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SUSTAINABLE FISHERIES MANAGEMENT PROJECT (SFMP)

AHOTOR OVEN CONSTRUCTION MANUAL

NOVEMBER, 2015

THE UNIVERSITY OF RHODE ISLAND GRADUATE SCHOOL OF OCEANOGRAPHY | COASTAL RESOURCES CENTER
Hen Mpoano
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Acronyms

CCM	Centre for Coastal Management
CEWEFIA	Central and Western Region Fishmongers Improvement Association
CRC	Coastal Resource Center
CSLP	Coastal Sustainable Landscape Project
DAA	Development Action Association
DFAS	Department of Fisheries and Aquatic Science
DMFS	Department of Marine Fisheries Sciences
DQF	Daasgift Quality Foundation
FtF	Feed the Future
GIFA	Ghana Inshore Fishermen's Association
GIS	Geographic Information System
GNCFC	Ghana National Canoe Fishermen’s Council
HM	Hen Mpoano
ICFG	Integrated Coastal and Fisheries Governance
MESTI	Ministry of Environment Science and Technology
MOFAD	Ministry of Fisheries and Aquaculture Development
NDPC	National Development Planning Commission
NGOs	Non-Governmental Organizations
SFMP	Sustainable Fisheries Management Project
SMEs	Small and Medium Enterprises
SNV	Netherlands Development Organization
SSG	SSG Advisors
STWG	Scientific and Technical Working Group
UCC	University of Cape Coast
URI	University of Rhode Island
USAID	United States Agency for International Development
WARFP	West Africa Regional Fisheries Development Program

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SECTION 1: ABOUT THE MANUAL

1.1 The design of the manual

This manual is designed to give first-hand information on the steps, procedures, tools and materials that stove builders require to construct an Ahotor oven. It outlines the basic steps involved in the construction of the oven based on field testing and experience. This interactive manual is developed in simple language with sketches that can easily be understood.

The design of the manual is intended to provide practical information and teaching aid for stove builders and technical knowledge in constructing the Ahotor oven to specification.

1.2 Sustainable Fisheries Management Project

Sustainable Fisheries Management Project (SFMP) is a five year USAID funded project with the objective of rebuilding marine fisheries stocks and catches through adoption of responsible fishing practices. The project is a Feed the future initiative and contributes to the Government of Ghana's fisheries development objectives and USAID's Feed the Future Initiative. Coastal Resources Center (CRC) leads the implementation of SFMP with a consortium of local and international partners and MoFAD.FC (Ministry of Fisheries and Aquaculture Development and the Fisheries Commission).

1.3 AHOTOR OVEN

The Ahotor oven was developed by SNV Ghana under Sustainable Fisheries Management Project (SFMP) to improve on the quality and competitiveness of smoked fish through the use of a clean smoking technology.

The Ahotor oven is designed as an improvement over the existing Chorkor smoker. The oven comprises of a combustion chamber fitted centrally to a Chorkor-like outer shell, with fish processing trays above as in a normal traditional oven. Above the combustion chamber, a fat collecting tray is fitted that allows the hot gases to flow up through to the fish while preventing any fat from dropping down onto the fire. A primary air inlet allows for oxygen into the combustion chamber to enhance efficient combustion of the fuelwood. The secondary air inlet located on top of the fuelwood entrance introduces cool air into the smoking chamber to meet with heat from combustion chamber, to enable even circulation of air and heat in the smoking chamber. The grate located underneath the combustion chamber improves combustion by elevating the fuelwood and allowing for better heat circulation. The Ahotor oven is energy efficient (reduces fuelwood consumption by 32%), emits less smoke compared to the Chorkor and produces smoked fish with low PAH levels of 10.93μ/kg which is less than the EU standard of 12 μ/kg.

COMPONENTS OF THE AHOTOR OVEN AND THEIR FUNCTIONS

Table 1: COMPONENTS OF THE AHOTOR OVEN AND THEIR FUNCTIONS

Component	Picture	Function
Combustion Chamber		It ensures efficient combustion of fuelwood It reduces smoke emissions It ensures heat retention
Primary Air Inlet		It supplies oxygen into the combustion chamber It is the channel for fanning the oven
Grate		It elevates fuelwood for better circulation of air It supports efficient and complete combustion of fuelwood
Secondary Air Inlet		It supplies cooler air into the combustion tube to mix with the hot gases from the combustion chamber It ensures fast flow of gases in the smoking chamber
Fuelwood Entrance		It receives fuelwood It regulates fuelwood use

Fat Collector		It redistributes heat into the smoking chamber It receives fat and other drippings from fish and channel it out of the oven It serves as the ash receptacle for it to absorb the fat.
Fat Exit		It is the exit for fats and other drippings from the fish

Table 2: Basic measurements

Oven Parts	Breath		Length		Height	
	Millimetre (mm)	Inches (inch)	Millimetre (mm)	Inches (inch)	Millimetre (mm)	Inches (inch)
Stove Wall (Outer)	1092	43	1120	44	840	33
Primary Air Inlet (Inner)	100	4	356	14	127	5
Firewood Entrance (Inner)	254	10	630	24 ¾	285	11
Combustion Tube (Inner)	150	6	150	6	356	14
Secondary Air Inlet (Inner)	229	9	350	13 ¾	220	8 ¾
Combustion Chamber(Inner)	254	10	629	24¾	660	26
Oil Collector	851	33 ½	800	31 ½	89	3.5
Grate	241	9.5	400	16	75	3

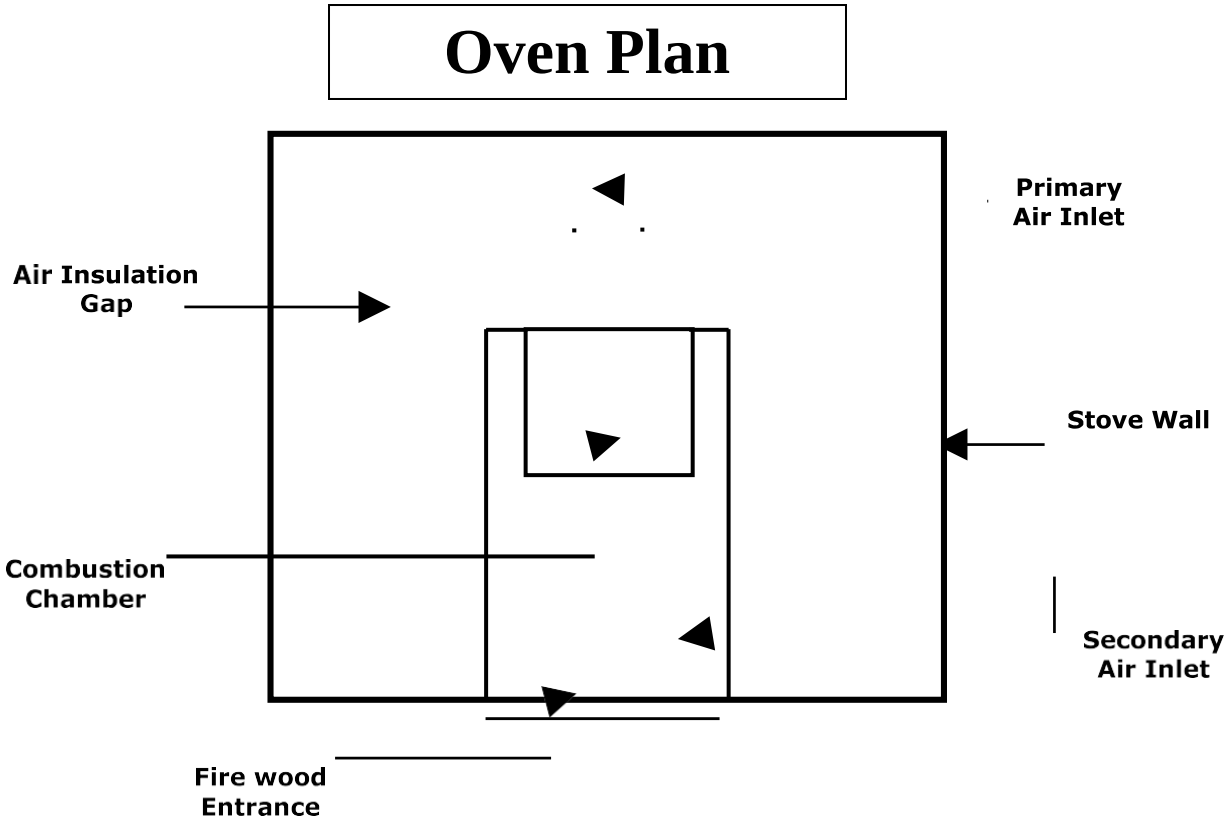


Figure 1: Oven Plan

Instructions

Brick & Block Dimensions

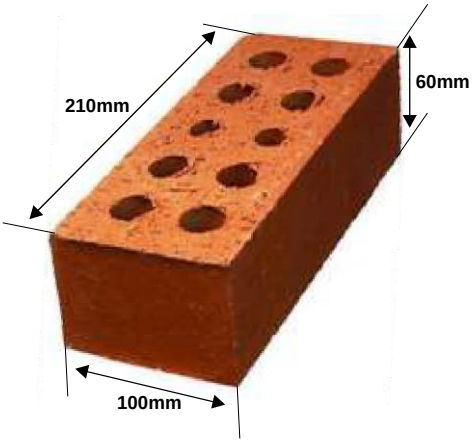


Figure 2: Brick

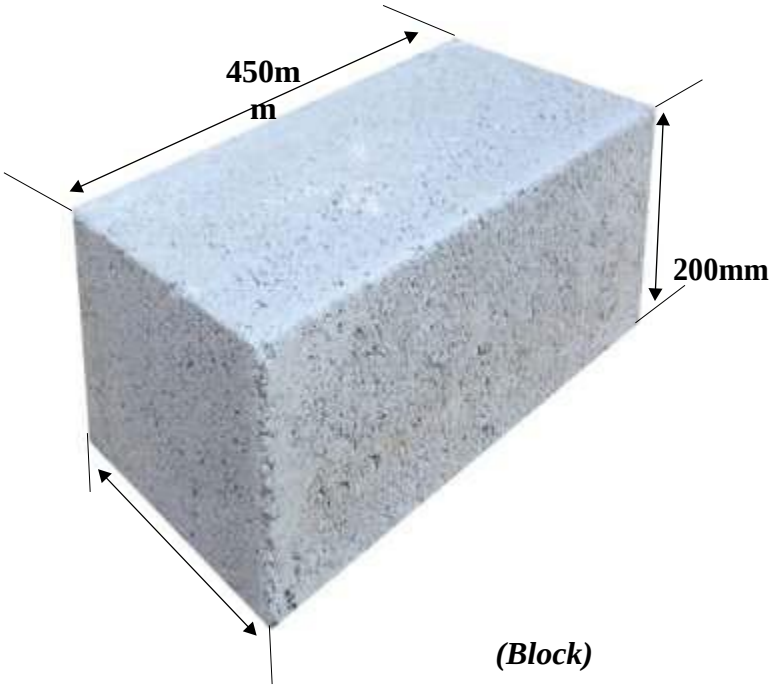


Figure 3: Block Dimensions

(Brick) ***(Block)***

127 mm

protective clothing
(hard hats, boots

Tools/Equipment

- √ Masonry Wood pan
- ü
- √ Wheel barrow
- √ Shovel/Spade
- √ Plastic bowls/buckets
- √ Hammer
- √ Saw
- √ Spirit level
- √ Trowel
- √ Try Square
- √ Head pan
- √ Measuring Tape
- √ Gloves
- √ Nylon rope/Line

1.3.1Construction Materials

The combustion chamber of the Ahotor oven is built with burnt bricks with mortar from clay and wood ash. Cement mortar is only used for the construction of the oven wall (outer Chamber) where there is limited exposure to heat. The quantity of materials and the given ratios are very important for both the physical and thermal strength.

Note: Mixing clay with grog (sand) or mica gives physical strength whereas mixing clay with wood ash gives thermal strength (can withstand heat)

Table 3: Clay Mortar Ratio and Cement Mortar Ratio

Clay Mortar Ratio

Materials	Parts
Clay	1 Bag
Wood Ash	1/4
Water	Considerable

Cement Mortar Ratio

Materials	Parts
Cement	1 Bag
Sand	3 Headpan
Water	Considerable

Table 4: Quantity of materials for constructing single unit Ahotor oven with sandcrete blocks as the wall

Quantity of materials for constructing single unit Ahotor oven with sandcrete blocks as the wall	
Material	**Quantity**
Clay	3 head pan
Wood Ash	1 head pan
Cement Blocks	30 pieces
Sand	3 wheel barrows
Burnt Bricks	100 pieces
Cement	1bag

Table 5: Quantities of materials for constructing single unit Ahotor oven with burnt bricks for outer wall/shell

Quantities of materials for constructing single unit Ahotor oven with burnt bricks for outer wall/shell	
Material	**Quantity**
Burnt Bricks	1 head pan
Sand	6 wheel barrows
Wood Ash	2bags
Cement	

Note: Cement is not heat resistant hence it is not advisable to use it for mortar for the combustion chamber. It may result in cracking and affect oven durability.

Table 6: Retrofit (Single Unit)

Retrofit (Single Unit)	
Material	**Quantity**
Burnt Bricks	100 pieces
Clay/Anthill	3 head pan
Wood Ash	1 head pan

OVEN CONSTRUCTION PROCESS

1. Using a measuring tape and a line, measure and mark out the area where the stove will be constructed.

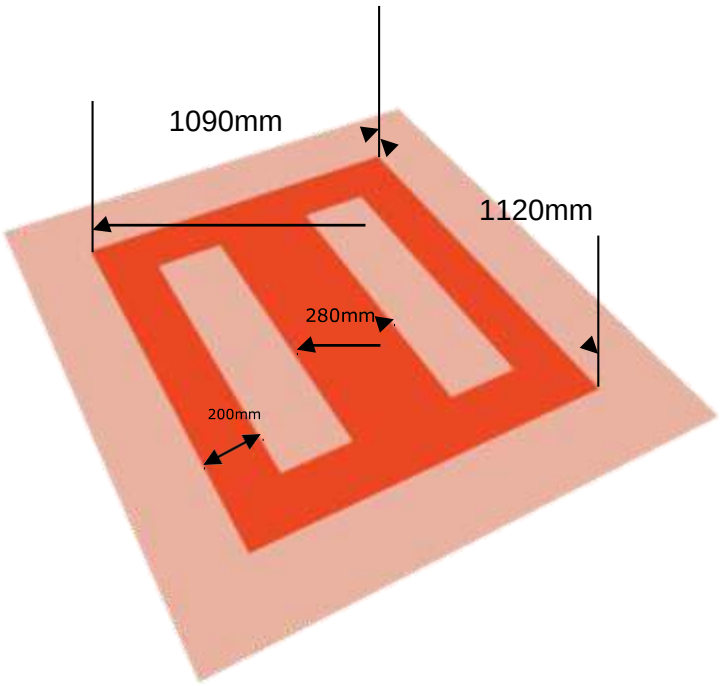


Figure 4: OVEN CONSTRUCTION PROCESS

2. Dig out the marked area about 50mm deep into the ground and pour cement concrete mixture into the dug area. Using the spirit level, check to correct slopping and dress the surface.

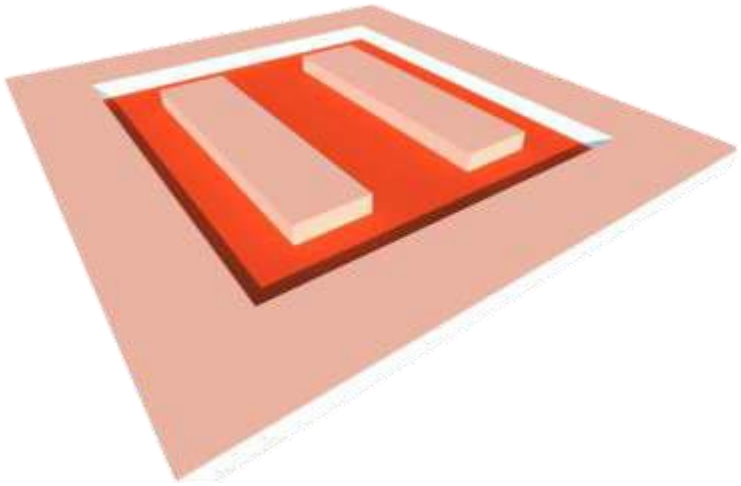


Figure 5: OVEN CONSTRUCTION PROCESS

3. Mark the mid-point to identify the center. From the center measure and mark out the firewood entrance and the primary air inlet which are the inner chambers according to the given measurements.

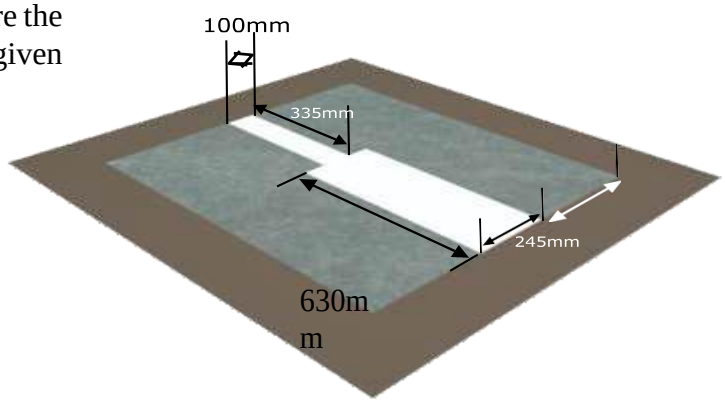


Figure 6: OVEN CONSTRUCTION PROCESS

4. Put clay mortar along the mark out and set bricks on them for the first course of the fire entrance and the air inlet.

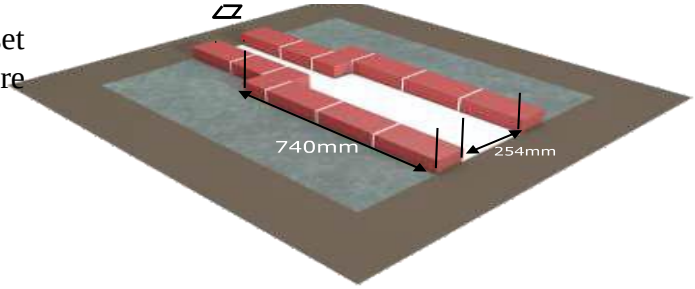


Figure 7: OVEN CONSTRUCTION PROCESS

5. Insert clay mortar to join all the bricks and lay bricks to bridge the air inlet.

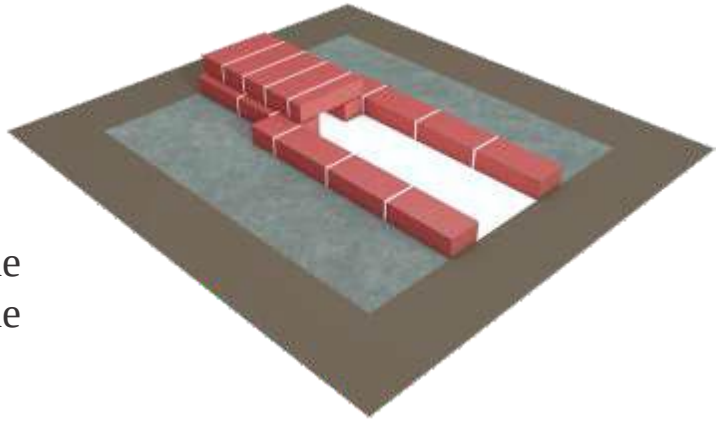
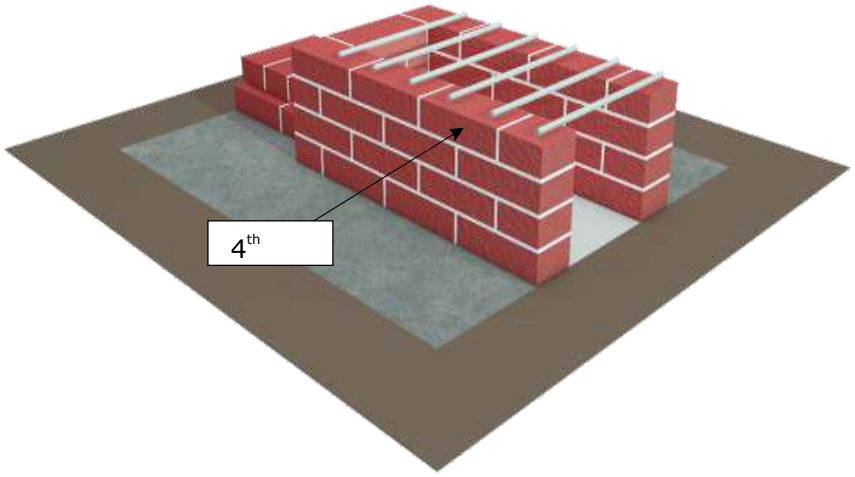


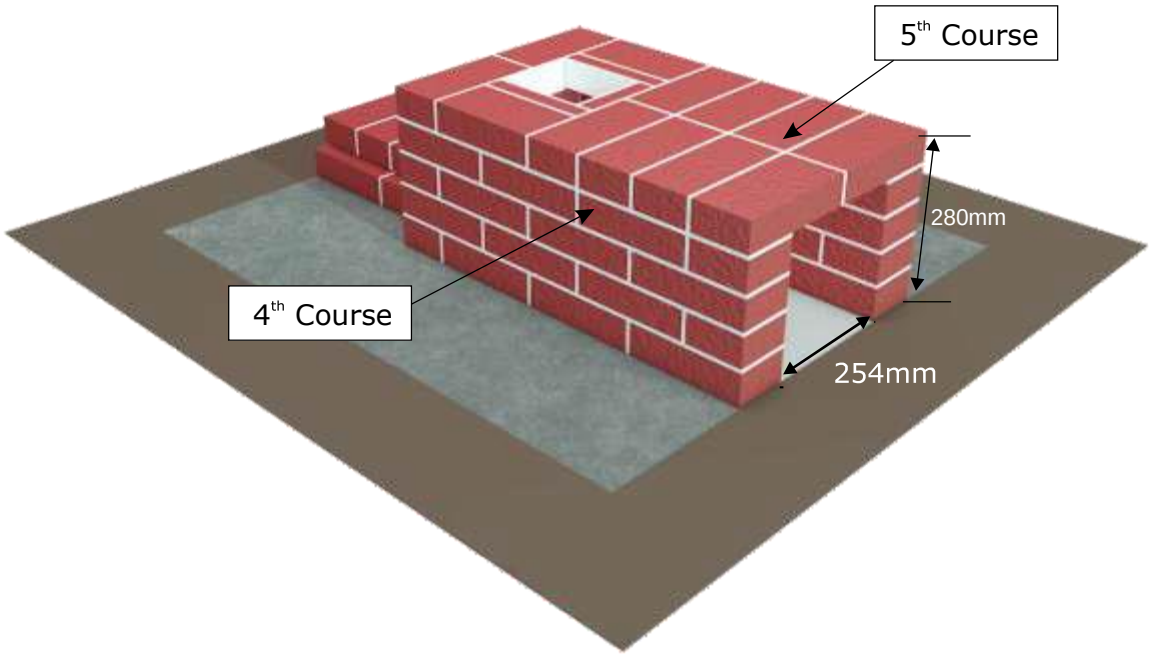
Figure 8: OVEN CONSTRUCTION PROCESS

Intersect the second course in order to avoid continuous joints and insert with clay mortar. Repeat this until you

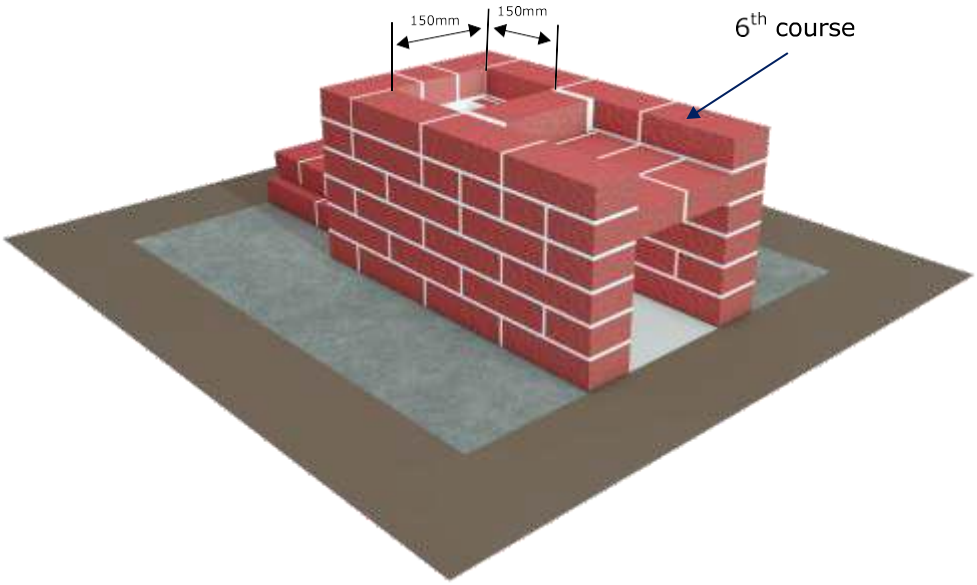
attain 280mm usually at the 4th quarter rods to hold bridge. Course and put across



6. Set and lay the 5th course to bridge the 4th course and leave an opening at the end measuring 180mm by 180mm. At the 5th course (bridge) shift the bricks in slightly, to attain the 150 mm x 150mm combustion chamber.



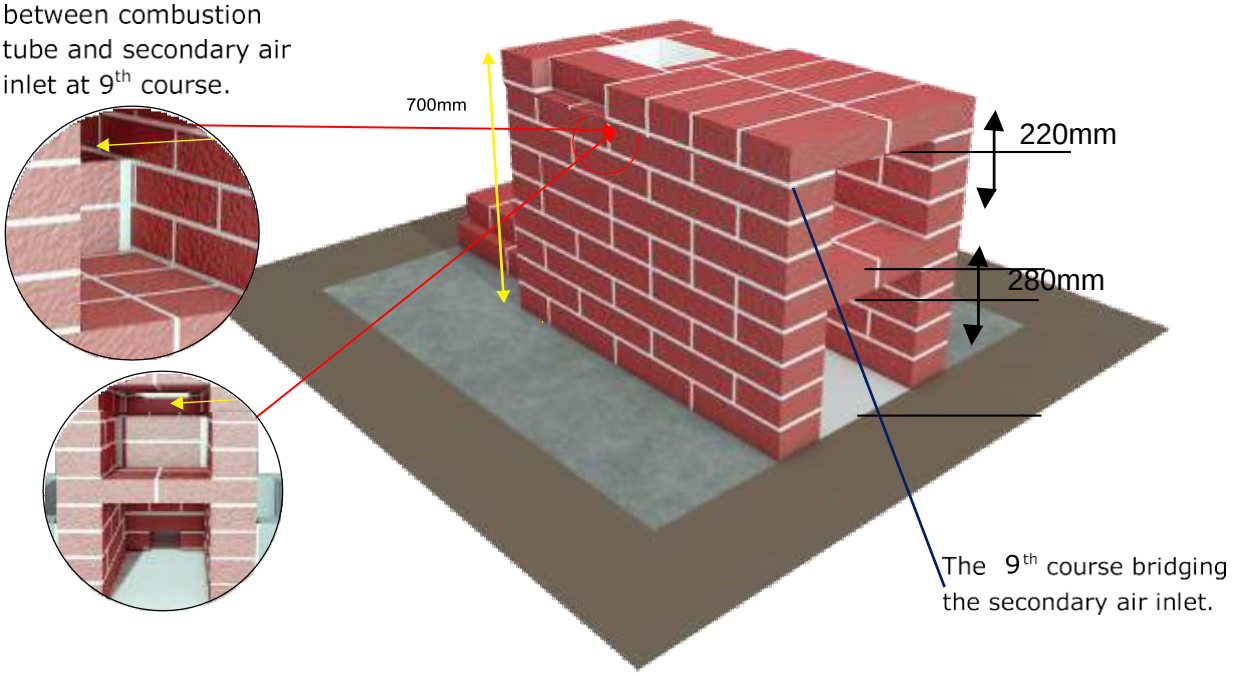
7. Set and lay the 6th course along the edge of the 5th left course and project the opening.



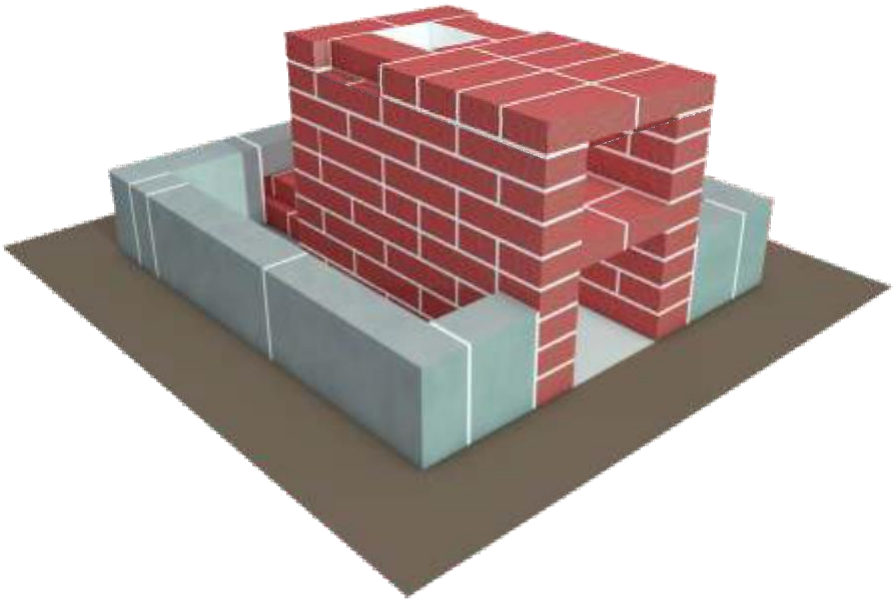
8. Repeat step 7 until the 7th course is complete leaving the last wall between the combustion tube and the secondary air inlet opened. At the 9th course, put quarter rods across the air inlet and bridge 320mm towards the combustion tube.

The fuelwood chamber opens into the primary air inlet whereas the secondary air inlet opens into the combustion tube with one brick opening.

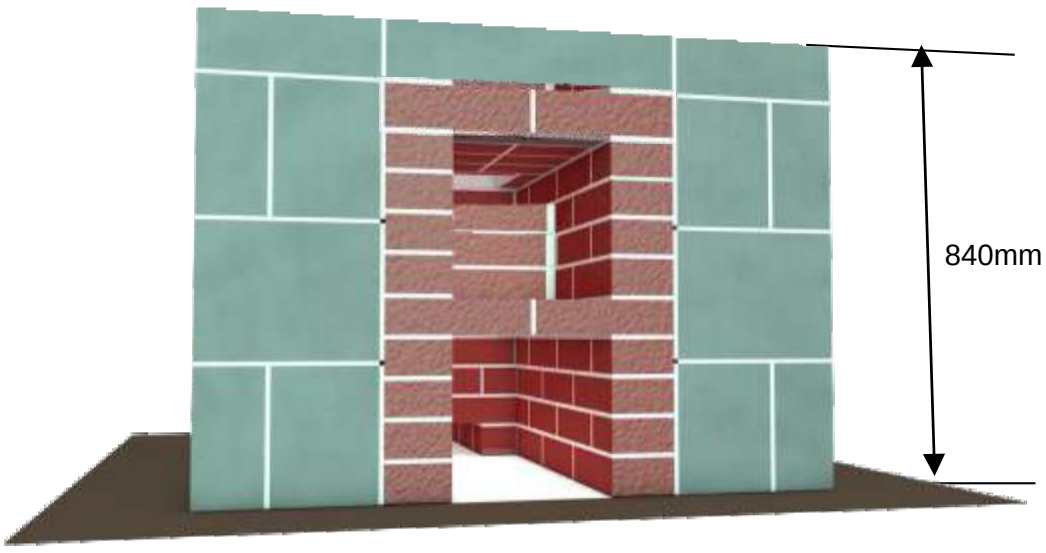
One brick opening wall between combustion tube and secondary air inlet at 9th course.



9. Put cement mortar along the marked outer line and set cement blocks on it touching the end of the brick where they meet the outer lines.

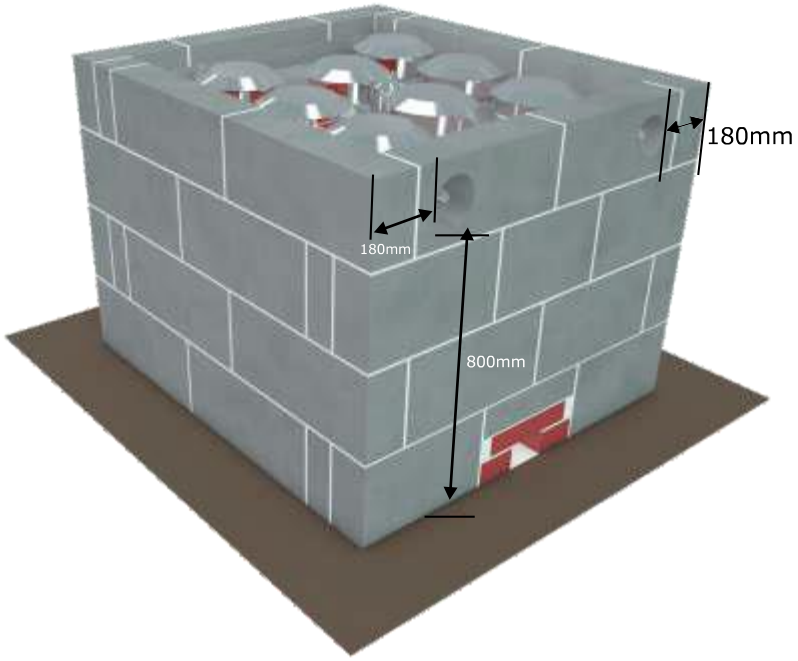


10. Intersect the 2nd layer in order to avoid continuous joints and insert with cement mortar. Repeat this for the 3rd layer.



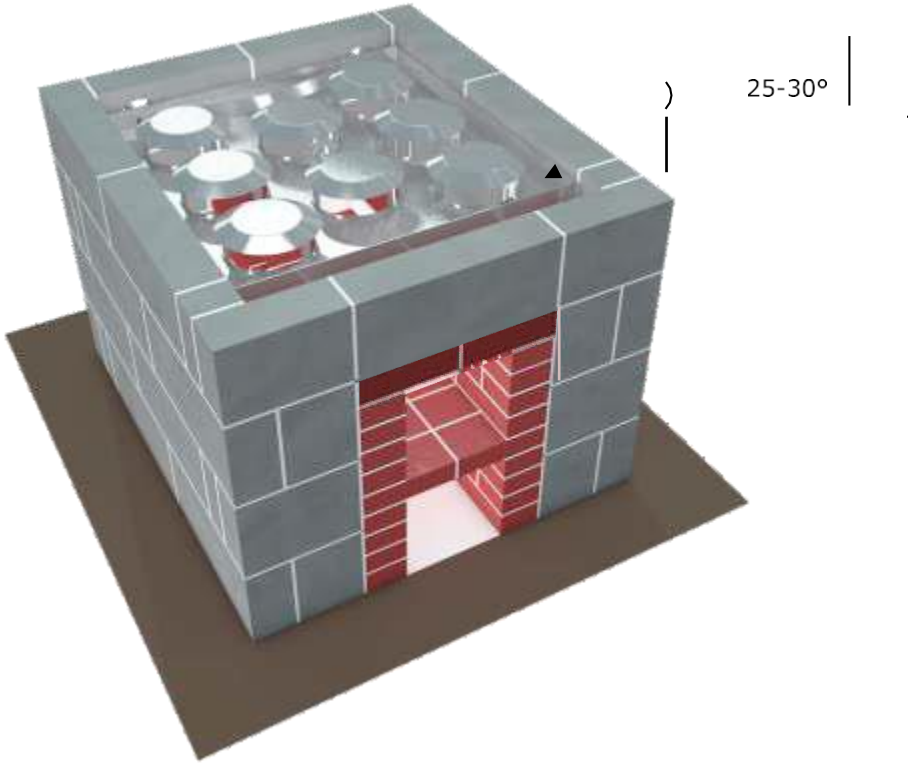
11. Drill/create two 100mm diameter holes on the wall opposite the entrances about 180mm long from each side of the last layer of the blocks and set the drain oil collector into them.

Set the fat collector first to be sure of the exact location before drilling the holes.

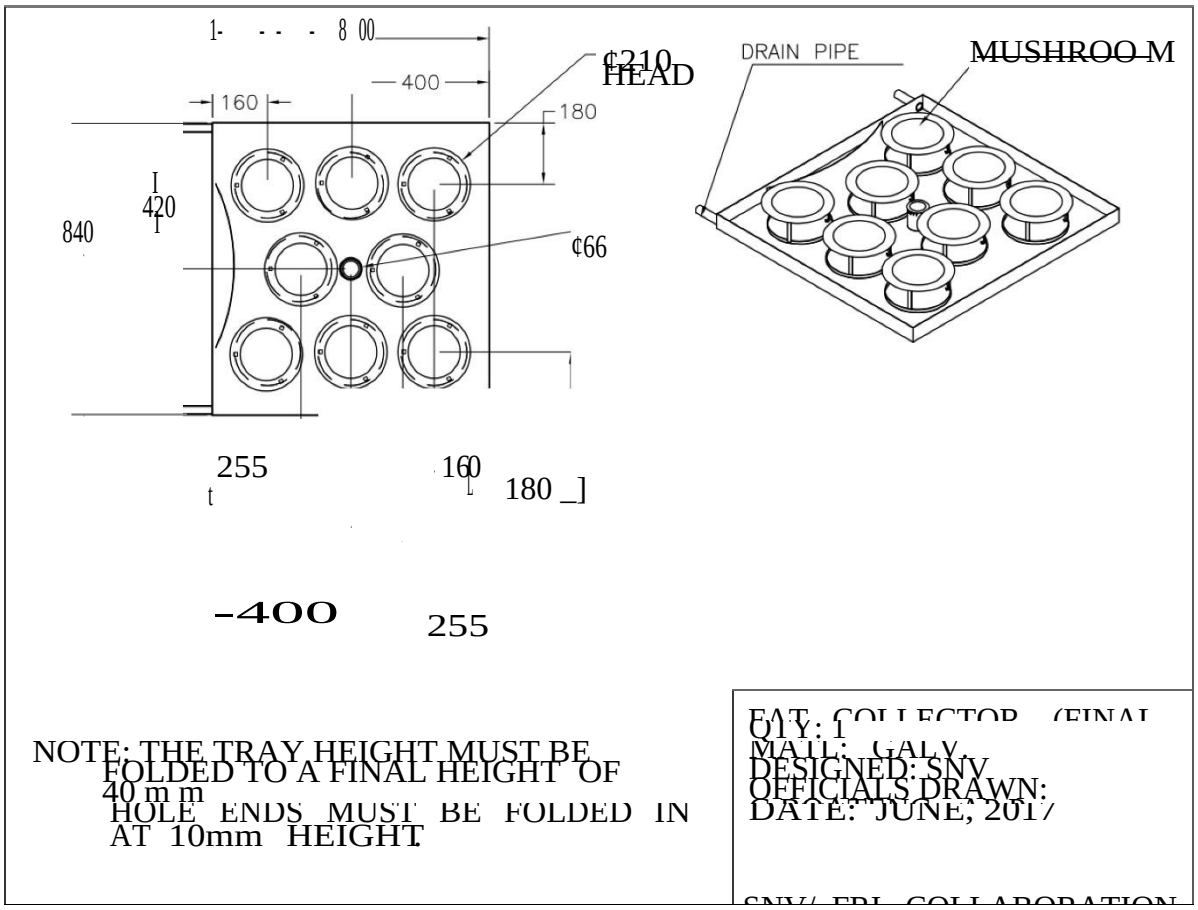


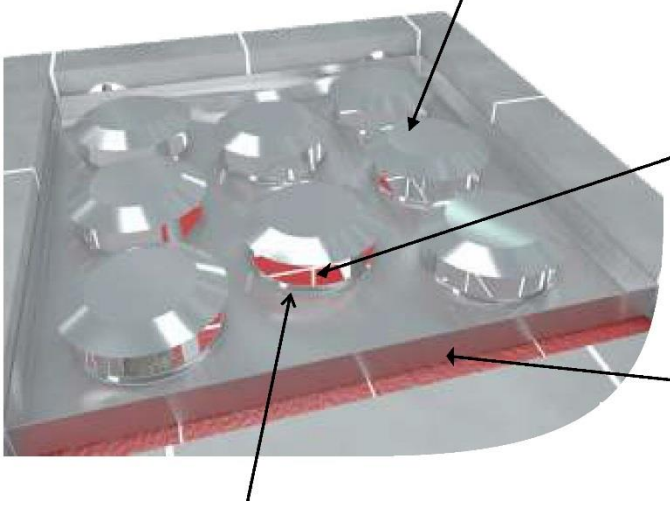
12. Set the oil collector at an angle of about 25°-30° inthe chamber with the higher end resting on the 10th course of the bricks.

Check the slope by pouring water on the collector to see the drains flow gently down through the fat exit holes.



Oil Collector

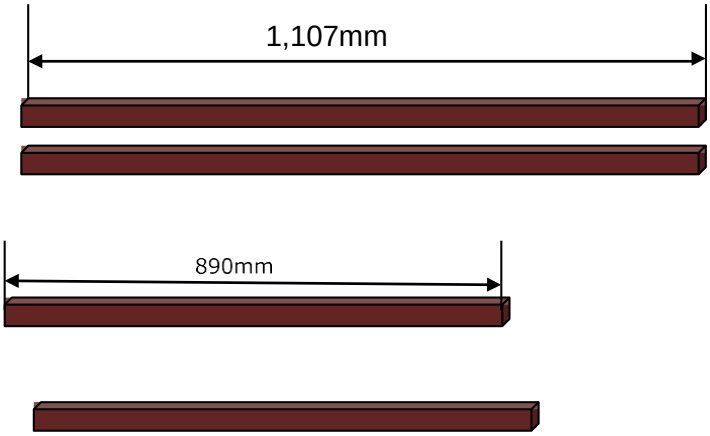




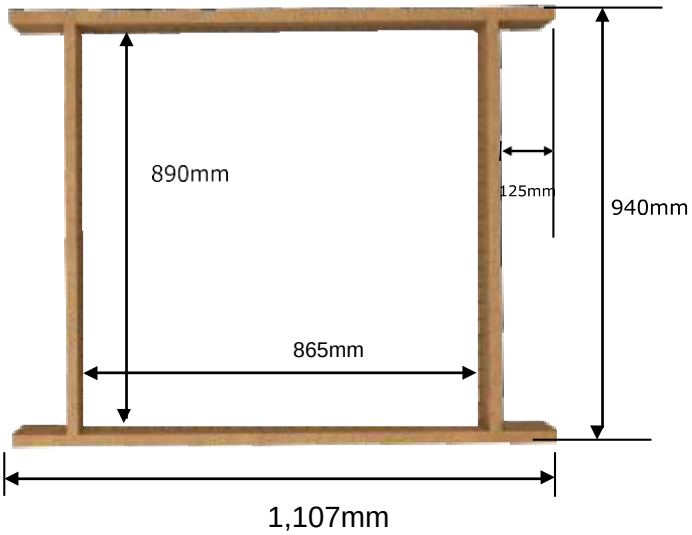
Raised mouth of heat escape hole (180mm 8) to a height of 5mm, which prevents oil from dropping into the fire

TRAY MAKING

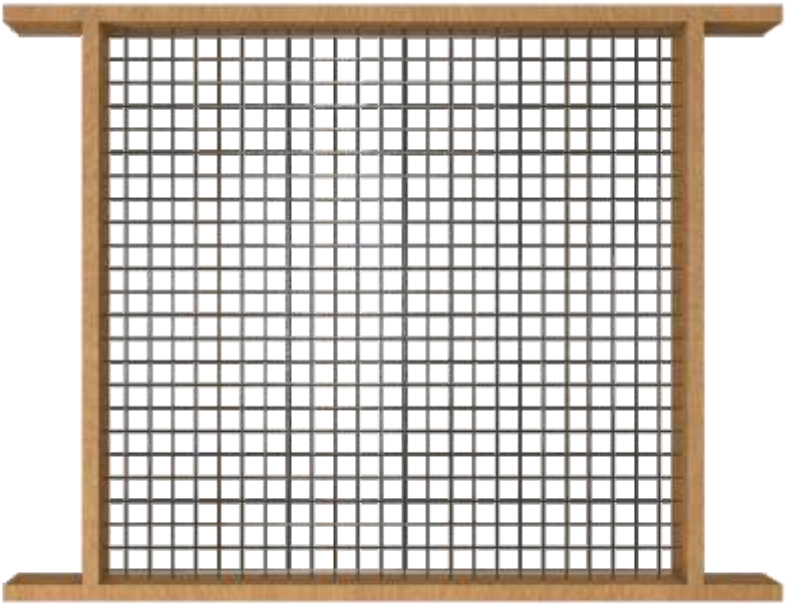
1. Cut a (2 by 1) Wawa wood beam in pairs of two, one-1,107mm long and the other-890mm long.

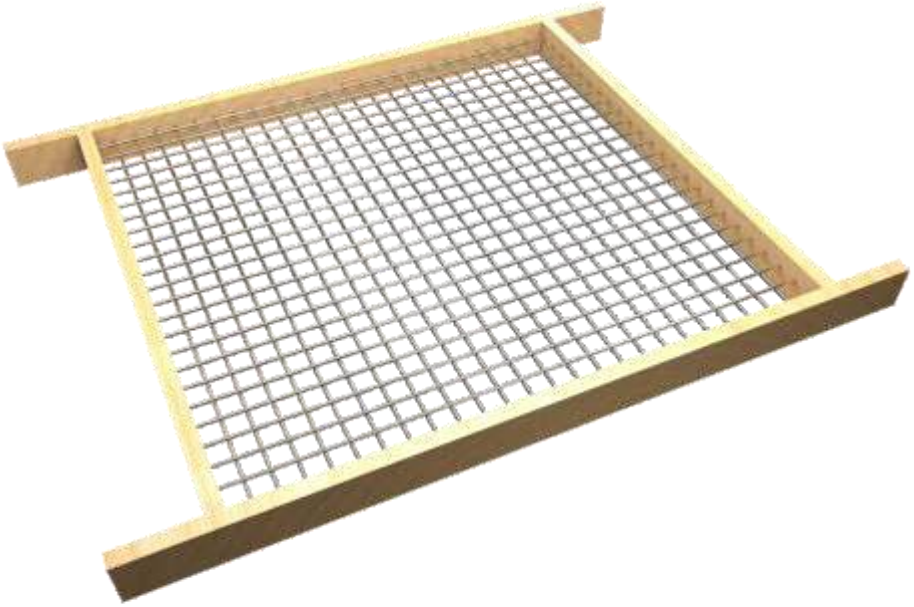


2. Mark 125mm at the ends of the long beam. Put the short beams between the long beams on the mark and nail them with a hammer.



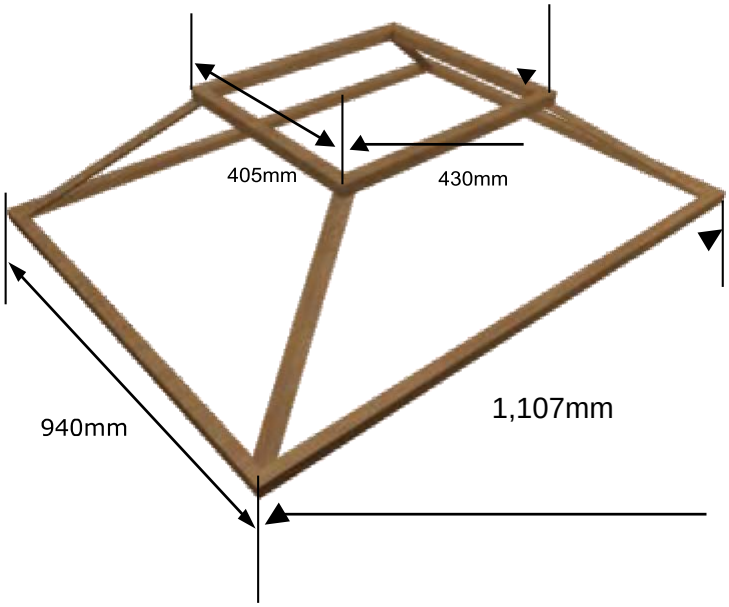
3. Turn it over and nail to the base of the tray wire mesh, usually 1cm².Then nail buttons to cover the mesh ends and hold them firm to the tray. Repeat the previous *steps* until the required number of trays is achieved.



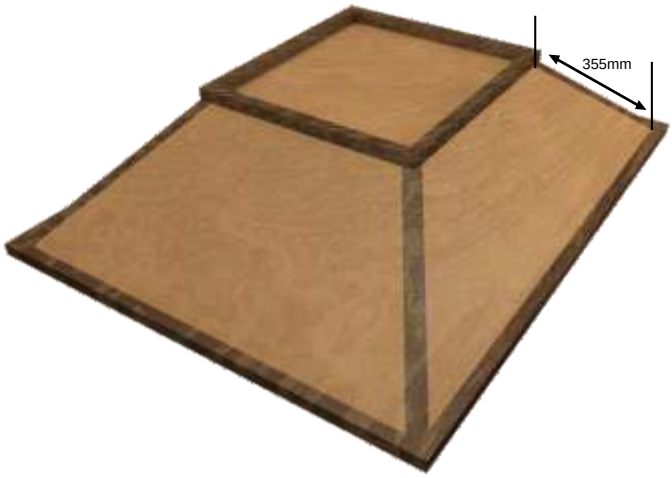


HOOD MAKING

1. Make one tray without a wire mesh and join it to a 475mm x 535mm wooden frame at a height of 270mm.



2. Cut and nail ply woods to cover the frame work.



3. Cut the top part of the hood to a diameter of 150mm ±20mm and place the mesh on top of it.

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Figure 9: SUSTAINABLE FISHERIES MANAGEMENT PROJECT (SFMP)