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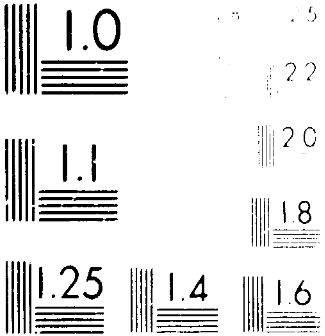
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Ethiopia

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Barun. C. Banerjee

UNIDO Building Materials Expert in Ethiopia

October 1982

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CHAPTER I

Summary and Conclusion:

1.1 On examination of the condition of various plant and equipments of Addis-Schekla Brick-plant, it is opined that the plant and equipments can be reactivated after repairing and overhauling and with replacements of certain equipments.

1.2 Tunnel kiln and dryer can also be repaired and put into commission, but the operation of these units with so much sophistication and automation cannot be relied upon in a developing country and there may be again break-down, resulting in stoppage of the plant. (as it happened number of times before)

1.3 Cost of repairing of Tunnel kiln may entail an expenditure of about 1.0 - 1.3 miliion Birr, where as constrction of Hoffman kiln of Ethio-brick specification to produce 8.5 million brick with dryers, will involve an expenditure of 0.9 to 1.0 million Birr.

1.4 In the light of above and also taking into consideration the following aspects, it is proposed to install Hoffman kiln.

a) Burning of bricks in Hoffman kiln is considered full proof in a developing country.

b) Already two Hoffman kilns are inoperation producing good quality bricks - where no major operational difficulties have been encountered.

c) Direct labour employment in Hoffman kiln is 30-35% higher compared to Tunnel kiln - which is of oparamount importance for this country.

d) In Tunnel kiln liquid and gaseous fuel can only be used where as in Hoffman kiln other fuels like wood, coal lignite and even industrial wasts can be used. Use of fuel other than mazut may not have immediate possibility in this country - but there is great possibility of utilising these fuels in near future.

1.5 With the above back-ground, techno-economic feasiability report had been formulated to produce 8.5 million bricks/annum running the green brick manufacturing unit in single shift and by constructing natural dryer of improved design and by installing a Hoffman kiln of same-specification as that of Ethio-Brick using mazut as fuel for which technical know-how is available.

1.6 There is apace available to accomodate single Hoffman kiln and natural dryer to produce 8.5 million bricks/annum.

1.7 The existing clay reserves at Addis-Schekla quarry will not be able to sustain the plant of 8.5 million bricks/annum capacity for more than two years, therefore it is proposed to bring the raw-materials from stelameda quarry - which is situated within 2.0 km. from Addis Schekla Brick-plant.

1.8 a) Cost of investment - 2275076 Birr

1.9 Cost of production per 1000 bricks:

		Birr
a) 100% utilisation of capacity	=	193.00
b) 90% " " "	=	203.00
c) 85% " " "	=	209.70
d) 80% " " "	=	216.8

1.10 Employment = 138 persons

CHAPTER 2

2.1 Back ground information of the plant:-

Inter kiln engineering provided engineering services, machinery, equipments, materials and labour, to build up Addis Shekla Factory at an estimated cost of 695,000 Birr. Factory construction completed in April 1970.

This is a most modern plant with sophisticated, automatic control system, particularly in drier and kiln sections. Inter kiln Engineering Inc. failed to comply with its constractual obligations in production.

2.2 According to interkiln's feasiability study, the capacity of the plant should have been:-

Daily production .... 84,000 bricks
Annual production .... 24,000,000 bricks
Break even point .... 51.1% production capacity

2.3 The production facilities installed by Interkiln Engineering to produce 24,000,000 bricks/annum, but maximum production achieved 5.7 million bricks a year.

This is only 24% of the planned production (24 million bricks).

2.4 Machineries and equipments installed by Interkiln Engineering Inc. were having Technical and operational deficiencies.

2.5 Successful commissioning was not effected for the following reasons:-

- The brick making machine was not producing even half of the specified capacity and all efforts to increase production failed.

- The triple track tunnel drier was not balanced and the re-circulating fans of the drier were not distributing heat as desired.

- Large quantities of bricks were cracking in the drier and kiln.
- The raw material ratio of the white and the red clay could not be established and all trial and error practices produced off graded bricks.
- The tips and nozzles of the kiln burners were damaged and controlled firing could not be achieved.
- The quality of bricks was so poor that customers opted to buy bricks from other factories.
- The downtine faced by the factory due to lack of spare parts and improper maintenance had played a major role in the crippling the factory financially and operationally.

Production:-

Ethiopian	year	1968	- 2.9	million	bricks
"	"	1969	- 3.2	"	"
"	"	1970	- 3.829		
"	"	1971	- 5.727	"	"
"	"	1972	- 3.921	"	"

2.6 Fixed assets of Addis-Schkla: as on 30th, June 1979 according to Audit report:-

	Fixed Assets	Cost Birr	Dep. Birr	Net Asset Birr
a.	Factory building & road	1,017,813.08	440,547.67	577,265.41
b.	Office building	87,470.91	39,726.13	47,744.78
c.	Office furniture & equip ments	21,350.75	11,055.87	10,293.89
d.	Plant & machinery	1,479,421.09	1220,249.96	259,171.13
e.	Machinery in transit	64,423.96	-	64,423.96
f.	Motor vehicles	103,799.98	91,264.65	12,535.33
g.	Tools	6,588.82	6,383.03	205.79
		2,780,868.60	1809,228.31	971,640.29

2.7 With the above background of the project, the condition of plant and equipments, were examined, to explore the possibilities of its reactivation to meet the growing demand of bricks.

CHAPTER 3

Present condition of various plant and equipment:-

3.1 Clay quarry:-

Availability of clay is approximately 31,500 m^3 (14mx150mx15m) which can be winned to produce, app. 16 million bricks. At the production rate of av. 8.5 million per annum, this quarry will not last more than two years. Therefore raw materials have to be transported from Stelameda quarry situated at a distance of app. 2.0 km. from Addis Schekla plant.

3.2 Clay winning:-

Condition of two Tax-cavators, are in working condition, but thorough overhawling will be necessary before these are put in operation.

3.3 The dumper and one Mercede trucks were working condition and the other trucks were out of commission as the motor was burnt out, before the plant was stopped.

3.4 Clay preparation:-

3.5 Hopper (M.S.) is in good condition:

Two types of raw materials Tuff and red clay are to be used in measured quantity, therefore, the hopper should be partitioned. It is proposed to install a jaw-crusher to crush hard tuff of Stelameda.

3.6 Screw-feeder:-

Shaft is in good condition, screw has worn out but can be re-paired and put into commission. Reduction gears are also in good condition. V'belts are required to be replaced. The screw feeders are to be modified to feed clay and tuff separatly in measured quantity.

3.7 Disintegrator:-

Ribs of the roller and roller body itself have worn out. Rollers have to be filled in by means of electrodes by welding and ground and smoothened and ribs have to be replenished.

Gear box is in good condition but 6 nos. 'V' belts have to be replaced.

3.8 Belt conveyor (Trough):-

Condition of belt is unsatisfactory and need to be replaced. Structure of belt conveyors and drive pullies are in good condition. Teeths of drive sprocket have broken. It is necessary to replace sprocket and chain. All ball bearing are in good condition.

3.9 Smooth roll crusher:-

The condition of roller bearings and other structures are in good condition. But the rollers surface have worn-out and become uneven. It will be necessary to grind the surface and shift the roller to maintain the gap not more than 2 m/m and also to overhaul other ancillaries. This is a vital equipment as quality of product is concerned.

3.10 Belt Conveyors:-

Belt conveyors is in bad condition and has to be replaced. The condition of seals of bearings are also poor. Belt conveyor, along with idealers, bearing and seals should be provided of the same design as that of conveyor no.1, as the existing design characteristic of the conveyor may give rise to operational trouble in future.

3.11 Hopper ahead of double shafted mixer is in good condition. This hopper will be used for souring of materials.

3.12 Double shafted mixer:-

The double shafted mixer is equipped with a gearbox, driven by 16 'V' belts. Conditions of gearbox and 'V' belts are good. Out of 33 mixing pedals - 10 are in poor condition need replacement.

3.13 Extruder:-

All auxilliary components of extruder are in good condition.

3.14 Green bricks cutter:-

Condition of green brick cutter is good.

3.15 Green brick transport belt conveyor:-

Conveyor length = 44 m.
width = 400 m/m (4ply)

The condition of belt is far from satisfactory. This belt has to be replaced. But it has been suggested to dispenses with this belt conveyor, altogether. The transport of green bricks will be done manually.

3.16 Dryer:-

There are three numbers of Tunnel dryer of 4.65m x 2.8m dimension each. Dryer doors of sheet metals are in bad condition needs replacement. The asbestos ceillings of drier, serving as insulator, should be replaced. It is reported that dryer became totally unbalanced after installation of some new Fans, resulting in the destruction of car-loads of green bricks by heat-shock.

3.17 Tunnel Kiln:-

The condition of Tunnel kiln is exteremly bad. In most places refractory lining, insulation bricks and common bricks have fallen down. Six sections of the top of the kiln at the firing zone have collapsed, when the loaded truck, passes through the kiln, they are obstructed by the ceiling of the kiln as a result transport car could not be pushed by the hydraulic system. Apart from this, sand particls serving as insulation to protect transport cars from heat, could not be put as broken bricks in the channel, hindered the process. Substantial nos. of bricks cracked inside the kiln, and bricks could not be fired at proper temp., resulting in production of inferior quality bricks.

3.18 Electrical motors and equipments:-

All electrical motor and equipments, cables are in good condition. But these require to be overhauled, heated, insulation resistance tested before putting into operation.

CHAPTER 4

4.1 Green bricks production/ Production capacity of the plant:-

The Bradly and Craven 16 P.M.T. Augur machine extruder was installed for clay brick forming. This machine, at its full capacity without breakdown and stoppage is able to produce 100 bricks per min. or 48,000 bricks per shift. But the machine had not produced more than 35,000 bricks, while normal production was around 30,000 bricks per shift. Based on this, maximum attainable capacity is estimated at 4375x6x50x8 = 10 million bricks/annum. But normal production is estimated at 8.5 million pcs/annum.

4.2 Weight of fired product:

Solid bricks - 3,320 kg/piece.

4.3 Wasteage of raw materials:-

Kiln - 3%, Dryer - 2%
loss in transit - 2%
Total .... - 7%

4.4 Production pattern:
- Solid bricks - 100%

4.5 Annual Capacity:

Solid bricks - 8,500,000 pieces. Annual raw material requirement
= 8,500,000 x 3.32x1.07 kg = 30,195,400 kg.
= 30,195,400 kg. ÷ 1.645
= 18,356 m^3/annum

Total clay requirement per day = 18,356 ÷ 300
= 61.2 m^3/day

CHAPTER 5

5.1 Planning for raw material supply at Addis Schekla:

Since raw material at Addis Schekla will be exhausted within two years time at the production rate of 8.5 million bricks per annum, hence alternative arrangement has to be made for raw materials supply right from the beginning. Stela Media quarry which is situated within a distance of 2.0 km. from Addis Schekla shows a great promise of being utilised for the manufacture of bricks. Geological prospecting of stela meda reserves of raw materials have been conducted by Techno-export of Bulgaria. The results of the geological investigation is quoted below:-

There are enough deposits of tuffs and red clay which are in the proportion of 1:2 to 1:3. The deposit allows for the production of good bricks. For the plant of 15 million pieces of bricks a quantity of 6000-7000 m^3 of Tuffs per annum will be necessary for a period of 30 years. According to Techno-export, the tuff is unsuitable for tile production and needs selective mining to get rid of hard tuff as to produce bricks only necessary to extract 5,000 m^3 annually for every 20,000 - 22,000 m^3 tuff which is needed for the yearly production of plant. Total raw material requirement for a 15.0 million is estimated at 34,208 m^3/annum of this 5,000 m^3 will be tuff which works out about 15.0% only thus red clay will be used 85%. Now taking into consideration various losses for production of 8.5 million bricks clay requirement will be approximately 18,356 m^3/annum.

5.2 Planning for winning and transport of raw materials keeping in view that during monsoon period there will be 50% of utilisation of capacity of mining and transport equipments:-

a) Total raw-materials required = 18,356 m^3/annum.

b) Working days of clay = 300 days

c) Raw material required/day = $\frac{18,356}{300}$ = 61.2 m^3

d) Effective working days of quarry = 365 - (45+40) = 280 days

e) Mining Transport equipments need to be provided for = $\frac{18,356}{280}$ = 65.6 m^3/day

According to 'Bulgarian' raw materials investigation report, 15% Tuff and 85% clay is required to be used in manufacturing process:-

Therefore (656x0.15) = 9.84 m^3 Tuff and (65.5x0.85) = 55.75 m^3 clay will be required to be winned and transported per day.

5.3 Winning of raw materials:-

There are two Texcavators, with bucket attachment - one is of Alice Texcavator and other one is Haimack. Both were in working condition in 1980, when the plant was closed. These equipments can be put into operation after overhauling to win both clay and Tuff at stelameda.

5.4 There are one Dumper of 10 ton and two trucks (marcedes) of 10 ton capacity each. The dumper and one truck were in working condition and the other truck was out of commission, as the dynomo was burnt out when the plant was closed. These equipments can be put into operation after repairing and overhauling.

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* Effective working days of quarry has been calculated taking that during 3 months monsoon period the utilisation capacity of quarry will be 50% and there will be 40 days leave taking sundays and holidays into consideration. Thus effective working days in a year is estimated at 280.

5.5 Requirement of Dumpers for Transport of raw materials:-

- Distance of raw materials from plant site	=	2.0 k.
- Speed of dumper	=	30 km/hr.
- Loading at the quarry	=	7.5
- Manuorering of the dumper/truck & unloading of materials	=	10 min.
- Effective working hours per shift	=	6.5
- Travelling time	=	8.0 min.
- Total cycle time	=	25.5 min.
- No. of dumper/truck trip in 6.5 hr.	=	15.3
- Capacity of the Dumper/truck	=	10 ton
- Materials required to be transported per day	=	108 T(65.6m^3)
- Nos of dumper required at 90% utilisation of capacity	=	$\frac{108}{15.3 x 0.90 x 10}$
	=	0.784

5.6 Requirement of Dumpers for transport of off graded raw materials

- Distance of dumping place of off graded materials	=	1.0 km.
- Average speed of the dumper	=	30 km/hr.
- Loading time	=	7.5 min.
- Manuovering of the dumper/truck and unloading of materials	=	10 min.
- Effective working hours per shift	=	6.5
- Travelling time	=	4.0 min.
- Total cycle time	=	21.5 min.
- Nos. of dumper/truck trips in 6.5 hrs.	=	18.14
- Capacity of the Dumper/Truck	=	10
- Nos. of dumper/truck required at 90% utilisation of capacity taking 30% maximum of total mined materials, termed as off-graded have to be transported	=	$\frac{108 x 0.3}{18.14 x 10 x 0.9}$
	=	0.198 No.

5.7 One dumper or truck will be able to transport the requsite quantity of siutable raw materials to the plants site, as well as off graded materials to the dumping place. Therefore no transport equipment need to be purchased.

5.8 Present value of mining and transport equipment. The audit report as on 30th June 1979, reveals cost of motor vehicles as 12,533.33 Birr (net). (This includes also a vaux-wagon which needs repairing and overhauling). The above cost and with the addition of book value Alice Excavator which has been shown at 68,146.20 Birr (in the audit report separately) and with the over hauling and repairing cost at 40,000 Birr and total value is worked out at 120,679 Birr

5.9 Cost of Consumable for mining and transport of raw materials

a)

Name of the equipment	Quantity required	Fuel consumption per annum	Lubricant consumption per annum	Petrol consumption per annum	tires consumption per annum
Dumper	1	3,868	72	-	-
Texcarator	1	24,650	8	-	-
Total		28,518	640	100 lt.	4 pcs.
unit price		0.79	4.25Br.	1.19	1250
[illegible]		22,529	2,720	119	5000

Total cost = 30,368 Birr/annum

Cost/1000 bricks = $\frac{30,368 \times 1000}{8500,000}$ = 3.57

b/ Cost of salaries and wages for mining and Transport of raw materials

Designation	Nos.	Salaries	
		Monthly	Yearly
1. Dumper Driver	1	300	3,600
2. " Asst.	1	100	1,200
3. Texcavator Driver	1	350	4,200
4. Quarry supervisor	1	500	6,000
5. Labourers	3	80	2,880
		Total....	17,880

Add - 6% pension fund ....
- 5% works man compensation ......} 3,397
- 8% other fringe benefits ......}

Total 21,277/annum

Cost per 1000 bricks = 2.50 birr

C/ Cost of maintenance/Depriciation/insurance:

1/ Maintenance 5% on 120,680 Birr = 6,034

ii/ Depreciation 20% on 120,680 Birr= 24,136

iii/ Insurance - 2.5619% on 120.680 Birr= 3,09

Total .... " 33,262

Cost per 1000 bricks = 3.913 Birr

d/ Total cost of raw-materials delievered at site per 1000 bricks:-

i/ Cost of fuel, lubricants, petrol and tires = 3.57 Birr

ii/ Cost of salaries and wages = 2.50 "

iii/ Cost of maintenance, depreciation & insurance 3.913 "

Total .... 9.983 "

CHAPTER 6

Total cost of reactivation of Addis-Schekla plant and equipments

6.1 Repairing overhauling and modification cost:

	Birr
a) Cost of repairing and overhauling of mining and transport equipments	40,000
b) Cost of placing partition in Hopper	10,000
c) Cost of modification repairing and overhauling screw conveyors	30,000
d) Do above disintigrator	15,000
e) Smooth roller	20,000
f) Do above dryer equipments	20,000
g) Overhauling of all motors electrical equipments switch gear, generator	30,000
Total	165,000
Add 15% unforseen = 165,000x1.15	189,750

6.2 Cost of replacement and installation of additional equipments:

a) CIF price of new belt conveyor No.1, overhauling of all 36' mx600 m/h. bearings & erection	35,000
b) CIF cost of belt conveyor, complete with idealess, seals, bearing of 36mx600m/m and erection	55,000
c) CIF cost 10 nos. of peddals of double shafted mixer	25,000
d) Jaw - crusher CIF	300,000
Total	415,000
Add 15% for erection 415,000x1.15	477,250
Add 15% as contingency 477250x1.15	548,838

6.3 Cost of Hoffman kiln and artificial dryer:-

Size of the Hoffman kiln same as that Ethio-brick - 64mx13.4x3.35

a) Firing equipments - 46,000 Birr F.O.B.

b) Hoffman kilns specialised parts

- Valves - firing holes

- Centrifugal fan (complete) capacity 16,000 m^3/hr. of air at 110°C and 150 m/m water pressure with motor.
- Centrifugal fan for waste heat complete of capacity 10,000 m^3/hr. of air at 125°C and 70 m/m W.G. with motor 120,000/FOB/

	Total......	136,000/FOB
c)	CIF cost delivered at site = 136,000x1.68	229080 Birr
	Add 15% for erection = 229080x1.15	263,442
	Add 15% contigency = 263,442x1.15	302,958

6.4 Civil construction costs of Hoffman kiln and artificial dryer:

a) Rectangular, Edge shape, knife shapted solid bricks 50,000 pieces average price 18 cents per brick	90,000
b) Portland cement 26 tons * 260 Birr/ton	6,760
c) Sand 320 m^3 * 15 Birr/m^3..........................	4,800
d) Gravel 175 m^3 * 35 Birr/m^3	6,125
e) Clay and Brick chippings - 280 m^3 * 15 Birr/m^3......	4,200
f) 2380 kg. reinforced steal 2.5 birr/kg	5,950
g) Sheet iron ducts for smoke gas recovery complete with insulation 1120 kg. @ 12 Birr/kg.	13,440
h) Sheet iron boxes for recovery - 300 kg. @4 Birr/kg.	1,200
i) Ladder over the kiln 770 kg. @ 3 Birr/kg.	2,310
j) Protection hand rail over the kiln 1330 - @3 Birr/kg.	3,990
	138,775
k) Mason and labour for construction of Hoffman kiln and dryer fabrication and erection of other items 15%.	20,816
	159,591
Add 15% for unforseen	23,939
Total	183,530 Birr

6.5 System design of Natural drying:

6.5.1 The climate of Addis - Ababa:

The maximum monthly mean temperature in Addis is about 23.2°C except three months July to Sept. which is around 20°C. The monthly minimum Temp. in Addis is about 9.2°C. Mean relative humudity is about 47% except June to Sept. when the relative humidity is high at 74%. Monthly average rain fall from June to Sept. is about 200 m/m, where as average rain fall in other months is about 43 m/m. Therefore Addis-climate is extremely suitable for natural drying.

6.5.II Planning of drying:

As the rain fall is spread over throughout the year open air drying is not possible.

This high cost of drying by artificial means should be dispensed with, and natural drying sould be resorted to. Addis climate seems to be very satisfactory for natural drying particularly for nine months in a year when the maximum temperature is high and humidity is low.

6.5.III Planning for Drying:-

About 60-100 k.cal/kgm. of burnt products heat can be recovered, enough to dry about 25-30% of the bricks to be fired. Drying of bricks is proposed to be done as follows:

a) About 2-2.2 million bricks by means of artificial drying in the dryer utilising waste heat from the Hoffman kiln.

b) 6.5-6.7 million bricks by means of natural drying under improved design shed using solar energy and radiated heat from the kiln.

6.5.III(a) Drying by utilising waste heat from the kiln:
= 5,700 - 6,200 solid bricks/day

III(b) Natural drying under shed: using solar energy and - radiating heat from kiln = 18,500 - 19,200 solid bricks/day.

Design of a natural drier has to be made to cope up with the requirement both for dry and rainy seasons. Rate of natural drying is likely to fall in the rainy season. Hennce provision has to be made to dry 6.5-6.7 million bricks in nine months time. These dried bricks will be stored in the existing Tunnel kiln and Tunnel drier for use in rainy season and separate storage space need not be constructed.

6.6 <u>The layout:-</u>

The revised layout plan enclosed reveals the Hoffman kiln is placed in the centre surrounded by the natural drier. The advantages for this arrangement are:-

a) The transport distances between the drier and the kiln are kept short.

b) The heat radiation from the kiln can be used fro drying of bricks instead of being wasted. The heat radiated from the kiln is estimated sufficient for drying 5-8% of the production.

c) The heat radiated from the kiln surface during night will keep the relative humidity lower, preventing reabsorption of water from the air by the bricks.

d) The high structure on the top of the kiln, which will be closed on the sides consisting of ventilation slots on the ridge, creates a draft through the driers, because of natural convection of air under the hot roof and because of hot air rising from the kiln structure. This helps the venting air to the drier for removal of water vapour.

6.7 <u>The natural drier:-</u>

The natural drier is shown in drawings AI, AII. (enclosed) The basic principle is that solar energy heat up the metallic roof, which on the bottom radiates part of the accumulated energy to the bricks in the drier and part of the energy accumulated in the roof is used to create a draft in the drier inorder to provide venting air for the removal of water vapour from the drying surfaces. The galvanised iron roof of the drier should be painted on both sides with bituminous paint mixed with carbon black as metallic surfaces are good reflectors and poor radiators of heat. This paint provides a black surface, which is an extremely good absorber of solar energy. This bituminous paint also provides a good resistance against of corrosive action of sulphurous fumes from the smoke gases.

Rain should be prevented from entering the drier, venting air must get access to the drier and air with water vapour should get easy exit from the dryer. This problem can be solved by covering all vertical sides of the central structure over the kiln and drier, including the openings of the shed roof by 3 layers of open knitted jute canvass, where each layer is separated by a space of 25 m/m by means of wood sticks, bolted to the steel sturucture. Along the outer sides of the drier, jute canvas will hang freely down up to 300 m/m above the ground floor, but a clearance of 30 m/m should be provided. This will provide the venting air to enter the drier just above the floor level, through the draft created inside the drier. As the shed roof openings too are covered by the open knitted jute, canvas, the venting air loaded with vapour can leave the drier through the canvas.

This canvas also acts as an air brake, which reduces the free air movement, underneath the hot roof, as a result the radiating roof surface is raised in temperature.

Ack. Technical Report No.42 UNDP Indonesia

The vertical outer wall of canvas provide the drier with a reasonably good heat isolation against heat loss by convection and conduction, because of its 20 m/m air space between the canvas layers. The heat loss by radiation through the outer-wall is reduced by painting the canvas with aluminium paint on the side facing the dryer. The jute canvas should be painted with bituminous paint on the outer side for protection against rain water. The floor of the drier is situated opposite surface to the radiating roof-surface, which sould also be used in transfer of radiation heat to the bricks, which is placed in between the two surfaces. To achieve this the floor is heat isolated by casting the floor-slab of 100 m/m light weight concrete with local available pumice as aggregate, on top of gravel and sand. When the floor slab is completely dry, the pores of the floor should be filled with bituminous paint, so that water vapor from the ground does not enter into the drier.

During sun-shine the floor is heated up by the roof and the heat is partly radiated to the bricks and partly stored in the floor. The stored heat will then be released to the bricks, when there is no sunshine. The aim of natural drying is principally to bring the water content of the bricks below the leather hard consistency, where drying shrinkage is almost finished, because then the final drying can be preformed in the kiln with little risk of drying cracks. This condition corresponds nromally when bricks contain about 10-12% balance water in the bricks.

6.8 <u>Dryer size:-</u>

The natural drier capacity = 6,500,000 bricks are to be dried in 9 months time or 26,000 bricks per day.

The maximum monthly temperature in Addis is about 23.2°C during non-monsoon three months. The roof temperature during sun-shine can be estimated 50-60°C. The average brick temperature of about 15°C may be a reasonable figure. Hours of sun-shine in Addis in non-monsoon months can be taken 6-7 hrs. between 8 A.M to 6.0 P.M.

The following equation is used for estimating heat transfer by radiation from painted metallic radiation roofs to objects of a known temperature Hr. = k.c.t (T roof - T bricks). Kct = 5 k.cal/m^{2}h^{o}C can be taken as surface radiation factor for painted metallic roof corrected for the temperature difference, in this case 40^{o}C. Hence, heat transfer from the inner side of the roof to the bricks then be calculated 200 - 250 k.cal/m^2 per hour of sun-shine. The natural drier will therefore receive a daily radiation heat supply from the roof at 6-6,500,000 k.cal with 3½ hrs. sun-shine for a drier of 5,000 m^2 surface (which is equivalent to 550-650 lt. of mazut). Furthermore, the drier will receive an additional heat supply from the Hoffman kiln and from the central structure of the kiln. Drying rate under shed at Addis in the conventional shed on an average is about 3 bricks/m^2 with the improved system of heat transfer by radiation, it can be raised to 6 bricks/m^2 radiation surface. A radiation surface of 3,500 m^2 of the drier will be able to dry about 21,000 solid bricks/day. But the drying rate during mon-soon period is likely to fall. Therefore radiating surface shed would be of 5,000 m^2 capable of drying app. 25,000-26,000 solid bricks/day. The bricks should be loaded on stillage and transported to the drier to make the natural drier efficient, because the radiation heat cannot effectively be transmitted to the bricks unless they can 'see' the radiating surfaces.

7.1 Cost of investment for reactivation of Addis-Schekla plant and equipments and also cost for installation of a Hoffman kiln of improved natural drying system to manufacture 8.5 million bricks/annu.

Items	Birr
a. Cost of overhauling & repairing of plant and equipments (Refer para 6.1)	189,750
b. Cost of replacements of equipments & installation of additional equipments	548,838
c. Cost of equipments(refere para 6.2) Hoffman kiln artificial dryer (refer para 6.3)	302,958
d. Cost of construction of Hoffman kiln and dryer (refer para 6.4)	183,530
e. Cost of construction of natural dryer of improved design (refer para 6.4)	500,000
f. Cost of equipments for internal transport system of green bricks/dried bricks/ burnt product	50,000
g. Cost of cleaning, painting of all structures	20,000
h. Tools and tackles	10,000
i. One car	85,000
j. Spare parts	400,000
Total	2,290,076

CHAPTER 8

Cost of Mazut per 1000 bricks

8.1 Fuel consumption in tunnel kiln shown by techno-export of Bulgaria in their feasiability report of Gedamba is at 0.037 kgm. of mazut/kg. product. Taking that Hoffman kiln may consume 10% higher fuel than that of tunnel kiln, fuel consumption in Hoffman kiln is calculated at 0.037x1.10 = 0.0407 kg. of mazut/kg. product. Therefore heat required is 0.0407 x 9500 = 9,500 = 386.7 k.cal/kgm. of burnt 388 k.cal/ kgm. product and well designed and run Hoffman kiln uses a minimum of 320 k.cal/kgm. of burnt product.

8.2 Total mazut consumption per year is estimated at

8,500,000x0.0407 = 1,171,525 kg. of mazut

$$= \frac{1,171,525}{0.94} = 1,246,303 \text{ lt/annum}$$

$$\text{Cost/1000 bricks} = \frac{1,246,303 \times 0.59 \times 1000}{8,500,000} = 86.5 \text{ Birr}$$

CHAPTER 9

Cost estimation of power consumption

9.1 List of electrical motors in the green brick preparation Section:

		Nos.	HP
a)	Jaw - crusher	1	50
b)	Clay even feeder	1	15
c)	Belt conveyor	1	2
d)	Smooth roll crusher	1	30
e)	Second conveyor	1	3
f)	High speed roll	1	22
g)	Pugmill mixer	1	80
h)	Pugmill extruder	1	120
i)	Cooling fan	1	5.5
j)	Pugmill vacuum pump	1	11.0
k)	Brick cutter	1	7.5
l)	Green brick conveyor	1	1.5
	Total		347.5

9.2 Hoffman kiln section:

a) 1 Centrifugal fan of capacity .. 16,000 m^3/hr. of air at 110°C and 150 m/m water presure with motore of 16 HP

b) 1 Centrifugal fan for waste heat capacity 10,000 m^3/hr. of air at 125°C 70 m/m presure of motor - 8.5 HP

Total .... 24.5 HP

9.3 Industrial Power Consumption /ton of burnt product =

(850,0000 pcs. bricks = 850,0000x3.32 = 28,220 tons/annum

a) Technological $= \frac{347.5 \times 0.736 \times 0.8 \times 300 \times 8}{28,220} = 17.38$

b) Dryer $= \frac{8.5 \times 0.736 \times 0.8 \times 350 \times 24 \times 1.03}{28,220} = 1,53$

c) Kiln = $\frac{16.0 \times 0.73 \times 0.3 \times 350 \times 24 \times 1.02}{28,220}$ = 2.86

d) Lighting power = 2.87

e) Unforeseen = 1.50

Total .... =26.14

Cost of power/1000 bricks @ 80 units per 1000 k.wh

$= \frac{26.14 \times 80 \times 28220 \times 1000}{8,500,000 \times 1000}$ = 6.94 Birr

CHAPTER 10

Cost of salaries and wages

Nos.	Raw materials winning & transport	Nos. of workers	Wages and salaries Monthly (Birr)	Annually
1.	Damper driver	1	300	3,600
2.	Damper Assistance	1	100	1,200
3.	Texcavator Driver	1	350	4,200
4.	Quarry Supervisor	1	500	6,000
5.	Labourers	3	80	2,880
		7		17,880
	Administration			
1.	Supervisor	1	850	10,200
2.	Chief Accountant	1	750	9,000
3.	Accountant	2	350	8,400
4.	Cashier	1	280	3,360
5.	Sr. Foreman	2	500	12,000
6.	Time keeper	1	150	1,800
7.	Pay roll clerk	1	200	2,400
8.	Store keeper	1	280	3,360
9.	Janitor	2	70	1,680
10.	Secretary	1	300	3,600
11.	Day & night watchman	10	80	9,600
		23		65,400

Nos.	Raw materials Mining & transport	Nos. of workers	Wages and salaries	
			Monthly(Birr)	annually
	Production Dept.			
	clay preparation			
1.	Jaw-crusher/clay feeder	2	150	3,600
2.	Conveyor Roller mill	1	150	1,800
3.	Clay mixer mill	1	150	1,800
4.	Extrusion/vaccum pump	2	200	4,800
5.	Cutting machine operator	2	150	3,600
		8		15,600
	Dryer and kiln			
1.	Dryer operators	4	200	9,600
2.	Kiln operators	4	250	12,000
3.	Kiln " Asst.	4	120	5,760
4.	Green brick shifter	25	80	24,000
5.	Kiln brick setters	30	80	28,800
6.	Mason	1	250	3,000
		68		83,160
	Miscelleneous			
	Finished Product Storage			
1.	Daily workers	25	80	24,000
	Maintenance:			
2.	Fitters	2	250	6,000
3.	Electrician	1	250	3,000
4.	Fitters helper	2	100	2,400
5.	Welders	1	250	3,000

Nos.	Raw materials Winning & transport	Nos. of workers	Wages and salaries Monthly(Birr)	annually
6.	**Car Driver**	1	150	1,800
7.	Auto-mechanic	1	300	3,600
8.	Asst. Auto mechanic	1	200	2,400
[illegible].	Others			
9.	Water - pump attendant	1	150	1,800
10.	Daily worker	25	80	24,000
		60		72,000
	Total	158		236,160

Total cost of salaries and wages/annum except for persons engaged in winning and transport of raw materials and car driver - which have been included in the respective chapters:-

Add - 5% for P.F.
- 5% W.M.C.
- 8% other fringe benefits 44,870

281,030

Cost of salaries and wages/1000 bricks .....= $\frac{281,030 \times 1000}{8,500,000}$

= 33.06

CHAPTER 11

11.1 Maintenance cost of plant and equipments:-

Depreciated value of Addis-Gebekia plant and machinery as on 30th June 1979, reveals 25,917,113* Birr. To this amount the following expenditure has to be added to determine the present value of plant and equipments.

	Birr
a) Repairing over hauling and modification cost (Refer chapter 7)	169,750
b) Cost of replacement and installation of additional equipments(refer chapter 7).	548,830
c) Cost of equipments for Hoffman kiln (refer chapter 7)	302,958
d) Cost of equipments for internal transport system (refer chapter 7)	50,000
e) Machinery which was in transit as per audit report (refer chapter 2)	64,423.96
f) Depreciated value of plant and machinery as per audit report (refer chapter 2)	259,171.13
*Total value	1,415,141

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* This value will reduce if depreciated value of e and f date is taken.

In 1975 Tunnel kiln and dryer and racks cost was 840,000 U.S.$ for a 8.4 million brick plant. Taking average 10% escalation of prices occured/year 1970 to 1975 (oil price like years) the value of Tunnel kiln, dryer and rack works out at 420,000 in 1970, when the plant was established. Taking 5% depreciation value in 1979 is arrived at 231,000 U.S.$ or 462,000 Birr. Therefore present value of factory building and road works out (577,265-426,283) = 115,265. Office building value as per audit report is 47,744 Birr is added to the above figure. Total cost of factory building plus road and office building = 163,009 Birr.

Due to inadequate space available in the present shed it has been proposed to instale the Hoffman kiln of same specifidation as that of Ethio-brick outside the shed. The natural drying shed is proposed to install in both sides of the Hoffman kiln so that heat radiated from the kiln can be used for drying of bricks in the drier, instead of being lost. The heat radiated from the kiln is estimated sufficient for drying 5-6% of production. In this connection layout plan enclosed may kindly be referred. It has been decided not to dismantle the existing tunnel kiln and dryer and office building as dismanthing will involve considerable expenditure.

Total civel cost is estimated as follows:- on which maintenance cost has to be taken (without tunnel dryer and kiln):-

a) Factory building, road, office building... 163,009

b) Cost of Hoffman kiln artificial dryer and hot air pipe line........................ 183,530

c) Natural drying shed 500,000

Total 846,539

Maintenance cost of civel construction at the rate of 0.5% per 1000 bricks ...... $\frac{846{,}539 \times 0.5 \times 1000}{8{,}500{,}000 \times 100} = 0.50$

CHAPTER 12 - A

Present Asset

	Civil		Birr
a)	Factory building and road	=	577,265.41
b)	Office building	=	47,744.78
c)	Cost of Hoffman kiln artificial dryer and hot air-pipe line	=	183,530
d)	Natural drying shed	=	500,000
e)	Cost of painting	=	, 20,000
	Total	=	1,328,539

CHAPTER 12 - B

Present Asset

Machinery and equipments:

			Birr
a)	Mining & transport equipment with cost of rehabilitation	=	120,679
b)	Depreciated value of plant & machinery (refer /d&e/ of para 2.5	=	323,595
c)	Cost of overhauling and repairing of plant and equipment (refer chapter VII)..	=	189,750
d)	Cost of replacement of equipments (refer chapter Vii)........................	=..	548,838
e)	Cost of equipments of Hoffman kiln and artificial dryer(refer chapter VII)	=	183,530
f)	Cost of equipments for internal transport system (refer chapter VII)	=	50,000
g)	One car	=	85,000
	Total	=	1,501,392

- The above asset will reduce if depreciated value of old construction is taken till to date.
- The above asset will come down if depreciated value of old plant and machinery is taken till to date.

CHAPTER 13

		Birr
a) Civil construction (chapter 12-3).	=	1,328,539
b) Machinery and equipment(chapter 12-3)	=	1,501,392
c) Office furniture and equipment	=	10,295
d) Tools and tackles	=	10,205
Total	=	2,850,430

CHAPTER 14

Cost of Depreciation:-

a) Cost of depreciation 5% on 1,328,539 Birr (refer chapter 12-A)...........	=	66,427
b) Cost of depreciation 10% on 1,295,713 plant and equipment. . (refer 12-3, c, d, 3, and f)	=	129,571
c) Cost of depreciation 33⅓% tools and tackles on 10,205.79. (refer item 4 chapter 13)..........	=	3,402
d) Cost of depreciation 20% on 10,294 Birr office furniture and equipment	=	2,059
Total	=	201,459

14.1 Cost per 1000 bricks = $\frac{201459 \times 1000}{8500000}$ = 23.70 Birr

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Cost of depreciation for mining and transport and car has been included in the respective chapters.

CHAPTER 15

Cost of operation of car:

It is assumed the car provided for mill make on average 50 km/day for 320 working days.

a)	Cost of petrol	$= \frac{50 \times 320 \times 1.19}{8}$	=	2,380
b)	Lubricants	= 100x4.25	=	425
c)	Tyres	= 1x200	=	200
d)	Maintenance @ 5% 8,500 Birr		=	4,250
e)	Depreciation @ 20% on 8,500 Birr		=	17,000
f)	Salary and wages for drivers	= 150x12x1.19	=	2,142
		Total	=	26,397

15.1 Cost per 1000 bricks $= \frac{26,397 \times 1000}{8500000}$ = 3.10 Birr

CHAPTER 16

Miscellaneous expenditure:-

a) Audit fees - = 15,000 Birr/annum

Cost per 1000 bricks = $\frac{15000 \times 1000}{8500000}$ = 1.764

b) Telephone, stationery etc. 5000 Birr/annum

= $\frac{5000 \times 1000}{8500000}$ = 0.588

c) Cost of insurance on total asset on 264,475 = $\frac{264475 \times 0.7 \times 1000}{8500000 \times 1000}$ = 0.217

d) Cost of state capital payment 5% on total asset of 2,850,430 = $\frac{2850430 \times 5 \times 1000}{100 \times 8500000}$

= 16.76

CHAPTER 17

Overall cost of investment:-

		Birr
1)	Cost of investment as per chapter 7 .... =	2,290,076
2)	Working capital as per annex A=	321,007
	Total ...... =	2,611,083

Cost of insurance for mining and transport equipment and motor vehicle, has been taken in respective chapters.

ANNEX - A

Break-up cost of working capital for 3 months operation:

			Birr
a)	Raw materials	=	14,612.00
b)	Salary & wages	=	59,726.00
c)	Power	=	14,736.00
d)	Fuel	=	185,632.00
e)	Miscellaneous such as operation of vehicle, telephone and stationary	=	7,349.00
f)	Insurance on erected plant and equipments	=	20,194.00
g)	Maintenance	=	18,758.00
	Total	=	321,007.00

CHAPTER 18

Cost of production at 100% utilisation of capacity

cost/1000 bricks:

a)	Raw materials (refer chapter 5 para 5.8.d).	=	9.98 Birr
b)	Fuel (refer chapter 8 para 8.2).	=	86.500 "
c)	Power (refer chapter 9 para 9.3)	=	6.940 "
d)	Salary and wages (refer chapter 10).	=	33.06 "
e)	Maintenance (refer chapter 11 para 11.2)	=	8.82
f)	Depreciation (refer chapter 14 para 13.1).	=	23.70
g)	Operation of vehicle (refer chapter 15 para 15.1)	=	3.100
h)	Audit fees cost for telephone, stationery, cost of insurance (refer chapter 16 para a,b&c)	=	2.57
i)	Cost for state capital payment (refer chapter 16 para 16.d)	=	16.760
	Total	=	191.43

CHAPTER 19

1. Fixed cost and variable cost at 100% utilisation of capacity cost/1000 bricks:

a)	Variable cost	=	101.68
b)	Fixed cost	=	89.75
	Total	=	191.43

2. Cost of production at 90% utilisation of capacity = 201.40

3. Cost of production at 85% utilisation of capacity = 207.27

4. Cost of production at 80% utilisation of capacity = 213.870

ECB/at