

MANUFACTURING AND SPECIFICATIONS OF PREFABRICATED FERROCEMENT ROOF CHANNELS

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SYNOPSIS

A ferrocement roof channel is a longitudinal element, semi-cylindrical shaped. It is easy to construct, uses less cement and steel than a conventional RCC roof and is also cheaper. During the installation process the roof channel is lifted into place and can immediately be joined together in order to provide a shelter, a roof or a floor slab.

The following document gives a detailed description of the manufacturing process of the most common and tested roofchannel developed by the Auroville Building Centre.

Introduction

Providing shelter to an ever increasing population is a challenge which cannot always be solved with the help of conventional available building materials like bricks and concrete. Although these two materials have a proven track record, they are becoming increasingly expensive and out of reach for many users.

Ferrocement roofchannels can be a solution as a roofing system for a wide variety of building situations.

The technique consist of making a mud mould on which the ferrocement roofchannel is cast, left overnight, demoulded within the next few days, cured and finally installed and finally installed and joined in suit at the required site.

The main advantages are:

- ✍ Less use of cement and steel for any given section compared with RCC, with a corresponding reduction in self weight.
- ✍ A major reduction in cost expenses compared to RCC.
- ✍ An easy manufacturing process, requiring only one mason and a mason helper.
- ✍ A simplified and cheaper installation practice compare to RCC
- ✍ The technique requires neither scaffolding, shuttering, nor a concrete mixer or a vibrator.

Some disadvantages could be:

- ✍ The need of a casting space and working area to prefabricate the elements and cure them, this may be difficult or expensive, especially in an urban setting.
- ✍ The need for strict control to ensure quality product
- ✍ The need for a proper applied curing method, usually overlooked in many building construction activities
- ✍ If the elements are not manufactured on the site they will have to be transported, which adds to the cost.
- ✍ Care should be taken not to damage the elements during transportation.

Manufacturing process

Mud mould construction

A prefabricated ferrocement channel is manufactured on a mud mould. This is a permanent fixed construction built up with the help of bricks and mud into the exact desired shape of the roof channel

After executing the desired shape of the mud mould, the whole construction is coated with a layer of cement mortar of about 10 mm thickness. Proper curing is necessary in order not to develop cracks during the casting periods of the roofchannel.

It is preferable to construct the mud mould under a covered space, to provide a protection against the heat of the sun.

After the curing of mud mould is over, the entire surface of the mould is cleaned with sand paper and coated with engine oil, this procedure has to be repeated until the cement stops absorbing the oil.

The mud mould is now ready for continuous casting of the ferrocement roofchannels.

In order to work accurately and manufacture roof channels of an even thickness, it is recommended to use a template made out of marine plywood or steel sheet.

A coat of waste engine oil is applied as the demoulding agent.

Steel and mesh preparation

The steel reinforcement used within the ferrocement roofchannel consist of the following materials :

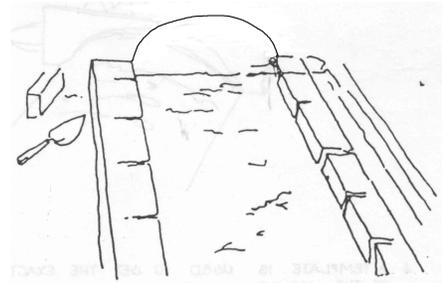
Two bottom steelrods of either 8, 10 or 12 mm thickness. The

two bottom rods change according to the span of the channel and the load it sill have to take.

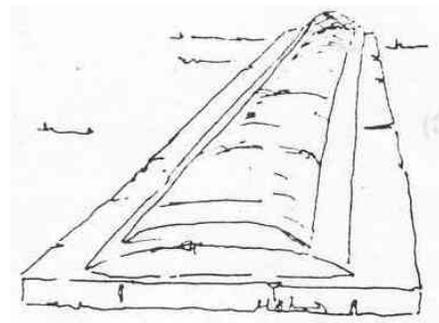
One top steel rod of 6 mm thickness, or 2 GI steel wires of 4 mm.

One longitudinal layer of GI hexagonal wiremesh (12 mm x 071 mm x 0.90 m) and two cross layers of GI mesh (1/2" x 22 gauge x 3") at both end s of the roofchannel.

1. The steel rods are straightened and cut to the required size.
2. The mesh is cut off from the roll to the desired length and flattened out evenly with the help of a steel rammer, if necessary.
3. On top of the outstretched mesh the steelrods are placed. The two bottom rods at the outside and the top steelrod in the middle. The steelrods are secured to the mesh with the help of binding wire.



Setting up of the mud mould



Shaping the mudmould to the desired form



The finished mudmould



A template is used to get the exact shape of the mould

Casting Procedure

1. The mud mould is coated with a layer of waste engine oil.
 2. The total amount of required mortar mix is prepared with a ratio of water / cement / sand as 0.45:1:2.
 3. A first layer of the cement mix is applied on top of the mud mould already coated with the waste engine oil. This cement layer should be around 5 mm thick and evenly spread out over the whole surface of the mud mould. Some care and training is necessary not to spread cement mortar mixed with the previously applied waste oil. One should learn to apply the first coat properly and directly. Places where the cement mortar got mixed up with the oil should be discarded.
 4. The prepared steel and mesh frame is placed on the first layer of the cement mortar.
 5. The second and final layer of cement mortar is applied over the steel structure. The use of a template is useful in this phase in order to maintain an even thickness over the whole ferrocement roofchannel. Several irregular lines (serrations) are made on the lower portion of both sides of the roofchannel in order to facilitate the bonding process with a concrete mix while joining the channels together.
- In case the roofchannel is used as a roof, some final polishing is done with the mason trowel. This is not necessary in case the roof channel is used as a floor or filled up for heat insulation.
6. After the casting the channel is left for one day on the mould.

Demoulding procedure

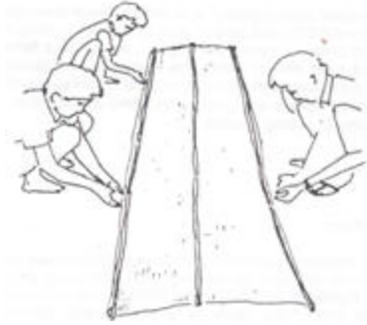
The demoulding of the roofchannel is done after 48 hours (with more handling experience one can even try to demould on the very next day)

For this purpose, the specially made small gaps in the bottom of the mould for an easy grip during the demoulding – are opened by removing the mud.

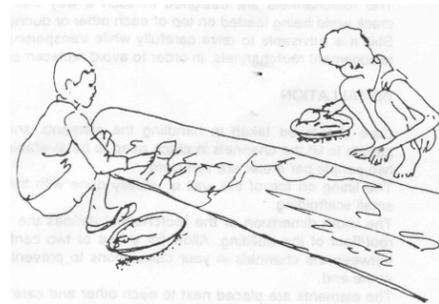
The roofchannel is slightly lifted on one side by using the gaps right under the border of the element, the other side is lifted and in the next move the whole channel is carried to the curing space.

Curing procedure

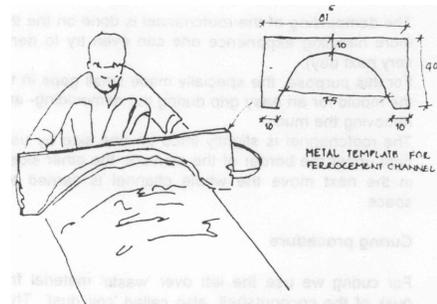
We use for curing the left over “waste” material from the fibre husk of the coconut shell, also called “coir dust”. This material is light, easy to apply and to remove and has a great water retention capacity which is an excellent quality for



Preparation of the mesh & steel bar reinforcement



Applying the first layer of mortar w:c:s 0.45:1:2



Achieving an even thickness of the channel by using a template a guide



Placing of the steel frame on top of the first mortar layer

curing practices. Other material, like sand or bags, or plastic sheets can be used.

The current material is place over the roofchannel, both ends are blocked off by a cheap or easily available material like empty cement bags. This procedure ensures that there is sufficient moisture on the inside of the roofchannel during the whole curing period. The curing medium is kept moist all the time and never allowed to dry out. One should keep watering accordingly. Curing may also be done by any other appropriate method for curing cement elements.

A solar curing tunnell is used at AVBC is bigger elements.

A curing period of minimum 7 days to maximum 10 days is recommended.

IMPROPER CURING PRACTICE RESULTS DIRECTLY IN A BAD OR WASTEFUL ROOFCHANNEL

TRANSPORT

Transport to the site can be done by any convenient available carrier method. A flat platform bullock cart is used for short distances. A lorry for longer distances. The channels are stacked one above each other, up to a maximum of eight channels.

The roof channels are designed in such a way that they don't crack while being loaded on top of each other or during transport. Still it is advisable to drive carefully while transporting a load of ferrocement roofchannels, in order to avoid replacement charges.

INSTALLATION

Care should be taken in handling the elements and sufficient people to lift the cannels in place need to be available. Normally two people per running meter are sufficient.

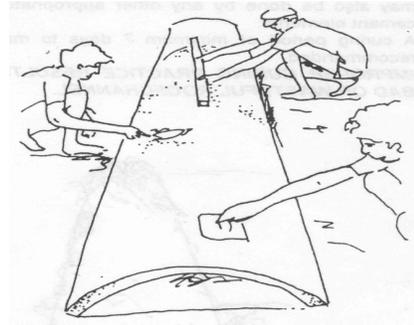
The lifting on top of the wall is usually done with the help of a small scaffolding.

The width dimension of the roofchannel defines the size of the roof/floor of the building. Allowance for a one or two centimeter gap between the channels during installation is in calculated.

The elements are placed next to each other and case is taken to adjust all the channels in one straight line.

After cleaning the sides with a wire brush, the valley in between is filled with a concrete mix having a ratio of 1:2:4.

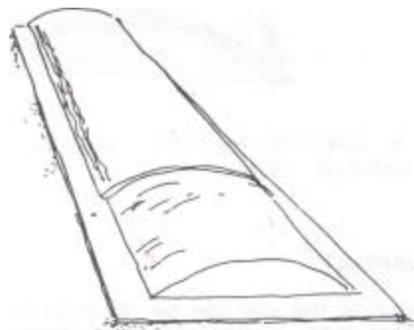
The finishing is done with applying a cement plaster, and a cement milk mixture is painted on as a last coat. A proper curing practice or method should be applied for the first 1 ½ week. Since the structure has to



Surface finishing touches



Applying the second layer of mortar



Finishing roof channel sides with serrations to facilitate joining channels



A curing method using coir dust & empty cement bags

function as a roof, proper curing of the joined channels is the most important feature.

Improper curing results in cracks and leaking problems. Needing energy consuming repair techniques and are a small economical disaster. Doing it properly the first time is still the best option, and the cheapest.

In the case of a floor application a brick border is provided around the entire floor structure, with a height corresponding to the chosen thickness of the overall filling.

The valleys can also be used for the laying of conduit pipes for electricity prior to filling them up.

The finishing layer should be done with a cement plaster or tiling and providing a rainwater slope for drainage is recommended.

FLOOR APPLICATION

It is advisable not to use concrete to fill up the entire roof, since in that case the heat insulation will be very bad. It is recommended to use a brick jelly and lime mixture in a ratio of 1:1 with no sand.

The tables for the strength calculations use the filling as a compression member, the need for a strong bonding between the filling medium and the ferrocement channel is essential.

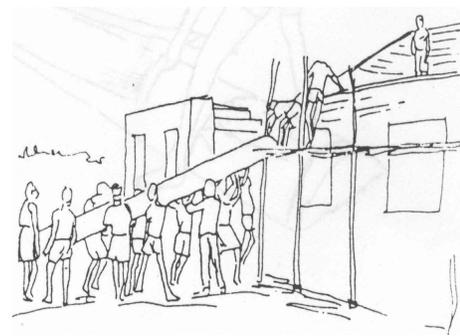
The maximum length of this channel design when it is fabricated for transport purposes is around 6 m.

Ferrocement roofchannels spanning more than 6 m up to 10.5 m can be custom designed and produced.

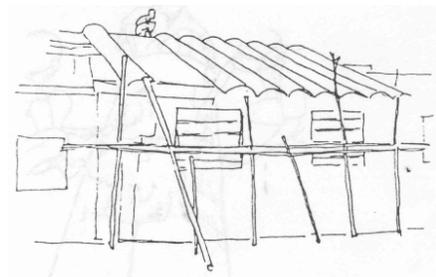
The manufacturing process follows the same procedure, with the construction on a mud mould. It is however recommended to produce this long and heavy roofchannels on the site itself in order to save oneself from the major headache of transportation problems.

APPLICATIONS IN URBAN AND RURAL CONTEXT

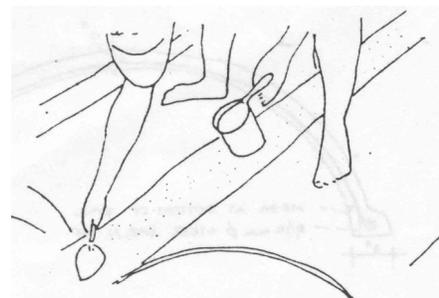
The described technique is applicable for the construction of cost-effective houses using stabilized mud block technology for walls and ferrocement roofchannels for the roof or floor in an urban as well as a rural context. Other interesting applications include factory buildings and work sheds for all kind of industrial activities.



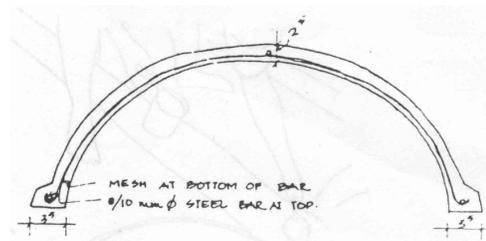
Lifting of the roof channel



Placing the roof channel next to each other



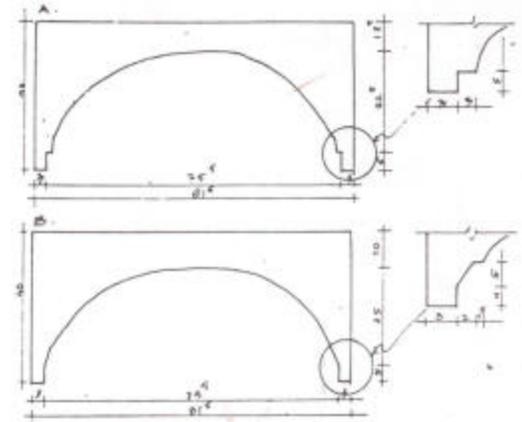
Joining roof channels with conc.mix 1:2:4



Finished roof channel

Table: Summary of technical details for ferrocement roof channels (per metre length)

Steel reinforcement bottom:	2 steel rods of 6, 8,10 or 12mm
Top:	1 steelrod of 6mm or 2 Gi wires of 4 mm
Mesh reinforcement:	1 layer of 12 mm x 0.71 mm (22 G) GI Hexagonal mesh, binding wire
Thickness:	Top side: 2.5 cm Bottom side: 3.5 cm
Weight:	Average: 55 kg/running metre
W:C:S: ratio W:	0.45 (for 1 meter: 6 liter)
C:	1 (for 1 meter : 13 kg)
S:	2 (for 1 meter : 26 kg)
Curing time:	7 to 10 days
Preparation reinforcement:	1 mason + 1 helper for 1 hour
Casting:	1 mason + 1 helper for 1hour



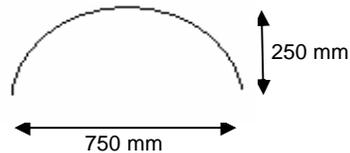
A. Metal template for mud mould
B. Metal template for ferrocement channel

PREFABRICATED FERROCEMENT ROOF CHANNEL

Element Profile

Dimensions : Length	6 mtrs
Width	0.75 cm
Height	0.25 cm
C / S / W ratio	1 / 2 / 0.45
Manufacturing time	1 day
Curing period	21 days
Thickness	25 mm
Weight	240 kg

Design Features



Manufacturing :

1. Raw materials:

Steel 12mm	(kg)
Steel 6 mm	(kg)
Mesh : GI Hex 22 G x 1/2"	(kg)
Binding wire	(kg)
Cement	(kg)
Sand	(kg)
Water	(ltrs)

Quantity	Unit price	Amount
10.5	26	273.00
1.8	26	47.00
3.25	85	276.00
0.5	30	15.00
100	175	350.00
200	30	60.00
45	0.25	12.00
Sub-total:		1,033.00

2. Consumables :

Used engine oil	(ltrs)
Water for curing	(ltrs)
Curing material	

0.5	15	7.50
50	0.25	12.50
	20	20.00
Sub-total:		40.00

3. Labour cost for manufacturing process

Mesh preparation
Casting
Demoulding
Curing

Labour	Time	Cost
M + H	3 hrs	90.00
M + H	5 hrs	205.00
		20.00
H	8 hrs	70.00
Sub-total		385.00

Total : Rs. 1,458.00

C / S / W = Cement / Sand / Water ratio

Professional qualification: M = Mason; H = Mason Helper