

building
to
learn

hemcrete tower

notes to
contractor



constructionarium

Construction Overview (Key Points):

- Concrete base slab formed to provide a sound footing to tower.
- Timber framing (studwork) with horizontal pieces (noggins) and a ply inner skin provide the main structural element.
- A cut timber roof at the top provides shape control at the eaves. The roof is not covered and is just the timber framework.
- The Hemcrete product is used as a thermal cladding and infill to the timber frame.
- Inside the tower a cut timber and plywood spiral stair is placed on joist hangers at the perimeter and stacked on top of each other with a central locating dowel. A quarter landing at the top provides a viewing platform.
- Accuracy of construction and setting out not as critical or as difficult as some other projects as the project is mainly cut / fixed to suit. See notes on stairs and roof.

Main Project Specific Safety Issues:

- Working at height to access framing and Hemcrete operations.
- Working with Concrete (placing, compacting and shuttering).
- Working with Hemcrete (as concrete but also mixing of product).
- Erection of framing and roof structure. Temporary stability during construction.
- Large quantity (volume) of work.

Major Materials Considerations (Project Specific):

- Concrete for base slab (if not left in place).
- Hemcrete product from Lime Technology Limited.

We ordered 10m³ of product (measured volume at 200mm thick is 8m³) and this just ran short partially because the wall thickness was increased from 200mm to 240mm due to problems of access within the shutter for fixing ply to external studs. This is also probably due to the students over compacting the Hemcrete in the shutter thus knocking some of the air out of the mixture and the shutters being out of position.

You will also need a large pan mixer with power pack. We hired one through Lime Technology.

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Abingdon

Oxfordshire

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Pan mixer with diesel power pack. Access steps provided separately

- Timber for studs, noggins, stair treads and roof. 4"x2" throughout. Allow extra for shuttering of outer face. Note lengths required, or use splice detail (requires additional bolts etc)
- 6mm thick ply, for inner skin (permanent) and shuttering of outer face (temporary).
- 22mm thick ply for stair treads and miscellaneous details.
- Mesh reinforcement for base slab.
- Some 25l water carriers for transporting water.
- Miscellaneous joist hangers, nails and threaded rod / nuts etc for stairs.
- Recommend inclusion of mini excavator, with driver, for ground works.
- Mobile tower access for higher levels during erection. Recommend at least 3 sets (one inside and two outside) though these will need to be constantly moved. We had a scaffolder on hand all week to undertake this. Alternatively you could scaffold the entire structure though this will take some time.

Smaller plant, equipment and materials (generally available in stores, though check beforehand):

- Concreting accessories. Including spacer blocks, tie wire with nips, vibrating poker (small diameter head), and finishing float.
- Sufficient hand tools and power tools for shuttering and carpentry. In particular short screw guns (impact drivers) would allow better fixing within the narrow shuttering width by using screws rather than nails.
- Long screws (250-300mm) for the shuttering.
- Sufficient shovels, barrows etc for hempcrete.
- Cordless drills, including sufficient bits.
- Spanners for threaded rod and bolts.
- Lengths of timber for propping of studs and/or rope (temporary works, depends on scheme adopted).
- Appropriate dust masks for mixing crew. "Use approved dust respirators to EN 149 category FFP2..." The mixing crew was also supplied with disposable boiler suits.

General Notes:

- Set up Hemcrete mixing operation near to site of project but downwind. Water will need to be fetched from the water point but this minimizes the weight of material to be transported. The material was on three pallets (one of binder and two of the hemp shiv).

We managed to make a start on placing the Hemcrete by the end of Tuesday and timings just worked out for a finish on Friday lunchtime.

- Mixing and placing of the Hemcrete product. Refer to documents at end of this report.
- The Hemcrete product is best left for 24 hours to gain strength prior to removing the formwork. This means that the Hemcrete placing should have finished by Thursday mid-day. That said the product should have sufficient stiffness to strike the shutters immediately though this was not tried.
- Setting up of main framework (studwork).

The studwork is not stable until it has sufficient noggins and ply inner skin attached. This was overcome using a system of guy ropes to angled stakes and an amount of horizontal bracing (see picture). Some temporary noggins were also used.

The studs were attached to the base slab via heavy duty angle brackets screwed to horse-shoe shape ply pads. The ply pads were simply nailed into the base slab as it was still 'green'.

Note, we ordered lengths of timber such that there was not need to splice the studs but a detail is provided should you need to.

Setting out, once the base slab is confirmed as level, is by simply running a string round off the centre point.



Guy ropes and horizontal braces used for temporary stability of tower

- The outer shuttering was done full height to eaves level. Timber studs were placed around the drum and spaced off the inner studs using long (300mm long) screws. The outer shuttering was the same ply as the inner face and nailed onto these outer studs. The Hemcrete is best placed in 600mm lifts so the shuttering was based on this dimension. Note the horizontal pressures generated from Hemcrete are very small and such a form of construction is adequate. As each lift was completed the top level of screws was moved up to be above the level being infilled. Noggins were fixed into position AFTER the Hemcrete and directly on top of the hemcrete layer just placed. This was to ensure the Hemcrete was placed below the noggin.



Outer shutter in 600mm lifts spaced off inner studs using very long screws

- The roof structure is all supported by the main 'truss' which has the cable beneath it. Installation should progress this item first, then the $\frac{1}{2}$ trusses at quarter points. Install the diagonal noggins at roof level (with joist hangers pre-fixed), adjust the turnbuckle to suit and then the remaining rafters on $\frac{1}{12}$ th points can be attached from the outside whilst the access inside the tower can now be removed and work can progress on the stairs.
- The stair construction can progress alongside the works on the drum provided the main timber bearers under each tread are made over long. Allow an extra 200mm or so at the intersection with the drum structure that will account for any tolerance issues. These are then offered up in turn, the joist hangers can be set out (ensuring they are attached to a vertical stud) and cut to suit the exact position. It is critical that the joist hangers for each tread bearer are nailed into a stud and not just into the ply skin (refer to details on drawings.) To this end the critical part of the setting out is to ensure that the vertical studs are evenly spaced around the circumference.



View of the roof being built

The central threaded rod is the 'fixed point' and the stairs are built from this point as the tread above needs the one below for support, No work can be undertaken from on top of the treads as this eventually presents a leading edge issue. All work was undertaken from below, off podium steps if necessary. Any final attachments for the top handrail etc were done by trained site operatives.

The lower steps need the ply tread to be left off so that they can be nailed through the joist hanger and fixed in position. Higher treads allow access from underneath so the ply can be pre-attached.

It is important that all the holes of the joist hangers to be nailed – including the ones on the side of the bearers of the treads – as each tread being partly cantilevering from the one below, a push pull action develops at the ends of the bearers of the treads.



Stair being erected

- When removing the temporary external formwork, if this formwork is kept in large sections when removing it, this should be done with the wind direction in mind and having made sure that no one is standing downwind.
- Before allowing anyone inside the structure, check the stairs and connections for any signs of distress. Ensure edge protection is in place at the top. The inner ply skin provides the perimeter handrail.
- Consider the construction options of building all of the structural elements first including the stairs first and this may provide a more stable structure to work around. Alternatively consider what other practical arrangements for temporary bracing there may be. The ropes worked but were a trip hazard and as the bulk of the team are outside the structure there is more chance of a problem than if the temporary bracing was internal.

A P P E N D I X

This appendix presents the principal properties of hempcrete along with a description of the main operations involved in the building of hempcrete walls.

Hemcrete[®] Construction Methods

Toolbox Talk for Shuttered Hemcrete[®] Walls

1.0 Materials

Tradical[®] Hemcrete[®] is a blend of Tradical[®] HB (hemp binder) and Tradical[®] HF (hemp filler - the fragmented internal part of the hemp stalk).

2.0 Storage and Handling

Tradical[®] HB and Tradical[®] HF should be stored in cool dry conditions. See data sheet for more information.

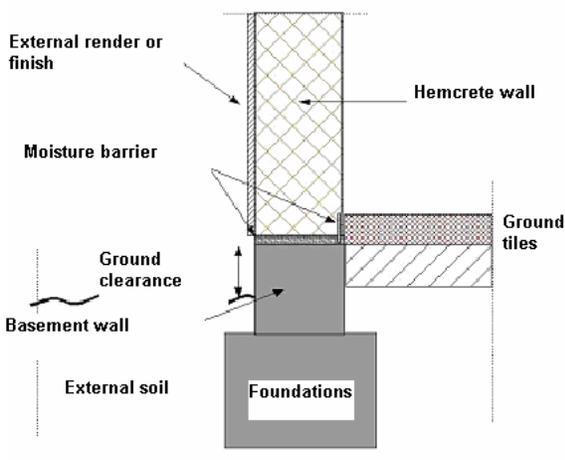
3.0 Health and Safety

Tradical[®] HB should be treated in the same way as any other lime or cement based binder. Gloves, goggles and masks should be provided to users. (See full data sheet for further details.) Tradical[®] HF is a non hazardous material. (See full data sheet for further details.)

4.0 Timber Frame

The timber frame should be designed to support the load from the upper floors and roof. This would normally require the services of an Engineer or timber framing specialist. A typical domestic timber frame would use 50 x 100mm studs at 400mm centres. Attention must be paid to the junction between wood-hemp in the case of a visible external frame. Other types of frame may be used, but require an adapted design.

5.0 Foundations



It may be possible to use simple lightweight foundations with Hemcrete[®] walls. Seek advice from your structural engineer.

6.0 Mixing

Hemp concrete can be manufactured on site with a concrete mixer or pan mixing machine. Mixing is best done in a pan mixer. A slow speed of rotation is recommended:

- Add the Tradical[®] HF followed by the Tradical[®] HB in the ratio of 1 bale of HF to 2 bags of HB.
- Allow the dry ingredients to mix.
- Add approximately 60 litres of water and allow the material to mix for about 2 to 5 minutes until thoroughly mixed.
- If you are using a drum mixer, then the mixes will tend to be smaller and have to be gauged with buckets.
- Use 3 buckets of HF to 1 bucket of HB with about one bucket of water.
- Using a dustbin lid to seal the drum mixer can help reduce the dust during the dry mixing stage. Alternatively adding most of the water to the HB first, before adding the HF can help to reduce the dust.
- Vary the water to suit the conditions, weather and time delay before the placing. The hemp is absorbent so the mix will dry out if it is left to stand.
- In all cases, the aim is to obtain a homogeneous mixture in order to produce an aerated concrete in which the particles of hemp are well covered by the binder, avoiding the formation of “pellets”.
- Do not use material that has been mixed for more than 6 hours.

7.0 Shuttering

Plywood is often used as shuttering. This should be oiled first with vegetable oil, or lined with polythene to allow for easy release. The shuttering should be constructed accurately and where spaced away from the timber frame, hollow tubular spacers (water pipe or similar) will allow the shutter to be screwed to the frame at an exact distance. The Hemcrete[®] is lightweight so the shuttering can be less robust than for conventional concrete. In some instances permanent shuttering may be used to form the final finish to the wall e.g. timber cladding. If using permanent shuttering, the panels used must be clean and must allow the external wall to meet the statutory requirements of flatness for applying render. We recommend the use of a breathable membrane between the Hemcrete[®] and the timber cladding.

8.0 Placing

After mixing, the Hemcrete[®] is tipped into the shuttering and levelled to form a 300mm thick layer. This then lightly tamped before the next layer is tipped in. Simple pieces of wood are ideal for tamping. We recommend making a small trial section to establish the level of tamping required. 1 bale of HF mixed with 2 bags of HB should fill 200 litres at the target density. A plywood box of 0.5m x 0.5m x 0.8m will be ideal as a 200 litre test box.

9.0 Striking Shuttering

The shuttering can be removed the following day and the spacer holes filled with Hemcrete[®]. The shutter panels are removed by sliding them sideways. In order to encourage drying, they must be removed as soon as possible.

10.0 Day Joints

We recommend that walls do not have vertical day joints. To avoid this you should work up to the side of openings. Horizontal day joints should be lightly wetted before the application of more Hemcrete®.

11.0 Openings

It is very easy to form openings in Hemcrete®. They are simply created in the shuttering.

12.0 Service Penetrations

Service penetrations in buildings are a source of air leakage and heat loss. We recommend that the Hemcrete® is cast around any service penetrations to avoid air leakage.

13.0 Curing, Protection and Aftercare

After removal of the shuttering the Hemcrete® should be protected against the extremes of the weather (frost, rain, snow and drying winds). In moderate weather no protection will be required. Building with Hemcrete® should not take place at temperatures below 5 degrees centigrade.

14.0 Alterations

Hemcrete® is very easy to alter if changes are necessary. Within the first 6 hours, it can be simply dug out, the shuttering altered and then recast. If the Hemcrete has set (even years later) it can simply be cut out with simple hand or power tools. Take care to avoid any concealed services. Take advice about the structural implications of any alterations.

15.0 Suitable Finishes

Hemcrete® is normally finished with a lime render on the outside and a lime plaster on the inside. However as long as the finishes are vapour permeable, a number of options can be considered to suit the style of the development. In all cases, external walls in Hemcrete® must have a protective covering on the external face, these include;

- Timber cladding, with a breathable membrane and/or a ventilated air gap separating the two.
- Tile, slate or shingle hanging, with a breathable membrane and/or a ventilated air gap separating the two.
- Brick or stone facing, laid in lime mortar.
- Mathematical tiles.

16.0 Rendering/Plastering

The Hemcrete® should be allowed to dry out for 28 days (under typical conditions) before the application of the render or plaster. Use Limetec® plasters or renders in accordance with the instructions provided

17.0 Paint Finishes

It is important that vapour permeable paint finishes are used with Hemcrete®. The main options are;

Internal:

Clay paint
Soft distemper
Contract emulsion
Lime wash

External:

Lime wash
Silicate mineral paint

Vapour impermeable finishes must not be used.

18.0 Fixings

It is possible to fix into Hemcrete® with a range of proprietary fixings (see data sheet for exact figures on strength of fixings). We recommend that heavy items (radiators, kitchen fittings, etc.) should be fixed back to the timber frame.

The frame should be shown on a working drawing in the CDM file.

19.0 Membranes

Hemcrete® is a fully breathing wall system. It is important not to use impermeable membranes. Breathing membranes may be used as separation layers such as against timber cladding.



Tradical® HF Technical Information Sheet

Product Trade Name;
Tradical® HF

Applications;
Building and Construction

Supplier;
Lhoist UK
Hindlow
Buxton
Derbyshire
SK17 0EL

Manufacturer;
Hemcore Ltd.
Blackwater Trading
Estate
Maldon
Essex
CM9 4GG



Tradical is a registered trademark of Lhoist Recherche et Développement S.A.
Hemcrete is a registered trademark of Lime Technology Ltd.

Composition;

Cellulose material produced from the industrial hemp plant, an agricultural crop grown under Government licence

Hazards to Health;

Material is chemically non Hazardous. Physical hazards include airborne particulates, airborne product and risk of splinters

Transport;

Not hazardous for transport. Under the Chemicals (Hazard Information and Packaging) Regulations the product currently has no classification for supply or conveyance

Properties;

A natural plant substance that is woody in character with an hygroscopic characteristic. In periodic contact with moisture the plant substance will decompose and decay over a period of time.

Environmental Impact;

No detrimental impact in normal use and handling.

Storage;

Store in a cool dry place. Stack in bonded pattern for stability. Isolate from sources of heat and ignition.

Handling & PPE:

For manual handling purposes consider the weight of each bag to be 25kgs. During handling of the product it is highly likely that protection will be required for handling of the associated Tradical®HB binder product and therefore operatives should refer to the Product Safety Data Sheet for Tradical® HB for protective equipment requirements. These include protection of the skin, eyes and air passages by PPE including close fitting clothing with long sleeves, gloves, dust respirators to EN149 category FFP2 and wide vision goggles to BS2092 grade 1 impact, with anti mist, for eye protection.