72 tons	393,574
Sanitary wares	102.6 tons	909,532
Asbestos-cement roofing sheets	23,000 m^2	516,230
Glass sheets	39,975 m^2	311,123
	Total	7[illegible],814,705

Source: National Trading Agency for Construction Materials, Mogadiscio.

Annex III

PROJECT PERSONNEL

		From	To
A.V.R. Rao (India), expert in building materials		23 September 1975	October 1976
G. Bechtold (Federal Republic of Germany), associate expert in building materials		14 September 1975	July 1976
Essa Salah Ahmed	Project director	September 1975	January 1976
Mohamed Hassan Egeh	Technologist	October 1975	October 1976
Farah Buh Gudel	Laboratory technician	October 1975	October 1976
Mohamed Omar Ali	Laboratory technician	December 1975	October 1976

Annex IV

UNDP-FINANCED SUPPLIES HANDED OVER TO THE GOVERNMENT

Item		Quantity
Svensk Byggkatalog (Swedish Building Catalogue)		6 volumes
Plasticity tester (Ton Technik), with moulding equipment and 2 brass plates		1
Analytical Balance METTLER H. 315		1
Air oven Baird and Tatlock, Unitem large		1
Universal ball mill model UB-31		1
Pots with balls with diameter (mm):	300	3
	210	3
	150	3
	90	3

Operation instructions for the above-listed equipment

Annex V

EQUIPMENT REQUIRED FOR THE BUILDING MATERIALS LABORATORY

Priority list - 1 Item	Cost (dollars)
1. One jaw-crusher: output 20 kg/h	1,700
2. One electric furnace, 350 x 350 mm, maximum temperature 1,350°C	1,300
3. Two particle-size apparatuses (Andereasen pipets)	80
4. One autoclave, capacity 20 litres, 12 atm pressure, maximum temperature 300°C	3,600
5. One pH-meter (range 2.12)	300
6. One viscometer, universal torsion suitable for ceramics	200
7. One clay making and filtering unit suitable for producing approximately 40 lb (18 kg) of clay per pressing with blunger, vibrator shifter, funnel-type magnet filter, storage tank, pump and filter press	10,000
8. One horizontal thermal expansion apparatus	1,600
9. One temperature gradient kiln	3,500
10. One tensile tester	2,500
11. One vicat apparatus with moulds	250
12. One vibrating machine	1,600
13. One Le Chatelier tester	10
Priority list - 2	
1. Bricket tester (soil test USA)	1,300
2. Mortar band tester (soil test USA)	135
3. Blaine apparatus (soil test USA)	136
4. 100-mm-diameter barrel in line deairing pugmill	6,200
5. Abrasion test (soil test)	900
6. Motorized flow table (soil test)	600
7. Standard sand (100 kg)	
8. Sample bags and asbestos gloves	
9. Moisture reagent (soil test)	
Total	35,911

Annex VI

BOOKS AND TECHNICAL PUBLICATIONS REQUESTED FOR THE NATIONAL LABORATORY FOR DEVELOPMENT OF BUILDING MATERIALS INDUSTRY, MOGADISCIO

American Society for Testing and Materials
1916 Race Street, Philadelphia,
Pennsylvania 19103, USA

Part 4: Structural steel; concrete reinforcing steel; boiler and pressure vessel plate. 1975. $21.

Part 10: Metals mechanical, fracture, and corrosion testing; fatigue, erosion; effect of temperature. 1975. $26.

Part 11: Metallography: nondestructive tests. 1975. $19.

Part 13: Cement, lime, ceiling and walls. 1975. $17.

Part 14: Concrete and mineral aggregates. 1975. $20.

Part 15: Bituminous materials for highway construction, waterproofing and roofing, and pipe; skid resistance. 1975. $28.

Part 16: Chemical resistance. Non-metallic materials, clay and concrete pipe and tile, masonry mortars and units, asbestos-cement products. 1975. $16.

Part 17: Refractories, glass, and other ceramic materials. 1975. $28.

Part 18: Thermal and cryogenic industry materials, building joint sealants, fire tests, building constructions; environmental accoustics. 1975. $28.

Part 19: Natural building stones, soil, and rock, peats, mosses and humus. 1975. $15.

Part 22: Wood, adhesives. 1975. $30.

Part 26: Gaseous fuels; coal and coke. 1975. $22.

Part 27: Paint-tests for formulated products and applied coatings. 1975. $26.

Part 28: Paint-pigments, resins and polymers. 1975. $17.

Part 29: Paint-fatty oils and acids, solvents, miscellaneous aromatic hydrocarbons; naval stores. 1975. $26.

Part 34: Plastic pipe. 1975. $18.

Part 35: Plastics-general test methods; nomenclature. 1975. $31.

Part 36: Plastics-materials, film, reinforced and cellular plastics; fibre composites. 1975. $24.

ASTM standards in building codes. 13. ed. 1975. $89.50.

Soil Test Incorporated
2205 Lee Street, Evanston,
Illinois 60202, USA

Concrete Testing Manual, Soil Test Cat. No. LT-742.

Crim, R. E. Clay mineralogy, Soil Test Cat. No. LT-717.

Dawson, Raymond F. Laboratory Manuals in Soil Mechanics, Soil Test Cat. No. LT-711, 2. ed. 1959.

Academic Press Inc.
Berkeley Square House,
Berkeley Square, London SW1, UK

Clews, F. H. Heavy clay technology. 2. ed. 1969. $5.

Methods of silicate analysis. 1965. $5.

Brick Development Assoc. Ltd
3-5 Bedford Row, London NC1, UK

Aldersley. Fuels, combustion and heat transfer. 1967. $1.80.

Atkinson, C. R. Clay winning and haulage. 1967. $1.80.

B.D.A. Technical Notes

Ford, R. N. Drying of bricks. 1964. $1.80.

Goodson, F. J. Clay preparation and shaping. 1962. $1.80.

Keeling, P. S. Geology and mineralogy of bricks clays. 1963. $1.80.

Rowden, E. The firing of bricks. 1964. $1.80.

West, H. W. H. The layout of bricks. 1963. $1.80.

Structural Clay Products Institute
1750 Old Meadow Road, McLean,
Virginia 22101, USA

Technical Notes on Brick and Tiles Construction

British Ceramic Research Assoc.
Queens Road, Penkhull,
Stoke-on-Trent, UK

Beach, D. C. Testing methods for brick and tile manufacture. 1974. $7.

This section mineralogy of ceramic materials. 1953. $4.

Transaction of British Ceramic Society.

Timber Research and Development Assoc.
London, UK

Brown, William and Henry. Particle board in building: A guide to its manufacture and use. 1971. $2.30.

Wood in building. 1971. $3.45.

<u>Benn Brothers Ltd</u>
154 Fleet Street, London
EC4A 2 DL, UK

Grimshaw, R. W. The chemistry and physics of clays and allied ceramic materials. 1971. $13.95.

<u>McLaren</u>
London, UK

Griffiths, R. <u>and</u> Radford, C. Calculations in ceramics. 1965. $2.50.

Annex VII

SCHEME FOR PRODUCTION OF 10,000 SOIL-STABILIZED BLOCKS AT DUJUMA

A. Work programme

1. Two sheds 15 m x 6.5 m each and levelled ground of 50 x 20 m should be provided by SCA as early as possible for starting the project.

2. As soon as the sheds are ready, 10 CINVARAM machines will be installed by the Ministry of Public Works within a week. Foundation concrete, machines and belts will be supplied by the agency.

3. One week after installation of the machines, the agency should provide the materials and labour required for starting the production as given in part B.

4. Training of local workers for production of blocks will be carried out by the Ministry of Public Works.

5. In testing and control of production of soil-stabilized blocks the Ministry of Public Works will assist the agency.

6. After two weeks of production the blocks will be ready for use in construction.

B. Materials, labour and building requirements for production of soil-stabilized blocks at Dujuma using 10 CINVARAM presses

1. Two sheds 15 m x 6.5 m each and materials required for the sheds
   - (a) Iron sheets: 120
   - (b) Timber: 6 m^3
   - (c) Nails

2. Leveled ground: 50 x 20 m

3. Concrete for foundations
   - (a) Each machine requires 0.24 m^3 of concrete
   - (b) Iron belts 15 cm in length and 10 mm in diameter: 50

Materials required for production

Cement: 50 kg (one bag) per 150 blocks (29 x 14 x 9 cm)

Lime: 50 kg per 150 blocks

Pickaxes, shovels, wheelbarrows

Wooden pallets, dimensions 40 x 20 x 2 cm 500

Tin cans with spray nozzle: 10

One 8-mm screen
One 3-mm screen

Wooden measuring boxes dimensions 100 x 50 x 33 cm and 30 x 30 x 25 cm, will be provided by the Ministry of Public Works

4. Labour

Six workers are required per machine

2 for moulding the blocks

2 for mixing the materials

2 for carrying the blocks and stacking

C. Step-by-step process of manufacture

Step

I. Procure the materials and equipment listed above before production of blocks begins.

II. Preparation of soil. Soil is dug and is broken up as much as possible during digging. It is carried to the mixing site and passed through 8-mm screen (5/16 in.). The oversize soil is crushed on the ground by tamping rods so as to pass through an 8-mm screen.

III. Fill two wooden boxes (dimensions, 160 x 50 x 33 cm) with sieved clay. Water is sprayed after about every inch of screenings. Adding water during the screening permits better distribution of moisture, which is important.

The quantity of water required is about 12 per cent. Add 70 litres of water slowly step by step.

IV. After the second screeing leave the soil-sand mixture in a pile overnight to obtain thorough moisture distribution.

V. The next morning, cement and lime are added in measured amounts to the soil as follows:

One box (30 x 30 x 25 cm) full of cement

Two boxes (30 x 30 x 25 cm) full of lime

Note: Hydrated lime has a bulk density of 700 kg/m^3 while cement has a bulk density of 1,400 kg/m^3.

Lime is sieved through 3-mm mesh before adding.

VI. After careful mixing the cement-lime-soil mixture, screen it through 3-mm mesh.

Note: Cement and lime should not be mixed with the soil until just before the blocks are made. The mixture should be consumed within one hour.

Fill the mould with the mixture using a triangular scoop. Two men are required to operate the machine to obtain proper compaction. While one removes the blocks from the machine and places it on the wooden pallets, the other fills the measuring scoop and pours the mixture into the mould.

To obtain blocks of uniform quality, special care must be taken to fill the mould each time with the same quantity of mix.

VII. Place the pallets with the blocks for the first 24 hours after making them in the shade under the shed.

VIII. After 24 hours place the blocks one above the other up to 10 blocks high only. Handle the blocks carefully, since they are likely to chip at the corners. Stacked blocks must be covered with wet gunny bags or grass and watered at intervals to keep the entire stack in cool dampness for the next seven days.

IX. After wet curing for seven days allow the blocks to dry gradually for one more week. The blocks are ready for use after two weeks of their moulding.

Annex VIII

REQUIREMENTS FOR PRODUCTION OF 3 MILLION CLAY BRICKS PER YEAR, OR 20,000 BRICKS PER DAY

Materials	Cost (thousand SoSh)
1. Bulls trench kiln (figure V)	10
2. Steel sheets for iron chimney and cover for the feed holes 2 tons	10
3. Coal of calorific value, 5,000-6,000 kcal/kg 600 tons	96
4. Wooden moulds, pallets, pick-axes and other implements	10
	126

Management and labour

A.	Supervisor	1
	Accountant	1
	Firemen	6
	Mechanic	1
		9

B.	Moulders and helpers	70
	Workers for loading the kiln	20
	Workers for unloading the kiln	20
	Workers for carrying water	5
	Miscellaneous	10
		125

Annex IX

PROJECT PROPOSAL FOR A LIME PLANT AT MOGADISCIO

Capacity:	60 tons of lime and hydrated lime per day (18,000 tons per year)
Location:	by the Gezira power plant, Mogadiscio
Capital investment:	SoSh 5 million (SoSh 4 million in foreign exchange)
Land required:	1 hectare
Working capital:	SoSh 300,000 (60 working days)

Capital outlay

	Cost (dollars)	Cost (SoSh)
1. Building and civil works		
(a) Office and laboratory building, 100 m^2 at SoSh 1,200/m^2		120,000
(b) Factory shed for hydration plant and storage, 300 m^2 at SoSh 1,500/m^2		450,000
(c) Time office and gate house, 20 m^2 at SoSh 1,000/m^2		20,000
(d) Roads and fencing and drainage		20,000
		610,000
2. Plant and machinery		
(a) Technical documentation	40,000	
(b) Limekiln, jaw crusher, skip hoist, including conveyor belt and electrical installations	270,000	
(c) Lime hydration plant, including pulverizer, electrical installation, conveyor belt	170,000	
(d) Freight, insurance etc.	60,000	
(e) Wages of experts, erection and factory trials	100,000	
	640,000	4,070,400
3. Laboratory equipment	10,000	63,600
4. Water supply and electrical installation, including overhead storage tanks		100,000
5. Vehicles		140,000
6. Miscellaneous items		
Furniture, stationery, office equipment etc.		25,000
	Total	5,009,000

Annual production

				Cost (SoSh)
1.	**Raw materials**			
	(a) Limestone	36,000 tons +5% wastage at SoSh	10/t	378,000
	(b) Coal	5,200 tons at SoSh	160/t	832,000
2.	Power and lighting	70,000 units	0 50 kWh	35,000
3.	Water	1.5 million litres	1/kilo	1,500
			Total	1,246,500
4.	**Salaries and wages**			
	Manager-engineer	1 24,000		24,000
	Control chemist	1 20, 0		20,000
	Administration and accounts director	1 15,000		15,000
	Administration and clerical staff	5 10,000		50,000
	Skilled persons	5 6,000		30,000
	Unskilled persons	30 3,000		90,000
			Total	229,000
5.	**Depreciation**			
	10% on plant and machinery, water and electrical installations			417,400
	4% on building and civil works			24,000
	20% on vehicles and laboratory equipment			40,000
			Total	483,400
6.	**Maintenance**			
	3% on plant and machinery			125,850
	2% on civil works			12,200
			Total	138,050
7.	Interest on capital investment at 6%			300,000
			Grand total	2,396,400
	Average cost of production per ton without packing charges			128.0

	Quantity (tons)
Production of calcined lime per year	18,000
Less 10% losses and rejection	1,800
	16,200
50% of lime will be hydrated, which will give hydrated lime	10,800

Return

		Amount (SoSh)
8,100 tons of ground lime at SoSh 150/t[a]		1,215,000
10,800 tons of hydrated lime at SoSh 200/t		2,160,000
	Total return	3,375,000
	Cost of production	2,396,400
	Profit before taxation	978,600

Return on capital investment = 19.5%

a/ Excluding packing.

Annex X

REQUIREMENTS FOR A SAND-LIME BRICK PLANT PRODUCING 20 MILLION BRICKS PER YEAR

Installed capacity	20 million bricks per year
Investment	SoSh 10 million
Working capital for 3 months	SoSh 0.6 million

I. Land required — 3 acres

II. 1. Plant and equipment	Quantity	Cost (million SoSh)
(a) Single jaw crusher, capacity 3-7 m^3/h	1	
(b) Ball mill, capacity up to 2 t/h, drum speed 25 rev/min	1	
(c) Air separator, diameter 1,800 mm	1	
(d) Automatic weighing batcher consisting of 2 weighing chambers, capacity 25 t/h and 5 t/h	1	
(e) Mixture reactor, capacity about 17 m^3/h, diameter 2.6 m, height 12.45 m	1	
(f) Automatic presser, capacity 2,700 pieces/h	1	
(g) Single girder overhead crane, hoisting capacity 5 tons, span 8 m	1	
(h) One-sided autoclave with other accessories, diameter 2 m, capacity 11 cars, working press 16 atm	3	
(i) Hardening platform railcars gauge 750 m	110	
(j) Gantry crane with other accessories, capacity 5 tons, span 16.5	1	
(k) Trough belt coveyor with accessories	5	
(l) Electromagnetic vibrating feeder with accessories	3	
(m) Vibrating screen, double deck	1	
(n) Bucket elevator with accessories	3	
(o) Screw conveyor with accessories	5	
(p) Steel silo, capacity 25 mm and 40 mm	2	
(q) Electronic maximal level indicator for silos and reactor	4	
(r) Flat gate valve	5	
(s) Double-shafted paddle mixer with accessories	3	
(t) Car shifter, capacity 2 loaded cars	1	

	Quantity	Cost (million SoSh)
(u) Special chutes with suppor ing structures		
(v) Cylinder air compressor, oil separator, compressed-air vessel and filter etc.		
Subtotal (approximate)		8.2
2. Civil works for factory and office building, including roads and drainage		0.8
3. Laboratory and maintenance workshop		0.4
4. Testing and technical documentation		0.6
Sub total		1.8
		10.0

III. Annual raw material, fuel and power requirements

	Quantity
(a) Sand	185,400 ft^3
(b) Lime	4,200 tons
(c) Water	31,000 gallons
(d) Fuel oil	200 tons
(e) Power	250 kWh

IV. Manpower requirements

(a) Skilled labour	11
(b) Semi-skilled labour	9
(c) Unskilled labour	12
(d) Management personnel	20
Total	52

Annex XI

CERAMIC PLANT FOR PRODUCTION OF FLOOR AND WALL TILES, HOUSEHOLD ARTICLES AND LOW-TENSION INSULATORS

Location:	Hargeisa
Capacity:	70,000 m^2 of floor and wall tiles 250 tons of household articles, low-tension insulators
Capital investment:	SoSh 6 million
Land required:	1 hectare
Working capital for 3 months:	SoSh 60,000

Capital investment

		Amount (thousand SoSh)
Buildings and civil works		600
Technical documentation, plant and machinery, including kilns and driers and erection		4,600
Laboratory equipment		200
Water and electrical installation		200
Vehicles		140
Miscellaneous		260
	Total	6,000

Plant and equipment

Item	Quantity
Jaw crusher 2 t/h	1
Ball mills 4 ft diam.	2
Ball mills 2 ft diam.	2
Pot mills	1
Blunger, vertical type, with fan and pump	2
Mixing arc	1
Filter press with 30 chambers	1
Disintegrator	1
Dry blender	1
Saggar press, hand-operated	1
Deairing plug mill	1

Item	Quantity
Jigger and jolleys	1
Semi-automatic hydraulic presses	2
Toggle presses, hand operated	2
Screw cutting machine for low-tension insulators	1
Spraying equipment for glazes	
Driers	
Tunnel drier for tiles	1
Wooden racks, plants for household articles etc.	
Furnaces	
Oil-fired tunnel kiln for tiles	1
Shuttle kilns for household articles etc.	2

Raw materials

Kaolin	400 tons
Feldspar	200 tons
Quartz	500 tons
Talcum	200 tons
Gypsum	40 tons
Fire clay	40 tons
Glazes, colours etc.	
Fuel consumption	700 tons
Electric power	400 kWh

Manpower

Technical	3
Managerial	3
Skilled operators	30
Unskilled operators	100

Annex XII

BRICK PLANT AT AFGOI

In 1973, the old brick plant at Afgoi, 30 km from Mogadiscio, was rebuilt. Modern machinery and a sophisticated drying system, except for a tunnel kiln and a double-shafted mixer, were installed at a cost of approximately SoSh 9 million. The machinery was supplied by well-known Italian brick machinery manufacturers. The factory manager, a civil engineer, and four skilled workers were trained in Italian brick plants. The plant was erected with the assistance of Italian experts. The plant management has entered into an agreement with the machine supplier whereby clay samples are to be evaluated regularly in Italy.

The installed capacity of the plant is 50,000 bricks per day, based on two shifts. The present production is reported as 40,000 bricks per day.

A survey of the clay deposits around Afgoi was carried out. Suitable clays for brick manufacture were reported to occur in abundance within a 5-km radius of Afgoi. The present clay pits are situated two km from the plant. The clay is won by bulldozer and transported to the plant by lorries.

The manufacturing process may be described briefly. The clay is fed to the box feeder installed at ground level. The raw materials - clay and sand - are proportioned in the box feeder, which supplies the raw mix at a constant rate to the processing machinery. The sets of primary crushing rolls are erected one below the other; and the raw mix from the box feeder falls into these crushing rolls, where it is reduced to 5.0 cm and 2.5 cm, respectively. The raw mix is conveyed by a belt conveyor (290 gradient) to the double-shafted mixer installed 1 m above ground level. Water is added to the raw mix with a double-shafted mixer, and the amount of water added is controlled mechanically so that the mass contains 20 per cent moisture. The clay mass then falls into high-speed rolls, where it is ground to 2.5 per cent moisture content. The ground mass is transported by belt conveyor to a vacuum extrusion press, where it is extruded. The extruded column having the cross section of the desired shape is cut automatically in three pieces at a time. The bricks and hollow blocks produced are conveyed further to the leader and finger cars automatically. No pallets are needed. The finger cars with bricks pass through tunnel driers 72 m long and with a capacity of 150 cars. Each car takes about 800 bricks. The humidity and temperature are controlled, which vary along the length of the drier - 36°C and

90 per cent humidity at the entrance and 80°C and 10 per cent humidity at the outlet of the drier. Drying time is 72 hours. The bricks are automatically unloaded and conveyed to the kiln department for setting up on the kiln cars manually. The drying losses are reported to be 15-30 per cent depending on the type of clay used. About 1.7 million kcal of heat is supplied to driers per hour. Heat is supplied to the driers by the burning chamber as well as by the cooling of bricks. The tunnel kiln for burning bricks has a length of 92 m. The capacity of the kiln is 24 cars; one car with a capacity of 2,500 bricks is drawn every hour. Naphtha is used as fuel for kiln, driers and power generators. Four transformers: 500 kVA, 250 kVA, two 110 kVA are installed that supply power not only to the plant but to the town of Afgoi.

Eighty-seven workers are employed, of which 14 are skilled, 65 unskilled, and 8 administrative.

About 5,400 litres of furnace oil costing SoSh 1.12 per litre is consumed.

The products and their selling prices are given below.

Product	Dimensions (cm)	Selling price (SoSh)
Perforated bricks	25 x 12.5 x 6.3	0.40
	25 x 12.5 x 12.5	0.90
Hollow clay bricks	23 x 19.5 x 18.5	2.50
	39 x 28 x 24	3.50

Annex XIII

ADDITIONAL EQUIPMENT REQUIRED BY AFGOI BRICK PLANT

Item

Automatic tile-cutting table, output 2,000-3,000 tiles/h

Automatic pallet loader for tiles with 16 racks

Fully automatic pallet loader for bricks (8 racks)

Double-shafted mixer, output 10-15 m/h

Finger cars and other transport equipment

Finger cars with 16 racks: loading capacity, 80-96 tiles

Hand-operated transfer platform with bridge

Electric transfer trolley: transport capacity, 2 loaded finger cars

Frame collector: output, 3,000-4,000 bricks/tiles/h

Hoffman kiln, 16 chambers using oil-firing system, capacity of each chamber 1,200 tiles

Artificial drier: 30 chambers, each with a capacity for 6,000 tiles

Annex XIV

SPECIFICATIONS OF CORRUGATED SHEETS MANUFACTURED BY LIGHT ROOFING LTD. MADRAS

1.	Size	4 x 2.5 ft corrugated diameter 1 in. pitch of corrugations
2.	Thickness	5 mm-6 mm nominal
3.	Weight	2.5 kg-3 kg sheet
4.	Asphalt content	About 45 per cent by weight
5.	Estimated useful life	Seven years, approximately
6.	Absorption of water per cent by weight	5 per cent (sample kept immersed in water tank for 24 hours)
7.	Percolation of water	After testing for 24 hours with 2 ft head of water in test tube, no apparent moisture could be detected on the reverse face of sheet.
8.	Beam strength at breaking	50 kg on a 2-foot span 100 kg on a 1-foot span
9.	Strength under impact of falling bodies	Can withstand a 3-kg hard load, such as brick or wood dropped on sheet from a height of 5 feet. The material can only tear, but will not shatter.
10.	Durability of aluminium paint in alternate wetting and drying tests	No visible deterioration of paint after repeated wetting and drying of sheet. Samples tested up to 100 cycles
11.	Frequency of repainting	Sheets need not be repainted after installation.
12.	Heat insulation	R.C.C. 4 in. slab .71 Asphalt roofing .44 A.C. sheets .21
13.	Fire protection	Fire protection covered by Clause "B" of National Board of United States Fire Underwriters, i.e. moderate protection against fire.

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