



INDUSTRIAL BRICK KILN THAT USES THE ZIGZAG FIRING TECHNOLOGY

USER GUIDE FOR CONSTRUCTION



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development
and Cooperation SDC

skat Swiss Resource Centre and
Consultancies for Development
PROECCO **PRO**moting Employment through
COnstruction Climate Responsive **CO**nstruction

00

TABLES OF CONTENTS

1.0	Introduction	6
1.1	Kiln sizes	6
1.2	The Zig-Zag brick firing technology	7
1.4	Advantages of the industrial kiln over other kilns	8
1.4	The key features and technical data of the industrial kiln	9
1.5	Technical data (Let's take sample of 3.5Million capacity)	11
.....		
2.0	The brick factory layout	12
.....		
3.0	The Construction Stages in Kiln Construction	14
3.1	Planning for the Kiln construction	15
3.2	The step by step construction stages of the kiln	17
.....		
4.0	The Mini-Hoffman brick kiln concept	56
4.1	Introduction	56
4.2	Relationship, difference, comparison and advantage of Zig-Zag brick kiln technology to Mini-Hoffman brick kiln.	58

4.3	Outer side smoke chimney (design and construction) descriptions stages for Mini-Hoffman brick kiln	59
<hr/>		
5.0	Appendices	64
5.1	Checklist for critical construction details quality control	65
5.2	Kiln construction schedule	71

FORWARD

This user manual is meant to guide the mason, engineers and the brick making investors through the crucial construction stages of building an industrial brick kiln that uses the Zig-Zag firing technology.

The industrial brick kiln is one of the major components required in establishing an industrial brick factory. Other major components required include the brick making machinery, the hangar's infrastructure that houses the brick making machinery, an office, clay bank, drying space and fuel and green products storage and the storage for the final products.

This user manual focuses on the step by step construction stages of the industrial brick kiln.

This manual has four sections:

1. The introduction;
2. The Brick Factory Layout;
3. The Construction Stages during brick Kiln Construction;
4. The Mini-Hoffman brick kiln concept;
5. The appendices.

01

INTRODUCTION

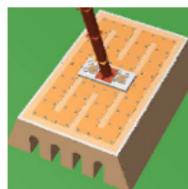
01.1 - KILN SIZES

The industrial brick kiln described in this user manual has eight chambers that facilitate the continuous firing of bricks and other clay products throughout the year.

The brick kiln can be constructed in phases that allow future expansion. It's possible to start building quarter or half the size of the industrial kiln and then expand it to a full size kiln in future. The different possible kiln sizes and their capacities are illustrated in the next page.

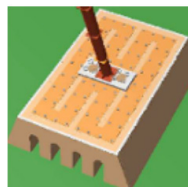
1. Industrial Kiln size
24.07m X 14.3m
2.89m high

Capacity:
6 million bricks a year
size 210x100x65mm



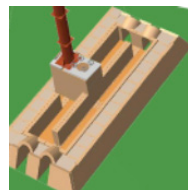
2. Industrial Kiln size
15.8m X 11.7m
2.89m high

Capacity:
3.5 million bricks a year
size 210x100x65mm



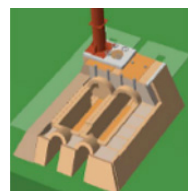
3. 1/2 Industrial Kiln size
19.8m X 9.2m
2.89m high

Capacity:
2 million bricks a year
size 210x100x65mm



4. 1/4 Industrial Kiln size
13.5m X 9.2m
2.89m high

Capacity:
1 million bricks a year
size 210x100x65mm



01

01.2 -THE ZIG-ZAG BRICK FIRING TECHNOLOGY

The zigzag brick firing technology has been used in Europe for decades. The technology involves building a kiln with various chambers for firing different clay products such as bricks, floor and roofing tiles.

The bricks are fired in one chamber at a time, allowing the cooling and loading of bricks in the other chambers. The controlling of fire from one chamber to the other is done by means of fire control valves, operated from a central fire control box.

This zigzag firing technology enables the continuous nonstop firing of the brick. This has been done with some kilns for continuous periods exceeding twenty years.

01

01.3 - ADVANTAGES OF THE INDUSTRIAL KILN OVER OTHER KILNS

The industrial kiln has the following advantages compared to other traditional kilns:

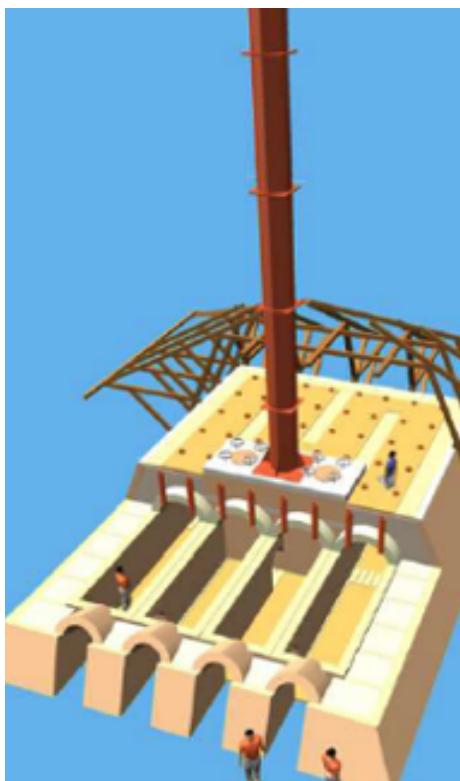
- Efficient and economical to run and as it uses less fuel for firing the bricks;
- Provides a healthy working environment, as it is smoke free;
- Facilitates continuous firing of the bricks;
- Can be used to store bricks, protecting them from rain damage as they wait to be fired.

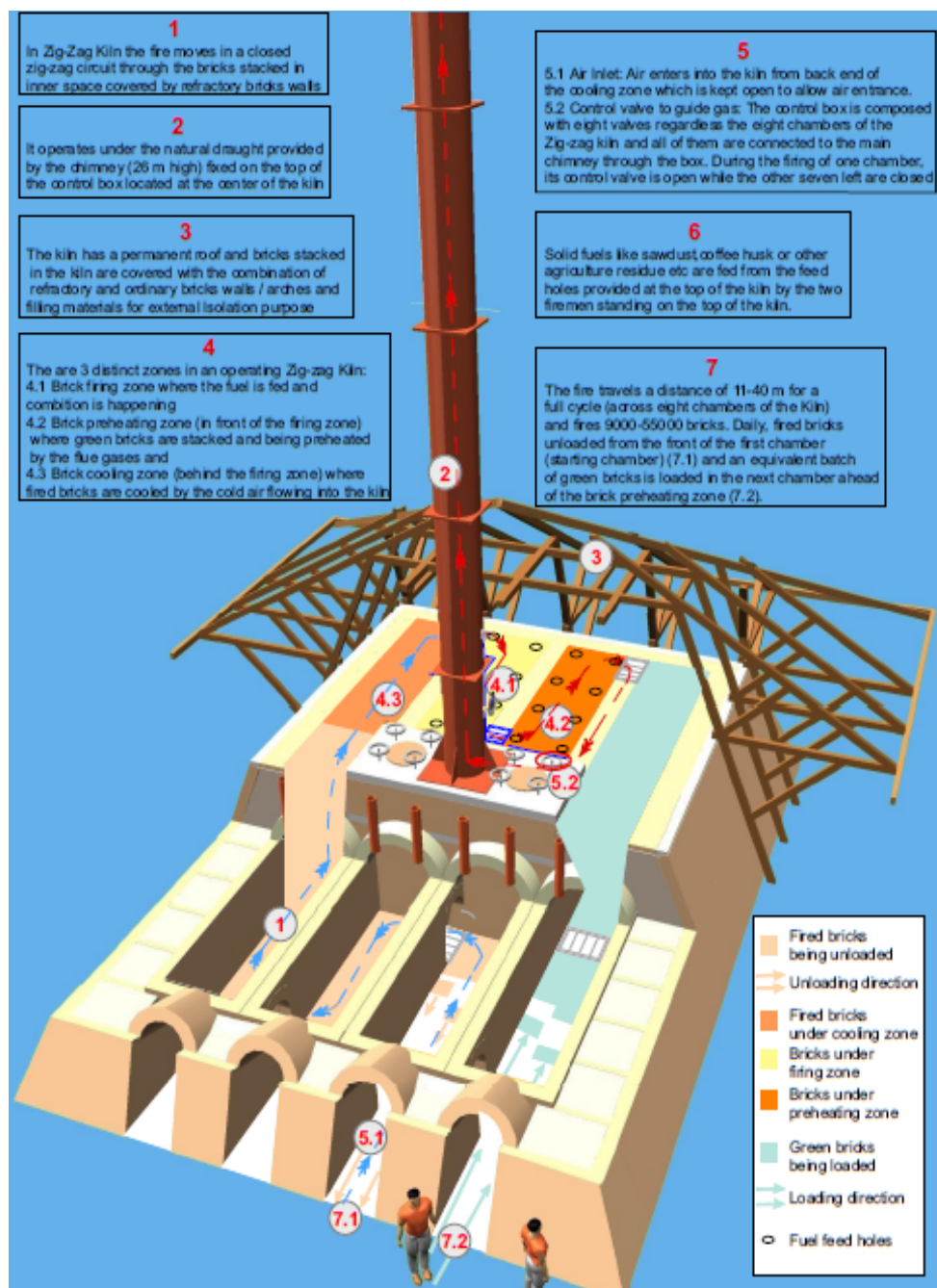
01

01.4 - THE KEY FEATURES AND TECHNICAL DATA OF THE INDUSTRIAL KILN

The industrial kiln has the following key features that make it economical and efficient to run:

- Eight (8) firing chambers, that allows a continuous firing (non-stop) even for decades as long as the brick factory can sustain a continuous production of bricks;
- Some of the chambers can be used for the storage of green bricks while awaiting firing;
- Uses coffee husks, rice husks or saw dust as fuel, hence contributes to environmental conservation of trees;
- Smokeless, providing a healthy working environment for workers.





01

01.5 - TECHNICAL DATA (LET'S TAKE SAMPLE OF 3.5MILLION CAPACITY)

- A full size industrial kiln (8-chambers) has an interior volume of 104M3, with a production capacity of 3-4million bricks in a year;
- Requires a brick moulding capacity of 14,000 bricks a day;
- Requires 360M3 of clay annually, equivalent to 0.3hacters of land a year;
- Requires 600 tons of sawdust/rice husks or coffee husks fuel a year;
- Can be used for firing bricks, floors and roofing tiles and other clay products;
- Employs 100-150 workers;
- Has a lifespan of 100years dependent on maintenance.

ATTENTION!

The industrial kiln is meant to serve the owner for decades with little maintenance. The builder therefore must pay careful attention to all the construction details described.

Failure to do so may lead to expensive demolition and reconstruction in correcting technical mistakes made.

It is therefore imperative to spend quality time planning and preparing for the construction to ensure that the kiln is built to the highest possible standard, at the lowest possible cost.

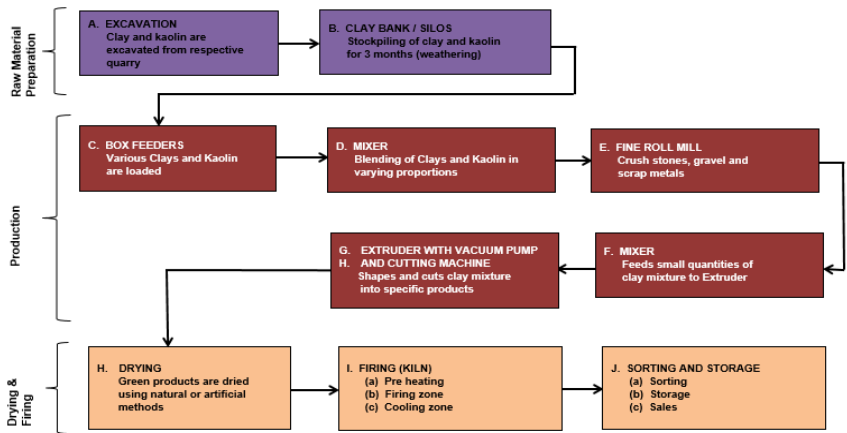
02

THE BRICK FACTORY LAYOUT

INTRODUCTION

The site layout plan for the factory must take into consideration all the production activities that takes place in the factory.

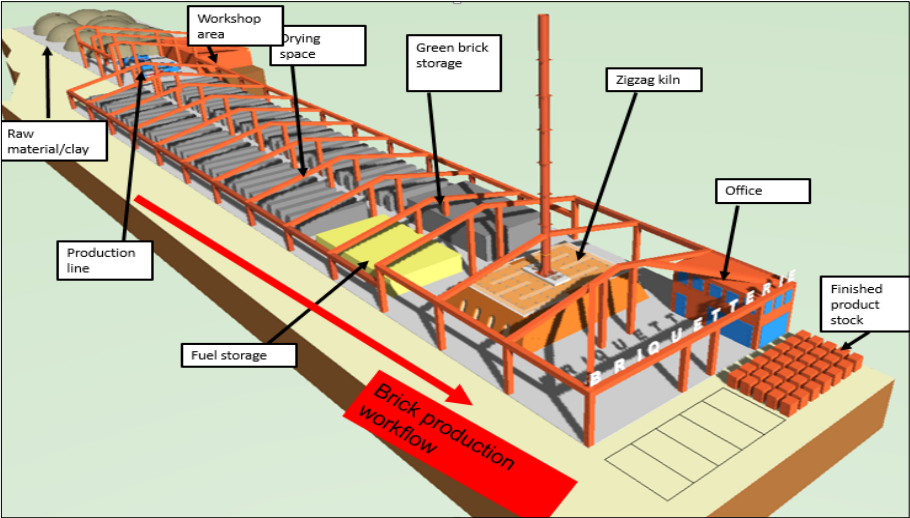
The activities must be set in a systematic sequence that allows a smooth production flow of the bricks. Some of the suggested brick factory layout are illustrated below.



The layout above illustrates the flow of the 3-main production stages of bricks; Raw materials preparation, Production, Drying & firing

POSITIONING THE KILN IN THE BRICK FACTORY

The kiln construction must be strategically located in the factory, next to the drying space of the green bricks and near the sales out let. The fuel storage should also be next to the kiln to facilitate smooth flow of the firing



The illustration above demonstrates the systematic flow of activities in a brick factory



The illustration above is a pictorial demonstration of brick making activities in a brick factory

03

THE CONSTRUCTION STAGES IN KILN CONSTRUCTION

Kiln construction has several stages that can be summarized as follows:

1. Planning for the Kiln construction;
2. Hangar construction;
3. Foundation works to floor level;
4. Walls construction to vaults level;
5. Vaults construction;
6. Construction of the Fire Control box;
7. Walls construction to kiln top level;
8. Kiln top construction;
9. Fabrication of the steel chimney;
10. Installation of chimney.

03

03.1 - PLANNING FOR THE KILN CONSTRUCTION

This is detailed planning and preparation of how the kiln will be constructed within a specific period and budget. It involves the following:

- Legal compliance: Design stages for Getting construction permit and environmental impact assessment approval;
- Logistics: Planning for the procurement for the resources (materials & labor) required;
- Construction management: Preparation of a construction schedule with timelines for key construction activities and materials required.

CONSTRUCTION SCHEDULE

A construction schedule has a systematic flow of all the construction activities, indicating the estimated construction time for each activity and materials required.

No	Construction activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Planning																								
2	Hangar construction																								
3	Foundation works floor level																								
4	Walls construction to vaults level																								
5	Vaults construction																								
6	Fire control box																								
7	Construction to roof level																								
8	Klin top construction																								
9	Chimney fabrication																								
10	Chimney installation																								

A construction schedule with summarized stages of the klin construction. for detailed construction schedule see the appendix

03

03.2 - THE STEP BY STEP CONSTRUCTION STAGES OF THE KILN

INTRODUCTION

The step by step construction stages of the kiln starts with the construction of the hangar.

The rest of the construction steps are presented in a chronological order with the estimated number of days a particular activity will take.

For effective and efficiency construction of the kiln, it's prudent that materials required for a particular stage of construction are delivered at least 1-week in advance.

A set of construction drawings and the bill of quantities with all the materials required to construct the 8-chamber kiln are provided in the appendices.

ACTIVITY N°1

“CONSTRUCTION OF THE HANGAR”

The construction of the hangar has to be built first before the construction of the kiln commences.

This protects the kiln from rain damage during construction. The hangar can be constructed from framework made from wooden poles, steel or concrete columns.

ESTIMATED DAYS: 20-25 days



ACTIVITY N°2

“EXCAVATION WORKS”

Kiln construction starts at a depth of 1.04M below the ground level. The excavation should therefore be done to a depth of 1.04M below the ground level.

The stability of the sub-soil at 1.04M must be tested to see if it meets the required strength.

ESTIMATED DAYS: 5 days



ACTIVITY N°3

"COMPACTION OF SOIL"

If the sub-soil at 1.04M depth is not stable enough, good soil (50M3) such as laterite must be brought and compacted to 2Kg/cm².

The thickness of the compacted soil required is 200mm thick.

ESTIMATED DAYS: 1-2 days



ACTIVITY N°4

“COMPACTION OF GRAVEL”

Gravel of minimum size 15- 40mm is then spread on the compacted ground to a depth of 40cm and then compacted with a mechanical vibrator.

This layer of gravel is for helping drain any water that may finds its way under the kiln.

ESTIMATED DAYS: 1-2 days



ACTIVITY N°5

“SETTING/MAPPING OUT POSITIONS FOR FOUNDATION CONCRETE PADS”

This exercise is for marking out the position of the kiln foundation pads. This should be done using strings and the 3, 4, 5 method for accuracy.

ESTIMATED DAYS: 1 day



ACTIVITY N°6

“ASSEMBLING FORMWORK FOR CONCRETE PADS”

Formwork should be made from straight timber (200x25mm) accurately assembled as per drawings.

The formwork setting must be checked and approved by the construction supervisor before pouring concrete.

ESTIMATED DAYS: 1-2 days



ACTIVITY N°7a

“POURING CONCRETE FOR PAD FOUNDATIONS”

The concrete mix for the foundation pads is 1:2:4.

This should be batched out (measured) using a bucket and not a wheelbarrow for quality concrete.

The concrete must be cured for a minimum of 7-days before bricklaying starts.

ESTIMATED DAYS: 1-2 days



ACTIVITY N°7b

"CASTING CONCRETE PAD FOR CHIMNEY FOUNDATION"

The concrete for chimney foundation should be poured separately from other concrete pads.

ESTIMATED DAYS: 1/4 day



ACTIVITY N°8

“CONSTRUCTION OF BRICK EXTERIOR WALLS”

Wall construction starts with the external walls that are laid in cement/ sand mortar of a ratio of 1:5.

Joints between bricks should be maintained at 5mm maximum.

ESTIMATED DAYS: 10-15 days



ACTIVITY N°9

“BUILDING THE SMOKE TUNNELS”

The smoke tunnels are built with semi-refractory bricks, with joints sealed with clay, kaolin and chamotte mortar. Joints between bricks should be maintained at 5mm thick maximum.

ESTIMATED DAYS: 10-15 days



ACTIVITY N°10

“MAKING THE KILN BASE TIE BEAM”

The tie beam is cast at a height of 0.95M above the concrete pad.

The ring beam is made from reinforced concrete of a mix ratio of 1:2:4 (cement, sand and gravel.)

- Use good straight timber for formwork.
- Oil the inside of formwork before pouring concrete.
- The engineer must check and approve the correct making of reinforcement cage and formwork fixing before pouring concrete.

ESTIMATED DAYS: 2-3 days



ACTIVITY N°11

“BACKFILLING TO FLOOR LEVEL”

Approximately 73M3 of broken bricks is required for backfilling the various sections of the kiln.

ESTIMATED DAYS: 3 days



ACTIVITY N°12

“LAYING THE KILN FLOOR”

The kiln floor is built with semi-refractory bricks laid vertically (soldier course) and tightly to each other.

ESTIMATED DAYS: 3 days



ACTIVITY N°13

“SETTING OUT FRAMEWORK TO GUIDE IN BUILDING THE SKEWED WALL”

The skewed or slanting wall is built with the guidance of a metal or wooden frame. Four (4) such frames need to be set at the four corners.

ESTIMATED DAYS: 1/2 day



ACTIVITY N°14

“BUILDING THE VERTICAL SMOKE TUNNELS”

The smoke tunnels are built with semi-refractory bricks. Joints between bricks should not exceed 5mm and are filled with clay/kaolin/chamotte mortar.

ESTIMATED DAYS: 7 days



ACTIVITY N°15

“BUILDING EXTERIOR WALLS TO VAULTS LEVEL”

The gaps between walls should be filled with well compacted broken bricks as wall construction progresses.

ESTIMATED DAYS: 10 days



ACTIVITY N°16

“FIXING THE EXPANSION JOINTS”

The external longitudinal walls have expansion joints in the middle built with special L-shaped semi-refractory bricks.



ACTIVITY N°17

“MAKING FORMWORK FOR VAULTS”

The kiln chambers are bridged with vaults.

Timber formwork is made to support the vaults during construction.

A plastic sheet is placed on top of the timber formwork. This prevents the liquid mortar that is used to seal the joints from sipping out through the joints.

ESTIMATED DAYS: 3-5 days



ACTIVITY N°18 a

“BUILDING THE VAULTS”

The vaults are built using the refractory bricks with joints filled with the special clay, kaolin and chamotte mortar.

The bricks for the vaults should be tapered (trapezium shaped), to make strong vaults.

ESTIMATED DAYS: 7-10 days



ACTIVITY N°18 b

“SEALING EXPANSION JOINTS IN THE VAULTS”

Vaults have expansion joints in the middle which are sealed with fireproof fibre matte.



ACTIVITY N°18 c

“INSERTING FUEL FEEDING HOLES”

Fuel feeding holes are placed in strategic positions as shown on the drawings.



ACTIVITY N°19

"BUILDING THE CHIMNEY AND FIRE CONTROL BOX"

The construction of the fire control box starts with laying a reinforced concrete slab.

Provision must be made for the 8-holes that will house the fire control valves when preparing reinforcement and pouring concrete.

ESTIMATED DAYS: 3-5 days



ACTIVITY N°20

"REINFORCED CONCRETE COLUMNS FOR THE CHIMNEY SUPPORT"

Four reinforced concrete columns are cast together with the firebox floor slab, in the middle of the fire box. These columns are for supporting the chimney.

ESTIMATED DAYS: 5 days



ACTIVITY N°21

“FIRE CONTROL VALVES ARE PLACED IN POSITION”

The fire control valves placed in position at this stage.

ESTIMATED DAYS: 1 day



ACTIVITY N°22

“CASTING THE FIRE CONTROL BOX ROOF WITH REINFORCED CONCRETE”

The roof of the fire control box is made from reinforced concrete. At this stage the bolts and the steel plate that anchors the chimney to the kiln are placed in place and casted together with the concrete.

ESTIMATED DAYS: 2 days



ACTIVITY N°23

“FIXING THE STEEL PLATE AND BOLTS FOR ANCHORING THE CHIMNEY TO THE KILN”

The steel plate with all chimney anchorage bolts concreted in position.

ESTIMATED DAYS: 2 days



ACTIVITY N°24

“CONSTRUCTION OF KILN ABOVE THE VAULTS”

Brick laying for the remaining walls up to kiln level and backfilling with broken bricks continues to the kiln top.

ESTIMATED DAYS: 5 days



ACTIVITY N°25

"CASTING THE REINFORCED CONCRETE TOP TIE BEAM FOR HOLDING THE KILN AT THE TOP"

A reinforced concrete top tie is cast on top around the entire kiln. This ties and holds the entire kiln together.

ESTIMATED DAYS: 3 days



ACTIVITY N°26

“LAYING THE BRICKS FOR THE KILN TOP (ROOF).”

The kiln top is made from two layers of bricks laid tightly on edge.
The fuel feeding holes continues through the kiln top and are visible from the top.

ESTIMATED DAYS: 3 days



ACTIVITY N°27

“FABRICATION OF THE STEEL CHIMNEY”

The chimney is made from noncorrosive steel (corten) in a metal workshop.
The chimney comprises of 3-sections, totalling 26meters.

- A. The bottom part of the chimney is 9-metres long made from 6mm thick steel.
- B. The middle part of the chimney is 9-meters long made from 4mm thick steel.
- C. The top part of the chimney is 8-metres long made from 2mm thick steel.

ESTIMATED DAYS: 21 days



ACTIVITY N°28

“CASTING CONCRETE CUBES FOR CHIMNEY ANCHORAGE AND BRACING”

Four reinforced concrete cubes are required in pre-determined corners of the kiln for anchoring and bracing the kiln to the ground, securing it from strong wind movements.

These concrete cubes should be cast at least 4-weeks in advance before the installation of the kiln to ensure total curing.

ESTIMATED DAYS: 4 days



ACTIVITY N°29 A

“INSTALLING THE STEEL CHIMNEY TO THE KILN”

The steel kiln is elevated and placed in position by means of a crane.
The final assembly of the 3-sections of the kiln is done on the site, and the entire chimney lifted by the crane and fitted in position.

ESTIMATED DAYS: 1 day



ACTIVITY N°29 B

“SEALING THE GAPS BETWEEN THE STEEL CHIMNEY PARTS”

Approved fire proof material/matt is used for sealing gaps between the various chimney joints.



ACTIVITY N°29 C

“BOLTING THE CHIMNEY IN PLACE”

The chimney is then bolted to the kiln.



ACTIVITY N°30

"BRACING THE CHIMNEY"

The steel chimney is braced and anchored to the ground using 16mm thick stainless steel cables.



ACTIVITY Nº31

"STRUTTING THE CHIMNEY TO THE CONCRETE CUBES."

The stainless steel cables are then and tied and fastened at to the concrete cubes cast at least 4-weeks in advance.



ACTIVITY N°32

"INSPECTION AND MAINTENANCE CHAMBER FOR THE KILN"

An inspection chamber is made at the bottom of the chimney for chimney maintenance.

The inspection chamber is best made in the workshop before the installation of the chimney.



ACTIVITY N°33

“INSERTING THE SMOKE/HEAT VALVE REGULATOR”

A steel regulator valve that can be accessed through the inspection chamber is installed.

This is for regulating heat and heat movement during the various firing stages/circles of the kiln.



04

THE MINI-HOFFMAN BRICK KILN CONCEPT

04.1 - INTRODUCTION

Hoffman kiln is a continuous, moving fire kiln in which the fire is always burning and moving forward through the bricks stacked in the circular, elliptical or rectangular shaped closed circuit with arched roof. The fire movement is caused by the draught provided by a chimney or a fan.

Hoffman kiln was developed and patented by Friedrich Hoffman in Germany in the year 1858. These kilns were once widely used in Europe for bricks, ceramics and lime production.

Hoffman kiln technology was introduced in India in the Malabar coastal region (south-west coast) by the German missionaries in 19th century and is still prevalent in the same region.

The original design of Hoffman kiln had a circular circuit built around a central chimney.

However, this design has been modified with time and now Hoffman kilns with elliptical or rectangular shape are more in practice.

For our case we have Min-Hoffman brick kiln which is composed half of the zig-zag brick kiln and it has the 4 chambers.



04

04.2 - RELATIONSHIP, DIFFERENCE, COMPARISON AND ADVANTAGE OF ZIG-ZAG BRICK KILN TECHNOLOGY TO MINI-HOFFMAN BRICK KILN

ZIG-ZAG BRICK KILN	MINI-HOFFMAN BRICK KILN
Obtained from incremental (Number of chambers) construction of Min-Hoffman brick kiln technology	By increasing the number of chambers it becomes zig-zag brick firing technology
All construction materials and type (refractory and ordinary bricks, isolation technics, etc.) are the same as Hoffman brick kiln	All construction materials and type (refractory and ordinary bricks, isolation technics, etc.) are the same as Zig-Zag brick kiln
Fire is burning products in zig-zag movement	Fire is burning products in circular movement
It has 8 Chambers	It has 4 Chambers
It has underground smoke channels	It has underground smoke channels
Smoke chimney can be at the center or outside of the kiln	Smoke chimney can be at the center or outside of the kiln
Continuous firing	Continuous but in experimentation

04

04.3 - OUTER SIDE SMOKE CHIMNEY (DESIGN AND CONSTRUCTION) DESCRIPTIONS STAGES FOR MINI-HOFFMAN BRICK KILN

The outside smoke chimney position is not only for Min-Hoffman brick kiln because it is possible for Zig-zag brick kiln technology.

This smoke chimney position happen when there is a need of increasing the volume of the chambers and reducing the distance of smoke through underground channels towards the main smoke chimney.

ACTIVITY N°34

"THE CHIMNEY DESCRIPTION (MASONRY STEEL CHIMNEY"

The smoke chimney composed of one steel part fixed on the RCC tie beam (fixed on the top of masonry part).



ACTIVITY N°35

“SMOKE CHANNELS (LINKING THE KILN TO CHIMNEY MASONRY PART)”

All smoke channels have the same correcting chamber in front of the masonry part where the control valves for every smoke channel will be fixed.

They have to be protected against the external lateral pressure by constructing the retaining wall for resisting this forces.



ACTIVITY N°36

“FIXING BOLTS FOR ANCHORING THE STEEL PART OF SMOKE CHIMNEY TO THE BOTTOM MASONRY PART”

The steel plate with all chimney anchorage bolts concreted in RCC beam fixed on the top of the masonry part.

The masonry part composed of the outer reinforced wall load bearing structure and the inner part which is semi-refractory brick wall.



05

APPENDICES

The appendices has three main documents:

1. Quality control checklist for kiln construction.
2. The detailed kiln construction schedule.

05

05.01 - CHECKLIST FOR CRITICAL CONSTRUCTION DETAILS QUALITY CONTROL

The site engineer who oversees daily supervision and construction of the kiln must pay close attention to the construction stages and details summarized in the table below.

This checklist is to help enforce quality control at every construction stage.

No	Construction state	What to check	Observations	Recommendations
1	Preliminary site visit. This is a basic site survey and feasibility study to determine the suitability of the site location for the brick factory.	a. Is the site accessible by road and big tracks? b. Have a soil topography been done? c. Have you established the key raw materials available locally? d. Is electricity available locally?	a. Yes/No b. Yes/No c. Yes/No d. Yes/No	
2	Site preparation This involves clearing the site of all top soil, vegetation matters, trees and levelling the site.	Is the site cleared of all bushes and levelled?	a. Yes/No	

3	Brick factory layout plan. The brick factory layout plan should be prepared in advance before any construction takes place.	Has the site layout plan taken care of? a. Clay & fuel storage? b. Water storage? c. Adequate production capacity & drying area? d. Kiln site? e. Storage for ready bricks? f. Office?	a. Yes/No b. Yes/No c. Yes/No d. Yes/No e. Yes/No f. Yes/No	
4	Hangar construction The kiln hangar must be built before the construction of the kiln starts. This is to protect the kiln from rain damage.	Is the hangar built yet?	a. Yes/No	
5	Setting out This is mapping out on the ground the floor plan of the kiln	Check that the setting out is accurately done by checking if the diagonals are equal.	a. Yes/No	
6	Excavation works The kiln construction starts at a designed depth below the ground level.	Check if the excavation of the kiln foundation is done to a designed depth.	a. Yes/No	
7	Soil compaction This should be done with a mechanical vibrator.	Has the soil been compacted with a mechanical vibrator to a load bearing capacity of 2Kg/Cm ² ?	Yes/No	
8	Gravel compaction	Has the gravel been compacted to a depth of 0.4M?	Yes/No	
9	Mapping out the position of foundation concrete pads.	Are the concrete pads correctly marked on the ground as per the drawing?	Yes/No	

10	Making the formwork for foundation concrete pads.	Is the formwork accurately set and firmly fixed to the ground?	Yes/No	
11	Foundation concrete pads The concrete for foundation pads is made from a mix ratio of 1:2:4. (1-cement, 2-sand, 3-gravel measured using a bucket.)	a. Has the sand and gravel been tested for quality required? b. Is there a batch box or bucket used to accurately measure the concrete ratios?	a. Yes/No b. Yes/No	
12	Positioning the drain pipe A drain pipe is required to drain off any water that may find its way under the kiln.	The drain pipe must be fixed when the foundation works is in progress. Is the drain pipe gradient (1:40) and drains out water from the lower end of the kiln?	Yes/No	
13	Construction of external walls. The walls are built using ordinary bricks with 25% perforation laid in cement/sand mortar.	a. Are the masons soaking the bricks in water before laying them? b. Are the joints between the bricks 5mm? c. Is the cement mortar used a ratio of 1:5 (<i>1-cement to 5-sand</i>)?	a. Yes/No b. Yes/No c. Yes/No	
14	Tunnels construction Tunnels are constructed using semi-refractory bricks.	a. Are the joints between bricks 5mm thick? b. Are the joints filled with clay mortar made from 50% clay, 35% kaolin and 15% chamotte?	a. Yes/No b. Yes/No	

15	Kiln floor The kiln floor is built with refractory bricks laid on edge.	Is the space between the foundations to the kiln floor level is filled firmly with well compacted broken burnt bricks or other approved materials?	Yes/No	
16	Chimney & fire control box Careful attention is required in building walls for the fire control box and the chimney.	a. Are the chimney and fire control box accurately set in the right place? b. Are semi-refractory bricks used laid in clay mortar? c. Is the first floor slab for the fire control box cast in concrete? d. Are the 4-concrete columns that support the concrete roof of the heat control box cast as per specifications?	a. Yes/No b. Yes/No c. Yes/No d. Yes/No	
17	Construction of vaults These are built with refractory bricks laid in clay mortar.	Check and verify: a. The accurate making and erection of the vaults formwork. b. That the wedge-shaped bricks are tightly laid against each other.	a. Yes/No b. Yes/No	
18	Fuel feeding inlet holes	Are the fuel feeding holes correctly positioned as per specifications?	Yes/No	
19	Construction works to roof top	Check the following: a. That filling the space between the vaults and kiln roof is filled with approved materials. b. That bricks are tightly laid against each other on edge to form the roof.	a. Yes/No b. Yes/No	

20	Construction of the fire control box	<p>Check the following:</p> <p>a. Are the fire control valves well fixed?</p> <p>b. Is the area around valves well concreted?</p>	<p>a. Yes/No</p> <p>b. Yes/No</p>	
21	Chimney installation	<p>a. Are the steel plates and bolts for fixing the chimney on top of the heat control box accurately and securely anchored to the heat control box?</p> <p>b. Is the chimney anchored on top of the fire control box with bolts tightly?</p>	<p>a. Yes/No</p> <p>b. Yes/No</p>	
22	Bracing the chimney The chimney is anchored and braced to concrete pads.	<p>Check the following:</p> <p>a. Are the 4-concrete columns cast to specified depths and widths?</p> <p>b. Is the chimney firmly braced and strutted to the concrete with 16mm thick steel cable?</p>	<p>a. Yes/No</p> <p>b. Yes/No</p>	
23	Chimney control A door is made in the chimney for inspection, where a valve is fixed for heat and smoke control.	<p>Check:</p> <p>a. If the valve is flexible, moving when turned?</p> <p>b. Does the door seal tightly when closed?</p>	<p>a. Yes/No</p> <p>b. Yes/No</p>	
24	Smoke channels The smoke channels linking the kiln to the main smoke chimney.	<p>a. Are the joints between bricks 5mm thick?</p> <p>c. Are the joints filled with clay mortar made from 50% clay, 35% kaolin and 15% chamotte?</p>		

		Does the outer part wall protected by stone masonry?		
25	Bottom chimney Masonry part The masonry part have to be well constructed in Reinforced wall load bearing wall (for external part) The inner part is constructed using the semi-refractory bricks.	a. Are the joints between bricks cement mortar? d. (For inner semi-refractory brick wall)Are the joints filled with clay mortar made from 50% clay, 35% kaolin and 15% chamotte?		

05

05.02 - KILN CONSTRUCTION SCHEDULE

INTRODUCTION

The construction schedule presented in this chapter is for the full scale construction of a semi-industrial kiln and assumes that the hanger that shelters the kiln has already been constructed.

The schedule therefore highlights key construction activities which guide the construction foreman and the kiln owner in planning for the required construction resources well in advance. The entire construction period ranges from six to eight (6-8) months.

In making the construction schedule, allowances must be made for bad weather and ample time allowed especially in ordering some of the construction materials such as the special refractory bricks required for specific works.

THE CONSTRUCTION SCHEDULE

Estimated construction period in weeks

n.	construction activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	SETTING OUT & EXCAVATION	■																							
2	ORDERING SPECIAL BRICKS	■																							
3	SOIL COMPACTION		■																						
4	GRAVEL COMPACTION			■																					
5	SETTING OUT FOUNDATION			■																					
6	FORMWORK PADS				■																				
7	CONCRETING PADS				■																				
8	EXTERNAL WALLS OF VAULTS					■																			
9	CONSTRUCTION OF TUNNELS						■																		
10	BACKFILLING							■																	
11	TIE BEAM FORMWORK							■																	
12	TIE BEAM CONCRETE								■																
13	WORKS ABOVE TIE BEAM								■		■														
14	FORMWORK OF VAULTS									■															
15	BUILDING OF VAULTS											■													
16	FABRICATION OF CHIMNEY												■												
17	FIRE CONTROL BOX													■											
18	WORKS ABOVE VAULTS														■										
19	BACKFILLING ON TOP OF VAULTS															■									
20	ROOF WORKS																	■							
21	CHIMNEY ANCHORAGE																			■					
22	FIXING OF CHIMNEY																					■			
23	CLEANING																							■	

Skat Consulting Rwanda
KG 5 Ave, No 40. Kigali, Rwanda
phone: +250 (0)78 838 57 90 (office)
www.madeingreatlakes.com

Skat Swiss Resource Centre
and Consultancies for Development
PROECCO Promoting Employment through
Climate Responsive Construction

Skat Consulting Ltd. (Head Office)
Vadianstrasse 42 CH-9000 St.Gallen Switzerland
phone: +41 (0)71 228 54 54
web: <http://www.skat.ch>