

How to build a **HEMP** HOUSE

An ebook and
construction manual

By Klara Marosszky and Paul Benhaim

v3.21

www.TheHempBuilder.com

Introduction by Paul

So, you want to build a hemp house. Congratulations! Enclosed in this book is all you need to know to build a house using industrial hemp.

We are not talking about building a shed, though you can do this without any problem, but a serious family size home. I am so glad to present these materials and methods developed by Klara and promoted in the attached construction manual. This is the first time this technology has been available for you to work directly with a sustainable material available direct from farmers – whole stalk industrial hemp.

Sure, there are other methods to build your own hemp house – using hydraulic lime, hemp hurd and concrete. What makes this method unique is the fact it requires no processing of the hemp crop – you can use the whole hemp stalk. You do not need decorticated hemp (where the fibre and hurd have been separated), which is usually an expensive process that requires large processing mills. There are only a handful of these in the world. So, without relying on these you can live in a home you build today.

If you were so inclined, you may even consider [Growing your own hemp](http://www.startahempbusiness.com) for your home! (www.startahempbusiness.com)

When you are done, please send us your pictures!

Paul

Introduction by Klara

With a background in Landcare, for me the primary attractions of hemp are the speed with which it produces an enormous fibre biomass (far greater than timber in a much shorter time). We should be planting hemp as well as forests. Also hemp's capacity to remediate soils and sequester carbon make it an invaluable crop, and the fact that it can be farmed sustainably without herbicide and pesticide inputs. My intention in getting involved in the hemp industry was to create a socially conscious business, driven by a sustainable business model.

Creating a sustainable product requires examining the costs and impacts of everything involved in the creation of the product and sustainable development by definition requires a focus on a triple bottom line. In other words a balanced emphasis on social and environmental outcomes and economic viability.

From the perspective of affordability, European hemp masonry models don't translate into a sustainable model for Australia. They are based on using hemp hurd which is relatively cheap if the hurd is a byproduct of a large hemp industry and there is no problem with availability. In France for example, the hemp paper manufacturing industry creates a surplus of hurd which is used for housing. Both the costs associated with the infrastructure needed to separate hemp and the lack of demand for hemp bast fibre, which would make hurd readily available at a reasonable cost, make this model impractical for Australia. Affordable

housing would need to wait for other major hemp markets to be established.

Discussion about hemp/lime building materials quite rightly focuses on the ability of the industrial hemp plant to sequester huge quantities of carbon in its growth cycle and on the evidence that hemp buildings can lock that carbon up for centuries. While these are major benefits, realistically quite a lot of this benefit is compromised if large amounts of fossil fuels are used in transporting the hemp for processing. The option of transporting specialist machinery to the site to separate hemp unless there is a suitable decorticator nearby, also involves considerable expense in fuel and freight in floating the machinery to farms.

It also takes away the opportunity for the farmer to value add to his product, so I was interested in finding out if hemp could be harvested and processed with machinery already available on farms or readily available in smaller farming communities, into a form that could be used to create a building material that would meet building standards. This meant finding out if a stable building material could be developed using the chopped whole stem of the plant. As far as I knew no one had really examined this as a serious commercial option.

Modern large scale agricultural enterprise has seen the majority of farmers struggling to earn an income on farms and in most western countries, a few large farming consortia dominate the industry, from supplying the seed to owning the distribution networks. Most of these consortia are still locked into high chemical input farming practices

and are reluctant to cost the long term impacts of their farming regimes. In some cases insurance for the farmer's crop is inextricably tied to seed supply, prescribed fertilizer regimes and growing methods.

The current goal to convert large tracts of Australia's farmlands to sustainable forms of agriculture could be achievable if hemp is grown by independent farmers who are prepared to adopt land management regimes that support the soil remaining healthy and viable. The conventional argument that these farmers produce slightly lower yields is outweighed by the fact that the farmer can value add and get a better overall return for the crop. Current research from Queensland has shown that massive annual increases of chemical fertilizer inputs (up by 300% over 8 years) have not resulted in higher broadacre grain yields. What we do know is that farming regimes like this have all but destroyed Australia's fragile farmlands.

My other challenge in developing the material was to develop binder materials that were not dependent on hydraulic lime, which is an integral part of European hemp/lime construction and is not readily available in Australia, or on large quantities of cement. In Europe hemp masonry binders can include up to 50% cement to achieve structural stability. The carbon footprint associated with cement production is very high (5% of the world's greenhouse gas emissions) because of the extremely high temperatures that cement production requires.

Development of the final binder products took place at NSW University under the supervision of my brother

Marton Marosszeky. At the time he was Professor in Construction Innovation at UNSW and directed a research centre at UNSW, the Australian Centre for Construction Innovation. Marton has a background in construction technology and management and is an experienced builder, teacher and management consultant. He is well known as an academic researcher for his work in construction process improvement, as well as for his work in the durability of reinforced concrete infrastructure in marine environments. He was the Chair of the NSW Construction Industry Consultative Committee, the state's peak industrial relations forum for the construction sector between 1991 and 2005. Currently he is an Executive Consultant with Evans & Peck, Australia's leading infrastructure consultancy.

What we arrived at was a binder in which the primary ingredient is hydrated lime which is commonly available in Australia. Its availability lends itself to being blended regionally. Admixtures totalling less than 10% of the binder and sand give the material its stability for commercial construction. The admixtures vary according to the application e.g. extreme cold or internal or external finishes. This ensures that the material demonstrates competitive curing rates despite minor variations in the chemical composition of regionally available hydrated limes.

To reduce the overall cost of the product including an energy cost associated with drying sand, which would be necessary if it was included in a bagged binder material, the sand is not included in the bagged AHMC binder and

the builder will be advised about the amount of local clean sand to be delivered to the site.

Less than a hundred years ago, industrial hemp was a staple crop throughout the world. It was revered by Emperors and respected by farmers because it was so productive and so useful in so many ways. I sincerely hope that this building material can make a significant contribution to renewed respect for industrial hemp.

Klara



ACKNOWLEDGMENTS

Thank-you to all who have made this book possible, including Toby Marosszky for his photo (above) of Klara, Steve Allen for his pioneering Hemp Building work, Tom Woolley for the same, Marton Marosszky for believing in this project, Deb, Tara, Dan, Nadia and all Aboriginal people of this land, past and present for letting us walk and work here. There are many others who know who they are and whom we thank from deep in our hearts.

DISCLAIMER

This book is intended to help you decide if you want to build a hemp home. Local and current planning regulations should be checked and adhered to. All safety considerations should be considered. Building should be carried out by a legal and licensed builder only. If you are not sure, check with your local council. Be safe – else be compost.

About The Authors



Paul Benhaim is a recognized world-authority in hemp research and development, as well as a published author of Hemp-related books and DVDs. He manages the world's most popular Hemp web sites and advises a number of international companies.

As well as acting as an independent consultant and mentor to those interested in business, usually the hemp business, Paul is CEO and Director of a cutting edge Hemp companies involved with hemp plastic and hemp food products.

Paul continues his quest to ensure the path for the widespread use of industrial hemp is accessible to all so new and revolutionary Hemp products may become available to a worldwide audience.

Born in London, after travelling the world for a decade, Paul now lives and works from his rainforest home in coastal Australia.

For further information on some of Paul's projects enjoy:
www.hempowered.com, www.startahempbusiness.coand
www.hempplastic.com



Klara Marosszky is the developer of the first commercially available hemp/lime building material, manufactured from Australian resources. It is suitable for hemp hurd and whole stalk fibre hemp building. She is also a co-founder of Northern Rivers Hemp Inc, an Association formed to advise government and inform farmers and the general public about the emerging NSW Hemp

Industry.

Klara has been a government licensed hemp researcher and grower for 10 years. She was a finalist in the Northern Rivers Regional Development Board's (NRRDB) Innovation Awards in 2008 for her research into regional hemp farming models and her work with UNSW, to develop hemp masonry building materials and construction methods for the Australian market. Her goal was to develop a hemp housing material for affordable social housing.

The lime based binder for the building material and the building methods in this manual were developed in collaboration with her brother Marton Marosszky at UNSW's Centre for Construction Innovation. The material has gone through testing both at the university and in a number of exposed structures. The first home currently being built with the material is situated at Billen Cliffs in Northern NSW.

Table of Contents

Introduction by Klara	4
About The Authors.....	10
Table of Contents	12
Interview with Klara.....	16
Hemp technology	38
Background	38
Hemp Preparation - Whole vs Hurd	46
GROUND FLOOR SLABS AND FOOTINGS.....	48
THE FRAMEWORK	48
ROOF OVERHANG.....	52
AROUND DOORS AND WINDOWS.....	52
FIXINGS TO HEMP LIME.....	53
OPENINGS, ELECTRICAL WIRING AND ALTERATIONS	53
USE OF INSULATION WITH HEMP LIME CONSTRUCTION	53
ATTACHING THE FORMWORK TO THE STUDS USING SPACERS	54
SHUTTERING OR FORMWORK.....	55
PREPARING THE MIX.....	56
PLACING AND TAMPING THE MIX.....	59
CURING	60
SHRINKAGE	61
RENDERING EXTERIOR AND OR INTERIOR WALLS.....	61
OTHER FINISHES	62
LONGEVITY	62
RETROFITTING AND RESTORATION	62
TECHNICAL DRAWINGS	65
Hemp Wall Detail.....	66
Hemp Window Sill Detail	67
Hemp Window Jamb Detail.....	68
Hemp Eave Window Head Detail.....	69
Hemp Bottom Plate On Slab Detail.....	70
Thermal Performance of Hemp lime construction	73
PPE.....	74
Minimum requirements:	74
FOR CONSTRUCTION	74
Small Tools:	75
First Aid Measures:	76
HANDLING AND STORAGE.....	77
HEMP & BINDER NOW AVAILABLE FOR HOUSING CONSTRUCTION.....	80

Hemcrete.....	84
BIOCORE- A 20 million Euro biorefinery project.....	87
Affordable housing workshops	89
Hemp Foods	93
Hemp Protein Powder.....	93
Hemp Seed Nut.....	93
Hemp Seed Nut Butter	93
Hemp Seed Oil	94
Hemp Cosmetics	94
Hemp Jewellery.....	94
Cannabis Seeds	94
Hemp Clothing.....	95
Hemp Plastics.....	95
Hemp Fibre, Industrial Hemp Growing Seeds, Hemp Stalk, Hemp Mulch, Hemp Insulation, Hemp Building Products and more	95



Hemp Harvesting in Ashford in Central Western NSW, March 2010

Grow the hemp for your hemp house – it's easy!

Really, it can be done with a hectare of industrial hemp. Even if you have never grown or harvested hemp before, it can be done! Yes, you can grow your hemp and build your own home from it.

People talk about sustainability, but this is the real deal. Import most of your material for your home from just metres to where it will stand, and one day (far, far away) go back to the Earth.

The book 'How to Grow Hemp for Profit' shows all the facts and figures, as well as outlays all the information you need to grow hemp on a small to medium scale. There is an interview with Klara, co-author of this book, on how she has grown hemp on a small scale using readily available equipment for harvesting and processing. If you have a little time and are willing to follow the simple instructions, then we highly recommend growing your own hemp for your house.

There are other high value bonuses with that book thrown in for free too!

I will also help you build and start your own business.

Go to www.StartAHempBusiness.com to find out the latest offerings!



Young hemp plants in Ashford, NSW

Interview with Klara

P: So I have my hemp fibre/stalk, what else do I need?

K: You need your building design. The hemp is not load bearing so your building needs a frame that is adequate to support the roof. We recommend timber framing as lime preserves timber well and a lot of buildings have been built in this way in Europe and they have performed well over time. More care needs to be taken with steel frames as galvanised frames can experience corrosion and there isn't the same building history.

The masonry material provides the racking strength to the uprights in the frame, so noggins are minimised. Your home will also need a slab or timber floor. In the future we'd like to market a hemp/lime flooring mix as they do in Europe. As well you need a binder to mix with your hemp (in Australia this is available by contacting www.thehempbuilder.com.)

You also need clean sand. The reason the sand is not included in the binder is because it is cheaper to source locally and there is an energy saving made by not pre-drying it for bagging, or consuming fossil fuels in freighting it. The goal was make the process as affordable and as sustainable as possible and to still retain the integrity of the material. Make sure you have access to water on site and to a 3 cubic foot drum mixer – a standard concrete mixer. Depending on how fast you are working and how much formwork you have set up, you can have two mixers going.

P: What kind of help do you need?

K: If you had say 3 people, one person can handle two of these mixers, one person is on the wheelbarrow and the other places the mix.

The mixing process is a bit slower than with concrete. The material you're making is quite different. It doesn't go off as fast as concrete. Your goal is to keep the air in the mix. The hemp is light and with the lime, you're after quite a fluffy, not too wet mix. Advantages of the mix are that it retains its handleability for much longer than concrete and it's much lighter to work with as well.

The alternative is to use a pan mixer. I'm just importing and about to trial a pan mixer. If it works well it will be available for hire. These can be used both on small and larger commercial sites.

P: Great – What else is needed?

K: A tamper, something that you can make readily from timber off-cuts. Basically a tamper is a piece of flat timber attached to a timber handle. To have a few different sizes is a good idea as smaller ones are useful for packing the hemp lime material around studs and into corners. You use the tamper for lightly packing the material down around the edges of the shuttering and to get into tricky spots. Although hemp masonry is easy to build with, you need to be very careful to fill the formwork thoroughly, especially around the studs and tamp it evenly.

Some form of shuttering system is also needed.

P: If I knew nothing about building, what would that mean?!

K: Shuttering is the term used to describe the formwork attached with spacers, to either side of the frame.

I recommend good quality formwork as it'll give you a good finish. We work with sheets 0.6m high. With this height you remove the shuttering the next day and replace it for the next lift and you can complete 2.4m high walls over 4-5 days all around the house, dependent of course on how many windows and doors or other detail you have included in your design. The mix achieves sufficient strength overnight, you just need to remember to moisten the surface slightly and the consecutive layers bond well to each other.

K: To explain the overall process a bit more ... the best way of building with hemp masonry is to embed the frame in the centre of the wall so you have a monolithic building. This is the most effective way to achieve air tightness in a building. There are generally excellent energy savings in heating and cooling with monolithic construction because of this. You greatly reduce the opportunity for gaps which can occur when you use different cladding materials in a building, for example. You also avoid the shrinkage problems you get when varying products dry at different rates. It's also the way your frame, be it steel or timber, is best preserved in your structure.

So, once you have built your central frame then you put shuttering or formwork on either side of that, depending on the width of your wall, with spacers to hold that out equally from the framework. We recommend 200mm wide external walls and 150mm internal walls for standard building. Of course the thicker the walls the better the insulation. In the Adnam's Brewery building in Suffolk England, hemp lime

walling 500mm thick was used and as a result the installation of air conditioning was avoided. This building has won design awards and features a wide variety of sustainable building features.

The material is not heavy, so the fixing of the spacers and formwork to the frame can be done relatively lightly. This is done by screwing through the spacers to the studs at the bottom of the formwork. At the top of the formwork and at the ends of wall sections, the formwork can be screwed to the studs or clamped well to the formwork.

P: Keep going!

K: So you blend the binder, clean sand, hemp and water until you get a nice fluffy mix, put it into the wheelbarrow and place it in between the two pieces of formwork. It is then tamped lightly around the frame and near the edges. It's different to sand, sawdust and cement or rammed earth construction – it is the opposite effect we're trying to achieve. With these materials you want to pack the material as solidly as possible, with hemp lime construction you want to pack lightly and evenly so you don't overcompress the hemp which gives the material its insulation qualities.

Horizontal timbers are minimised in hemp lime construction other than around windows and doors, which makes it easy to place the material. You are only packing underneath or around surfaces when you're working around windows and doors or where you have put a cross timber, because you intend to attach cupboards for example, to the wall.

It's important not to over-tamp or ram the material too much, or you get a paste forming at the edge of the walls.

The lime binder gets pushed out of the mixture and this results in a weaker wall. There is also a very real danger that by forcing the paste out of the mix, carbonation* will occur unevenly in the wall. Having a regular mix and placing it well is vital.

** Carbonation is the chemical reaction that occurs between lime (calcium hydroxide) and carbon dioxide from the atmosphere, converting the lime back to calcium carbonate*

It's also quite an important reason to work with a proprietary binder, rather than just one of those free recipes you can follow. The savings in making up your own mix are marginal and the risks can be substantial. Hemp lime has been found to be a simple but high-technology product that requires high standards of quality control. According to experience in the UK, it's a mistake to think that any hemp and any lime mixed together will produce good long term results.

The AHMC Binder has been developed to ensure you do have regularity in the binder mix and that the relatively small amount of binder by comparison with the large volume of hemp, is strong enough to form a durable stable building material in which even carbonation occurs.

P: So what goes into the mixer again, can you go back to that bit?

K: Chopped hemp and binder, clean sand and water in advised proportions.

P: So why can't I just make my own binder and save money?

K: Well, the reasons for using a commercially blended binder I'd suggest are that it's very important to ensure your mix is consistent right around the house for both early and longer term strength. Different proprietary lime hemp blends are used for different applications because they cure at different rates, have different kinds of strengths and have different weather resistance. UK researchers, where hemp masonry is an established commercial industry, also caution that a poor quality mix can result in water being drawn from the binder by the hemp in the mix, which is very absorbent, resulting in unreliable wall strength.

The material we are supplying in this housing material has had both short and longer term testing in the lab and in external environments. One aspect of the lab work was ensuring that there would be no slump in 0.6m high mixes within a commercially competitive timeframe for example. When you are building with this method you are going right around the house and doing one layer 0.6m high all around the house. The next morning you come and take that shuttering off and you lift it up and do the next level around the house. Consistency in the mix and in placing the mix is important to ensure even strength and consistent carbonation, also if you want to leave sections of wall unrendered, as you can when the material has been placed well. You'll get beautiful walls if your mix is nice and even.

P: Are there other ways to mix lime binders in building?

K: Yes, lime has been used for centuries in a lot of different ways in building construction including as mortars and for

restoring wattle and daub. Different applications require different lime blends and types of limes. For example, highly hydraulic limes set under water and were used in installing underwater piers. There are also ancient and modern building methods where lime based binders are used with other cellulose products. I don't know about how they perform over time. One of the advantages of working with hemp is that there is a quite a lot of historical information about hemp masonry in construction and existing structures that are very old.

P: What about colourings – can I add these to my mix?

K: You can certainly add oxides so you have nice effects. The colour of the sands used in the render can also influence the colour of the wall.

P: And how long are these mixes left in the mixer?

K: Around 10 minutes, during which time you would need to check that the material is mixing evenly and if you're working with a small mixer, that you do not have lime coating the barrel. If you do, turn the mixer off and use a stick to scrape the lime off the sides. It needs to be really well mixed.

P: Do you need a foundation for a building if just building a shed or a chook house?

K: No, you could just have footings, and a dirt floor.

P: Am I limited to designs for a hemp building?

K: You're not limited in anyway really but it's important to think about not having too many small, awkward to fill, wall sections. The material lends itself to shaped walls if you are interested in that. In French buildings you often see curved

and moulded sections. The internal framework which is supporting the roof, governs how high the building can be. Shaped formwork is likely to be more expensive than standard flat sheets.

P: Are there any particular conditions that suit the mix. What about freezing weather, rain or the tropics as extremes?

K: Yes, it's not advisable to work with lime binders at temperatures as low as -5 degrees. So, if you have a period of consistent, heavy frost or there's snow around, wait. We would be able to supply a varied binder mix for really cold environments if necessary. If there is rain you will need to work under cover and keep the rain off the walls. If walls are going to be exposed to driving rain then keep them covered for up to the 4 weeks needed for sufficient curing before renders are applied.

P: Great, that was my next question. How long do you leave it and why?

K: You need to leave it around 4 weeks for sufficient carbonation and curing to occur before you render. Carbonation happens when air moves through the wall. If you render too early, you will limit the air circulation and then you might end up with a wall where you have a powdery mix on the inside and yet it looks like it is a good wall on the outside.

P: How long will my building last if made correctly.

K: Companies in Europe are claiming they will last for centuries. There are certainly remnants of ancient hemp buildings. There is a building in Japan that is 300 years old. It is pictured in the construction manual (see later). We

have continued research with the New South Wales University under lots of conditions and over a seven year period and we think these buildings, when built correctly may also live at the least hundreds of years.

P: Tell me about waterproofing. If I am going to last that long, I want to be dry!

K: We recommend that you build with a generous overhang, although the first wall I built at Corndale, in northern NSW had no overhang for research purposes, and this is the sub-tropics. After two years there was absolutely no impact and it had survived some major storm events and months of rain. So it seems this material is naturally very durable. It's not what I'd recommend to do though, if you're after long term durability. An overhang is definitely vital to managing thermal efficiency in your building.

If you have intense, driving rain often coming from one direction, then you may even consider cladding with some other material over the hemp masonry, but with an overhang this is not normally necessary. You can also leave your hemp home un-rendered as I mentioned earlier. In fact, in snowy and sunny Switzerland they build mainly with un-rendered hemp. In most countries though, hemp masonry is rendered and often internal walls are painted.

It's important not to use an acrylic paint, that is, use a paint that still breathes. It is also possible to lime wash. It can be finished to look like a conventional concrete rendered building. Or a more architectural or a rustic finish is also possible – your choice! In the UK, where insulation is even more of an issue in winter, some social housing projects include an additional thin layer of insulation material and

internal plasterboard lining. It really depends on the finishes you like. In some of the retrofitted buildings in France the finished product looks nothing like hemp in any way, it's beautiful but very conventional. They've done it purely for the great insulation value of using hemp.

P: Can you drill into the walls.

K: Yes, but if there are really heavy things you want to hang off or attach to the walls then these need to be attached to the framework, so plan for this. You can drill or cut hemp masonry easily.

P: So, does that mean it is good for extensions.

K: Yes, it's really suitable for extensions because you can blend the material in with the existing materials of your home by finishing it in different ways. Also if you build a hemp home and decide after a period of time that you want to re-model a section, take out a wall, add a room, providing your roof is adequately supported, you can cut out sections of hemp masonry material, break it up and re-mix it again with fresh binder and build your new wall, or you could put left over material straight out into the garden.

P: Any recommendations for a roof?

K: My dream roof would be a green roof however it's not something I've trialled. The Adnam's Brewery and Distribution Centre buildings in Suffolk, UK mentioned earlier has a green roof. It's a living roof, like they're starting to build all over the world, planted with low growing vegetation that collects and cleans their rain water.

P: What about hemp insulation?

K: Hemp masonry has excellent insulation properties and I am aware of at least two other products, one is a loose pelletized form of hemp that is blown into roof cavities and the other is a form of matting that can be placed in the roof cavity or wall sections. That hemp is treated though, so it is fire retardant.

P: What about your material, is that fire retardant?

K: Yes, because the lime makes the hemp fire retardant. It also makes it rodent resistant. Lime's a very effective material.

P: What about planning regulations.

K: You just take along the construction manual part of this eBook and that should be enough to show your local council and/or your local builder who could do that for you.

P: How long would it take to build a small 40-60sqm cabin for my teenage daughter?

K: Once the frame and formwork is up, 4-5 days work with a couple of friends. Then you need to wait 4 weeks before it is finished.

P: What about other products like the English hemcrete and all the others?

K: They are all based upon the same principle of blending lime and hemp to create a building material. The difference is in the limes that are available in different parts of the world. In Australia we do not naturally produce large quantities of good quality hydraulic lime, unlike Europe. That is a fundamental difference. We had to start with hydrated lime so we had to find a different solution. The stability of our mix is achieved by a combination of adding

some sand and our admixture which is a part of our blend. In Europe and the UK they can use quite high levels of cement and hydraulic lime or in some cases greater amounts of sand. In France, I've heard of a mix of hydraulic and hydrated lime being used. Hydrated lime is slower setting than hydraulic lime and you can't simply build a wall within 4 days with hydrated lime without having some slump in the walls.

P: Did you tell me how long the pieces of hemp that you need in the mix should be?

K: It doesn't have to be identical in length. There are some advantages to having a variety of lengths in there. It needs to be cut between 1-3cm maximum. If there are much longer lengths in the mix you will get an untidy finish. You need the material to interlock well as we maximize the volume of hemp in the mix because it's the truly renewable resource. We can grow that!

P: What if my hemp was not chopped up?

K: On a very small scale a portable fibre mulcher is good, though you may not be able to control the length of the cut very well. But you will get an adequate mix. If you are getting some long pieces put them aside and reprocess them. The processed hemp needs to be chopped reasonably cleanly and any clumps of long separated fibre that may gather in processing machinery should not be included in the mix. This bast fibre should be set aside for other uses.

How long the hemp has been growing and when it was planted is significant, because there is quite a lot more

hurd in mature hemp and the hurd component is essential to the mix. In my experience late flowering varieties of hemp if planted as late as February, in northern NSW at least, will grow but will not produce anywhere near the hurd yield of say October planted hemp.

On a larger scale, i.e. for an eco-village, where hemp was grown on the site, so far the best results I've achieved have been using a forage harvester alternately you'd bring in a round baler and a chaffer to chop – that is the next step in mechanization.

Using a tedder rake and square baling hemp is possible but more suited to hemp bale housing which is rendered. At a recent trial with square baling and chaffing we've found that square baling makes the chaffing more difficult. Chaffers are common in rural communities in Australia. We've also use a chipper with success, when the fibre is fed in end on. (Paul notes: One larger scale commercial harvesting unit has been made from a specially modified Kemper front with an added billetising unit designed to handle the hemp stalks, even in high yielding paddocks, chopping it into required lengths ready for infield drying, raking and baling.)

P: Does the stem need to be dry or green for harvesting?

K: It can be chopped green or dry. It is easier to chop green, however you would only harvest in dry weather when the plant moisture content is low and then you need a good solar dryer i.e. access to a big slab under a metal roof where the material can be turned to dry it, otherwise it will begin to compost. It needs to have a moisture content of 10% or less to be bagged.

Hemp definitely gets tougher the older and drier it gets. With some textile varieties, it's harvested as soon as the males are flowering. This signifies that the plants will die off fairly soon afterwards and then the stems begin to become very tough to harvest. In other words even though the female plants will continue growing slowly, you are making it harder to process by letting it get too tough. For more information about harvesting people should contact their regional hemp organisation.

P: Tell me more about rendering.

K: The render mix needs to be very similar in composition to the mix you are building with. It's not advisable to put a very dense render on the wall. We put hammer milled hemp in a render so it maintains the look of being hemp, or a very fine chop of hemp.

P: Can it be retrofitted?

K: The hemp building industry in Europe started this way. Hemp lime construction has a long history in restoration work because hemp masonry adheres well to existing walls; including in old buildings where damp is a problem in the wall. This is unusual. Again you're putting up a simple frame and then filling behind formwork that you've attached.

Another situation where you might be interested in retrofitting a wall, would be if you have moved into a home where the Western wall (in the southern hemisphere) doesn't have much insulation, or protection from an overhanging roof and you are finding you have to use your air conditioner a lot in the summer because your house

gets very hot. On the Gold Coast in Queensland, where development has been dense, there are houses like this.

P: Tell me about hemp blocks.

K: The concept of blocks is often associated with wanting ease of building as people think it is easier to build with hemp blocks. Generally speaking it's more time consuming to build well with blocks and mortar and requires different skills. It's possible to produce hemp lime blocks, however to produce a block, the materials need to be compressed to a much higher degree and there also needs to be quite a lot of cement in the mix to get to the stage where you can put the block on a production line, throw it on the back of a truck and get it out of the yard, at some kind of commercially viable rate. The reason people who work with lime and hemp tend to recommend monolithic construction rather than blocks is that in block manufacture you have to significantly compromise the insulation value of the material and it is a more expensive process. The most sustainable way to build an energy efficient home isn't by using blocks; it's by building nice thick walls and using a material that is not too dense.

P: What about bales? I know about straw bale homes, what about hemp bale homes?

K: The first publicly reported hemp bale home has been built in Europe, though I am guessing others may have been built. I don't know too much about them. I mean I don't know why they would use hemp instead of straw. Hemp bales are going to cost more. There would be a value in using a hemp lime render on straw bale.

P: So they are not cost effective, but I reckon it would be fun to build a hemp bale house if there were no financial constraints. No practical reason not to do that!

P: If there were a secret about hemp masonry what would it be?

K: It's about the carbonation process, what occurs is that the cellulose fibre mineralizes. Some people refer to it as a process of petrification. So, while you're building, when you first mix it up you're conscious that it's a fibre you're working with. As the lime and hemp interact it becomes a very hard material, it mineralizes yet it retains great flexural strength unlike concrete.

P: What's the value of flexural strength?

In extreme weather events, the building has some flexibility. In the Newcastle earthquakes, the buildings with lime mortars were the ones that remained standing. The University of Hawaii has looked at hemp lime construction because of these qualities.

P: Any shrinkage?

K: There is very minimal shrinkage – this is discussed in the manual.

P: What else did you find from the research of the University of NSW?

K: Hemp lime construction is often referred to as carbon neutral building or zero carbon building and the reason for that is that hemp sequesters a massive amount of carbon in its growing cycle. Hemp's growing cycle is 110 days. Average sequestration rates in Europe are 11 tonnes of

carbon per hectare. Between 1-2 tonnes of carbon are locked into the soil which stays as soil organic carbon as well. Rates of up to 100kg can be stored in a hemp masonry building. So every process from growing hemp to building a hemp house is sequestering carbon from the atmosphere.

“Hemp lime masonry is a trade in itself. It's not an imprecise form of building. It is a simple, high tech form of building.”

P: Wow!

K: It's a carbon sink.

P: Who else has done excellent work in this field?

K: I love the work of Yves Kuhn – he incorporates bamboo in his structures to make curved wall sections. He takes the hard edge off hemp masonry structures.

P: I believe his company is <http://www.canosmose.com/>

K: Yes.

P: Ok, so what problems may someone find in building with hemp, because I am sure you have experienced them? My intention is to save people time by putting focus where they could possibly ‘mess up’.

K: One issue relevant to making your mix in a drum mixer is that you need to be careful that the lime doesn't accumulate on the sides of the barrel. It's important to ensure that you keep the mixer reasonably clean and that as much of the binder as possible adheres to the hemp. To achieve this, start the process by putting the water in, then the hemp and ensuring it gets coated with water as quickly

and evenly as possible, then add in your binder and lastly toss your sand through. If the sand is in the mixer for too long what happens is you will get balling of the hemp and the lime mixture instead of the lime binder and sand mixture coating the hemp evenly.

P: Great, is there anything else?

K: The other thing is to not over tamp the wall because you want to retain the air in the wall. Also keep driving rain off the wall by having a good overhang. Cover your wall if it freshly made and subject to driving rain.

It's also important not to make the mistake of finishing the walls with something that will stop the walls from breathing. That is actually a major thing. 75% of allergies including asthma are due to moulds growing in buildings. In conventional masonry you get high levels of mould growth because the material does not breathe. The fact that the walls breathe is one of the major bonuses of hemp construction because it makes for healthy indoor living environments.

P: What about the frame – anything to look out for there?

K: Yes, I'd generally advise against having too much timber detail in the frame. If you particularly like the look of Tudor style building, that is having exposed timber, you will have a lot of horizontal timbers in it, and it will be more difficult to pack the mix underneath. You also increase the risk of shrinkage because you have a lot more small sections. That all affects the insulation because you will need to deal with air gaps. I really recommend monolithic constructions with the frames embedded in the wall.

P: What about wiring and plumbing? I am guessing you need a very clear wiring design beforehand.

K: Yes, all the wire is run through conduits, it's quite simple to install power points and wiring.

P: What do you not know about hemp buildings?

K: When we looked at a broad variety of hemp mixes I realised that there are other applications for hemp lime masonry that I have not focused on yet.

P: Such as?

K: We haven't yet taken the research as far as we could with developing flooring or roofing insulation materials.

P: So, I have built my eco friendly passive solar hemp home with a green roof, how else may I complement that with hemp?

K: Well, hemp rugs on the floor, hemp techno board where you need a composite in your home. Hemp plastics and certainly hemp textiles. If you want to effectively reduce the amount of heat from your windows then you would be well advised to use hemp material for curtains. It is UV resistant and very durable compared to other fabrics. Hemp strings & ropes, hemp fabric for all the soft furnishings. You can get hemp moulded furniture, I would think.

P: Yes, I co-created the first commercial factory for producing those. That is being upscaled now and I hope products will be available from them soon. I also know of hemp tiles that were sold in the UK. Of course, filling your cupboards with hemp foods, and your wardrobe with hemp clothing and hemp shoes, and your bathroom with hemp

cosmetics goes without saying. Now don't get me started! You know you can find out about and buy directly most hemp products at <http://www.hempowered.com>

P: As a final question, where would you make (financial) savings in building a hemp home?

K: You are minimising the noggins, so there is a reduction in timber use. You will also be making energy savings on your heating and cooling bills if you have a monolithic wall that is at least 200mm thick, which is what we recommend. That's been monitored really well in Europe.

Also your internal and exterior walling is finished with one material, so there is a potential labour saving component here quite simply because you are engaging fewer tradesmen. By reducing the inclusion of a whole range of different building products, you probably also coincidentally avoid off-gassing from a whole range of chemicals included in commonly used cladding materials, adhesives and finishes.

P: So you are saving the labour and complications that occur when you combine a lot of different materials in a home.

K: Yes, hemp construction is a relatively simple building process compared to brick or block work which use mortars. It is an easy way to build a house providing you have a good quality consistent mix and you take care with packing the material into the walls to avoid gaps, or over-tamping.

K: Thanks Paul, I hope your readers will send you pictures of their finished product. I would love to see all the different things being made of hemp.

P: Thank you Klara. I will surely pass everything on to you!

Send your pictures to me at info@thehempbuilder.com

Hemp Building Construction Manual



Hemp Building Construction Manual

HEMP LIME CONSTRUCTION IN AUSTRALIA

Klara Marosszeky

As public awareness of green issues increases sourcing materials responsibly or green procurement is an area of growing importance in the construction industry. There is a worldwide trend towards reducing the carbon footprint of buildings and a growing demand for natural and non-toxic materials as an alternative to synthetic building materials. Although this manual is designed and 100% relevant to Australia, most, if not all of this information is applicable no matter where you live in the world. You are recommended to check with your local council or a local building firm as to building and/or planning regulations.

Hemp technology

Background

An overview of hemp based building is best obtained from watching a short video on YouTube at the following link <http://www.youtube.com/watch?v=RWJolxPjvDI> A second video interview with Ian Pritchett Chairman and Technical Director of Lime Technology in the UK at the construction of the first Hemcrete dwelling in the US. This video talks more about the characteristics of the material as a built element of a building <http://www.youtube.com/watch?v=r3uHQwk1Ug8> It talks about carbon sequestration, vapour permeability and thermal insulation properties of the material.

The first video illustrates the entire life cycle of commercial broadacre production in the UK, including:

- Cultivation of the hemp crop;
- Drying, baling and transporting the hemp;
- Separation of the fibre and the hurd or shiv; and
- Wall construction including shuttering, placing, tamping and finishing.

The second video discusses the properties of the material, including:

- Material is a mixture of a lime based binder and hemp hurd;
- Vapour permeability, thermal mass and thermal inertia;
- Low density, high insulation values creating effective thermal separation between the inside and outside of buildings; and
- The recycling of hemp masonry walls.

Hemp masonry is a highly sustainable, low-embodied energy product requiring no kiln baking and it has excellent thermal insulation properties. It is a carbon positive material; it takes more carbon out of the atmosphere than it adds. These characteristics recommend the material in the context of legislation such as Basix and the expected development of further legislation related to energy consumption and greenhouse gas emissions.

Construction from hemp masonry is not new; it has been practiced for a few hundred years in Poland and Austria, 25 years in France and the last ten years in the UK.

Hemp masonry is now accepted in the UK as an efficient carbon neutral form of construction and is being increasingly used in the construction of individual homes and social housing schemes. While early hemp lime building research projects suggested that hemp lime masonry was 10% more expensive to build with than conventional masonry, a standard 3 bedroom home completed at the National Non Food Crop Centre in the UK for just £75,000 has proven that hemp masonry can be used to build affordable homes on a large scale. In the past few years the material has been used in commercial developments such as the Adnam's Brewery and Distribution Centre in Suffolk and in France it is being used for large scale multi storey buildings.

In England and Ireland where industrial hemp is also cultivated, hemp housing was introduced at [Haverhill](http://bit.ly/haverhill) <http://bit.ly/haverhill> by the Suffolk Housing Society about ten years ago. The Building Research Establishment of the UK studied the project and published three reports on aspects of thermal and construction efficiency. These can be accessed via the Suffolk Housing Society web page above.

Since the Suffolk Housing project, further projects have been built in the UK including the Adnam's Brewery Building in Suffolk. The walling of the 4400 sq metre brewery distribution centre incorporates a number of hemp lime products, as does the associated commercial vehicle maintenance facility. The choice to build the Adnam's Brewery Building from hemp masonry rather than conventional masonry meant that 500 tonnes of CO2 emissions were saved during the building process as hemp

masonry captures carbon from the atmosphere and locks it into the fabric of the building. According to Prof Woolley, the warehouse development “*has catapulted this environmentally friendly technology into mainstream commercial building*”.

Many people ask if building a hemp house uses a lot of energy. Overall it is a very low embodied energy product. While lime production does have a significant carbon footprint, the fact that the material has such a high composition of hemp offsets this. As does the fact that there is no kiln baking in the production of the final product. In contrast, concrete has a high carbon footprint due to the nature of cement production from limestone which requires kiln baking at extremely high temperatures. Its substantial fossil fuel appetite contributes large quantities of CO₂ to the atmosphere and make it a very high embodied energy construction option.

There are also health issues associated in concrete construction. It's been shown that there's a correlation between high levels of damp and mould in concrete buildings and increased incidence of allergies, in particular respiratory related allergies and asthma.

Industrial hemp is a highly renewable resource. Hemp produces the world's longest and strongest fibres and enough hemp can be grown in 3-4 months on one hectare to produce about 40 cubic metres of hemp lime mixture, enough to build a 2-3 bedroom home. Hemp takes up vast quantities of carbon while it is growing and this is locked into the building material. Estimates in Europe are that

between 100 and 110Kg of carbon are locked up per cubic metre. Industrial hemp can be grown as a break crop between cereals or potato crops and has many benefits for farmers, improving the ground and suppressing weeds.

Another advantage of building with hemp masonry is that it is a simple form of construction that can be grasped by builders in a short period of time. The most typical form of construction with this material worldwide, uses a conventional timber frame with the hemp lime cast around the frame to create a solid wall. Keeping the form of a hemp lime house simple is crucial to keep the shuttering simple. There is often no need for breather membranes, internal finishes like plasterboard and external cladding.

Joining all of these together effectively can make achieving air tightness a challenge in conventional construction. The complexity of layers and combination of many materials can often create 'leaky' buildings. The ability of hemp lime to ensure air tightness means that it can outperform other building material combinations.

In hemp lime construction, the homogeneous nature of the material fills all voids and creates acoustic and thermal insulation. It is an uncomplicated method of building that ensures better quality and robustness, saves money by reducing trades and speeds up construction. It also significantly reduces risks with fire, damp and rot and adds thermal mass to timber construction.

Hemp and lime masonry also has the advantage of being a lighter weight masonry material that has, from a thermal and acoustic perspective, better characteristics than

traditional heavier materials. It can both store heat and insulate, and this allows it to balance thermal and humidity variations. However, it is also a hygrothermal material which slows down these changes and can therefore maintain much more stable internal living conditions. Achieving thermal comfort is a key factor in housing. There is little risk of thermal bridging, because the timber frame is buried in the hemp masonry mass. The thermal properties of hemp masonry walls have been assessed by independent authorities a number of times. The following is an excerpt from Rachel Bevan and Tom Woolley's book "Hemp Lime Construction".

Tests of the thermal conductivity of walls at Ralph Carpenter's house in Suffolk by Plymouth University led to an agreed reading of 0.08 w/mK. These were taken on a wall which was 200 mm thick and had been constructed a number of years ago so the walls could be assumed to have fully dried out and the lime carbonated. Based on this we calculated the "R" value (thermal resistance) to be 2.75 with plaster and surface resistances taken into account. The team at Plymouth University agreed that a "U" value derived from this would be in the region of 0.36-0.37 W/m²K. This empirical work confirmed a lambda value of 0.08-0.09 for hemp and lime and as this conservative figure has been repeated by so many authorities that it seems reasonable to accept this when making building regulation applications. (Bevan and Woolley 2008)

The breathability of the hemp lime masonry substantially improves the indoor air quality of buildings. Conventional buildings where ventilation is inadequate can develop problems with mould growth which can be very damaging to health as can the volatile organic emissions from synthetic building materials.

The porosity of the material also creates a large area for sound absorption and ensures a high standard of sound insulation. This makes it effective in improving noise

reduction in buildings.

Hemp masonry homes can be easily finished with a simple render on the exterior and interior surfaces, however home owners may also choose to leave the surface unrendered on the interior walls. If it is cast carefully it is not necessary to plaster or render it internally. There are examples in Switzerland, where walls have been left unplastered. It provides very good acoustic absorbency. The material can also be painted.

Unrendered wall surface, hemp home, Billen Cliffs Northern NSW.



It is possible to produce satisfactory hemp lime construction mixing hemp and lime binders in a variety of ways however it is a mistake to assume that any hemp and lime mixed together will produce reliable results.

Cementitious or lime binders that have not been designed to be used with hemp may produce unacceptable results. The overwhelming evidence from experience in the UK is that the main advantage of using a proprietary product such as Tradical (UK), Isochanvre (France) or the Australian Hemp Masonry Company (AHMC) binder is the predictability of the results providing instructions are followed. This product requires high standards of quality control. Mixes that are too wet or using the wrong mix proportions may lead to the walls failing to cure properly. The failure is often related to there being a competition for water between the binder and the hemp.

The rapid uptake of hemp lime construction in the UK and Europe by designers, builders and their clients who want to minimise their impact on the environment has provided a great deal of evidence to support claims that hemp lime construction is one of the greenest products available.

Hemp is replacing quarried materials in the masonry and the energy used in planting, harvesting and processing is quite low. Unlike synthetic fossil fuel based building materials hemp masonry does not emit toxic chemicals during manufacture and unlike other masonry materials it does not require kiln baking. It is a very effective way to capture and store CO2 in buildings.

Hemp lime construction has had no difficulty in getting certification approval as a suitable wall construction system under Building Regulations in the UK.



Hemp Preparation – Whole vs Hurd

Our research has shown that hemp for construction is effective both where whole stem hemp is chopped or where the hurd only is used for construction. The issue here is more about how long the hemp has been growing and when it was planted, because there is significantly more hurd in mature hemp and the hurd component is essential

to the mix. The rationale behind the research that has been undertaken is not to replace building with hemp hurd only. What's of more interest, is that with hemp there is the opportunity to really significantly address social housing needs around the world because hemp produces such high yields of material on so little land.

In some countries where large quantities of hurd are readily available because it's a byproduct of hemp farming for bast, for the European automobile industry, hemp housing is moving ahead. However we need to acknowledge that hemp can be processed on a smaller scale and major decorticating facilities are not needed to get the hemp housing industry started.

Also that regional and sustainable community scale models are possible if whole hemp stem is used. It makes it possible for a local farmer to process in field or on farm and supply hemp housing construction quality material.

GROUND FLOOR SLABS AND FOOTINGS

Foundation design for hemp lime masonry does not vary from conventional construction. Hemp lime masonry can be used with concrete strip footings, prefabricated piled footings, reinforced slabs or post and beam timber frame where the wall is infilled on timber beams. The width of foundations is governed by the width of the walls. A damp proof course should be used at the base of the walls to prevent damp from the ground rising in the masonry wall, as it would be with any other kind of masonry construction. It is important that applied finishes such as sheets or renders do not bridge this impermeable separating layer. The installation of an impermeable barrier is always advised with the use of hemp construction to ensure the satisfactory long term performance of the walls and furthermore, the ground should fall away from the walls of the building to ensure walls are kept dry.

THE FRAMEWORK

Detail drawings are included later in this manual.

The framework in hemp lime masonry construction can be timber, concrete or steel. Lime is an alkaline substance which does not corrode steel and it also preserves timber protecting it from rot and insect attack. Lime has been in use for centuries as the main way to preserve timber. Even where moisture is absorbed into hemp lime walls, the hemp

has the ability to dry out again and the general view is that this removes the risk to encased timbers.

However as for any framed construction, constant exposure to moisture through poor construction practices or through failure of waterproofing systems (in roofs and around wet areas) and neglect can lead to durability problems in both timber and metal frames. As there is long history of hemp lime construction using timber framing, our preference is for this method and treated timber is recommended for framing in all wet areas of the house.

In the event of minor flooding or inundation the walls should recover if dried out naturally. In addition, the lime is a natural biocide protecting the hemp from biological decay, mainly through its ability to wick water away from the hemp. It's high alkalinity protects the material from vermin or infestation and, as well it provides essential fire resistance.

As the hemp masonry is not load bearing with this type of construction, the frame is constructed to standard specifications to support the load of the roof of the building. It can be used with the full range of timber frame construction including stud construction, post and beam, double stud and so on.

The timbers can either be offset to one side, or placed in the centre of the hemp masonry wall. Placement in the centre of the wall ensures the most protection for the frame and creates optimal air tightness. The thickness of the walls does not relate to the width of the timber studs. Standard studs with a thickness of 89mm x 38mm are sufficient for hemp masonry construction. Taller walls and more

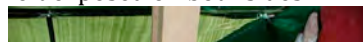
exposed situations will require deeper and wider studs and/or closer centres. This is a structural engineering function and is not related to the hemp masonry.

Horizontal noggins should be avoided where possible as they get in the way of effectively placing the wet hemp masonry material. Noggins between the studs are not required to reduce the stud effective length due to the continuous restraint provided by the hemp masonry, however if the roof or second storey structure are built before the hemp masonry infill is placed at the lower level, noggins may be needed as specified by a structural engineer. Hemp masonry is an infill system which provides thermal and acoustic insulation and in addition stabilises the timber frame depending on the construction sequence adopted. It is not a load bearing material.

Home owners may prefer the finished appearance of offset structural timbers especially where quality hardwood is available and exposed timbers are a feature of the design. This kind of construction may have evolved because hemp masonry was initially used in Europe in restoration of old buildings as a replacement for wattle and daub. Many of these buildings were Tudor style buildings where the timber is traditionally left exposed. It was also commonly used in Switzerland in this way.

Wall section off retrofitted shed wall with offset timber structure, Corndale NSW

Wall section of Swiss hemp home. Formwork is attached to the substantial structural timbers which in this case are left exposed on both sides.



Completed Swiss hemp masonry home. In this case the hemp masonry is left unrendered and exposed timbers are a feature of

Plywood shuttering or formwork being attached to Post and beam framework for hemp masonry home Carolina USA



Within the limits of the framework and formwork, curved walls can also be created.

Where the framework is in the centre of the wall this creates a monolithic structure i.e. the framework is totally encased in the hemp masonry and no timber or framing material is visible.

ROOF OVERHANG

As with any building method using natural materials, where heavy and driving rainfall may occur it is advisable to provide a good overhang to the roof to reduce the amount of driving rain on the surface of the wall. However hemp lime buildings in the UK are generally built with conventional roof overhangs and there has been no damage to walls.

If a hemp masonry construction is allowed to remain in a saturated condition through poor design, poor construction or neglect, then, as with other forms of construction, durability issues will emerge with the embedded timber and metal structure. Critical details for designers and builders in hemp construction are similar to those required in other building systems and include:

- Roof overhangs generally used, particularly to protect wall openings;
- Ground to fall away from the building; and
- Sills and thresholds to fall away draining water from the building.

AROUND DOORS AND WINDOWS

Doors and windows sit outside the line of the frame and are fixed to the frame with brackets.

Openings for doors and windows should be 5mm larger than the frame size on the sill and on the sides. The head above the window frame should be 25mm larger than the frame size and should allow for a permanent shutter. See the detail drawing.

FIXINGS TO HEMP LIME

The timber frame in hemp lime walls should be used for supporting any heavy elements that have to be fixed to walls. Non structural elements like kitchen units and shelves need to be supported off the timber frame. The hemp masonry wall material can be drilled and plugged for lightweight fixings.

OPENINGS, ELECTRICAL WIRING AND ALTERATIONS

If changes are required due to any error, hemp masonry can simply be dug out by hand within the first 6 hours, the surface can be reshuttered and recast. Once the material has set, being mindful of concealed services, sections can be simply cut out with hand or power tools.

To create openings in the hemp lime masonry for services such as electrical and plumbing fittings, simply create the opening in the shuttering. Hemp lime masonry should be cast around any service penetrations to ensure air tightness.

USE OF INSULATION WITH HEMP LIME CONSTRUCTION

Synthetic insulation materials such as polystyrene or polyurethane will compromise the breathability of hemp lime walls. It is normally not advisable to place an insulation quilt or batt directly in contact with hemp masonry as moisture when the material is initially cast, can migrate to the insulation material.

ATTACHING THE FORMWORK TO THE STUDS USING SPACERS

As hemp masonry is not as heavy as concrete, the shuttering or formwork can be much more lightly attached to the frame and spacers are used to keep the formwork equally distant from the studs.

In new hemp masonry builds, the stud is generally in the centre of the formwork and tubular or small square timber spacers are used to attach the formwork or shuttering so that the masonry mixture can be placed into the gap between the timber and the shutter easily and lightly tamped. When the shuttering and the spacers are removed the resulting cavities are filled with a small amount of hemp masonry mix.

To determine the length of your spacers, measure the width of your studs and cut equal length spacers from either dowel, or pieces of square section so that your total wall width will equal 200mm. At times in retrofits, the formwork may need to be offset, so spacer length needs to be adjusted accordingly.

The dowel or square sections you use, need to be wide enough for you to drill through and into the stud, without the spacer splintering. At the same time, you do not want them to be too large, as the spacers are removed from the wall with the formwork leaving some holes to be filled.

You will only need to drill through and screw the spacers to the studs at the bottom of the formwork. At the top of the formwork in most instances, the spacers and formwork can be clamped firmly to the studs with large G clamps.

The spacers should be placed as close to the bottom and top of the formwork as possible. Fill the formwork with hemp masonry material to just under, or next to the top row of spacers.

If you are forming up the whole perimeter of your house, you will need twice as many spacers as you have studs.

At the end of each wall section, near doorways, a piece of formwork the width of the wall, replaces the role of the spacers. This formwork is screwed directly onto the stud to enclose the end of the wall.

While this set up is time consuming, it is necessary to get well finished walls, particularly where you might be considering having unrendered internal walls. Slight variations in the surface can be sanded if necessary, once the material is cured.

SHUTTERING OR FORMWORK

Once the framework is completed 600cm high internal and external shuttering is attached with spacers to the frame around the base of the house. Shuttering can be made from a wide variety of materials, as the load on shuttering is much less than for concrete work. Proprietary formwork and shuttering systems such as Geo-panel, plywood or PSB sheets are often used in overseas hemp construction. Proprietary lightweight plastic systems such as those used for rammed earth construction may be useful in hemp

construction. If reusable shuttering is used the surface must be clean

The formwork can be removed from a cast wall the following day and any spacer holes filled with hemp masonry mix. It should be removed by sliding the sheets slightly sideways. *Formwork should be removed at this time in order to encourage drying.*

In moderate weather no further protection of the drying wall is needed except against the extremes of the weather such as snow, frost, rain and drying winds. Using this method the shuttering or formwork is then attached to the frame higher up to build up the next 600cm of walling.

Permanent shuttering using a sheeting board can also be used to form the final finish of the wall. Where home owners choose to finish the home with timber cladding externally or internally, the use of a breathable membrane between the hemp masonry and the timber is recommended. This ensures that the movement of air or breathability of the walls is maintained.

The sheeting board should be of a breathable, vapour permeable material. The use of particleboards and plywood is not recommended as permanent shuttering as these contain glues and may have limited breathability

PREPARING THE MIX

Varying proprietary hemp binder manufacturers may advise different mixing methods. With the Australian Hemp

Masonry Companies hemp lime building material the aim is to obtain an aerated mix resembling sticky crumble in which the hemp particles are well covered by the binder materials without the building material being too wet. The hemp should be as clean and dry as possible with minimal dust or foreign matter. If there is suspicion of damp or rot the material should not be used. Hemp for building should always be stored in a dry environment.

Your mixer should be selected to suit the task and site organisation. While it is possible for an owner builder to mix hemp masonry onsite in a normal 60 litre or 3 cubic foot rotary drum mixer or to improve work flow 2 drum mixers might be considered, however a commercial builder would be advised to mix in larger batches using as a minimum a 250 litre pan mixer.



*For information about hiring pan mixers
www.hempmasonry.com*

Lime based masonry needs thorough mixing so that a light fluffy mix is achieved.

To make the mix put the water in the mixer and allow it to coat the walls of the mixer then add the hemp. Allow the ingredients to mix for a few minutes till all of the hemp has been coated with water. It is important that all surfaces are wetted so that the binder can adhere to the hemp. It's equally important that this wetting is done quickly because hemp is extremely absorbent and you don't want the water absorbed, you want enough moisture on the surface of the hemp for the binder to adhere to.

Add the binder next and mix for 5 – 10 mins. This is dusty initially. Wear a dust mask. Using a garbage bin lid to seal the mixer can reduce the dust initially. It's important that all of the hemp is coated in binder. So stop the mixer and check the mix to ensure the material is mixing evenly.

While it's important not to make the masonry mixture too wet as you need the binder to coat the hemp, vary the water to suit the conditions by water spraying the mix slightly in very hot weather. This is also necessary if there are any long delays before placing the mixed material.

If the mixture is too wet and tamped firmly, a paste is forced to the outside of the mix and the lime solution leaches out of the shuttering resulting in a poor mix.

Do not use material that has been mixed for more than 6 hours. According to the hemp building industry in the UK any old mix material should be added to new mixes at a rate of 10% per mix.

The sand is added as the last ingredient to the mix to avoid the formation of pellets or balls. Once all of the hemp in the mixer is evenly coated with the binder, half of the sand is tossed into the mix, mixed briefly, and then as the material is being emptied into your wheelbarrow the second half of the sand is tossed through the remaining material. If this process is not done quickly the sand and the lime combine to form balls in the mix.

For large commercial construction projects, larger mixers up to an 800 litre pan mixer operating on a slow speed of rotation is recommended so that bigger batches can be made up and there is no down time while workers are waiting for mix to place in the walls. For single home construction a 250 litre mixer is recommended.

PLACING AND TAMPING THE MIX

Once it is mixed the hemp masonry material is placed or tipped into the shuttering and lightly tamped to form a level 200 to 300mm thick layer. A tamper is a flat piece of timber with a long timber handle. The handle needs to be just long enough for you to comfortably reach into the formwork. Tampers are easily made from wood offcuts. At least one tamper should be just under 200mm wide, the width of your wall. It's also good to make a narrower tamper to work in corners and around studs.

It is highly recommended that prior to commencing building a small trial section is made to determine the amount of tamping required. Conduct a density check on materials

reconciliation. It is important not to over tamp the mix. If the material is too heavily tamped into the shuttering then the insulation value is compromised.

Hemp walls are cast in stages. Ideally the first layer of the whole building should be set up with formwork and a 200-300mm layer of material should be placed all around the house and then tamped. The next layer is then placed and tamped until the 600mm high formwork is filled parallel to the top spacers around the full perimeter of the house. Horizontal day joints should be lightly wetted before the application of the next layer of hemp masonry. Vertical day joints should be avoided. Always work up to the side of openings.

CURING

Initial curing of the material takes place within 24hrs and shuttering can be removed, moved up and another 600mm of hemp masonry can be placed on top of the initial layer. It's worth noting that unrendered walls should be rubbed as little as possible when the formwork is first removed and the material is green. This is a slower curing material than concrete.

Even where the walls are to be rendered it is still advisable to allow the material to cure for up to week before it is handled much. People are tempted to touch the walls because the concept of building such an obviously fibrous wall is fairly unusual nowadays however little or no carbonation has taken place when the formwork is first removed.

When the material has dried out it becomes a strong and solid composite which creates a weatherproof mass providing thermal insulation, thermal storage and a wall substrate which can take a number of different finishes, these can be sheeted, rendered or painted or with a range of different existing finishes. Thorough curing of the material can take up to 4 weeks dependent on temperature and humidity.

Building with hemp masonry should be avoided in temperatures below 5 degrees Celsius. Very high humidity and low temperatures can delay curing times.

SHRINKAGE

Hemp masonry shrinks around the same amount as timber in the direction of the grain but only around 10% of the shrinkage across the grain. This means that there is little differential shrinkage between the frame and the hemp masonry. However differential shrinkage of around 5mm can occur at the floor zone if solid softwood floor joists are used. This could lead to cracking in the finishes therefore engineered floor joists are recommended to limit the effects of shrinkage in floor timbers.

RENDERING EXTERIOR AND OR INTERIOR WALLS

Hemp masonry should be allowed to cure for 28 days (under typical conditions) prior to rendering. A lime based render is recommended for rendering as it has good vapour

permeability which is essential to maintain the vapour permeability of the whole wall. This can be lime washed or self-coloured. Oxides can be added.

OTHER FINISHES

Hemp lime masonry surfaces can be painted with vapour permeable paints such as silicate mineral paints, clay paint, soft distemper lime wash and water based emulsions. Using natural paints that are low in volatile organic compounds is important so as not to compromise the health benefits of using hemp lime. It is also essential to maintain the breathability of the walls. Polymer based paints and renders should not be used.



300 year old hemp home, Miasa Mura, Japan

LONGEVITY

According to the industry in the UK, it is expected that hemp lime buildings will survive for centuries.

RETROFITTING AND RESTORATION

Hemp lime masonry is as useful in building renovation as in new construction. It is much more flexible than cement and

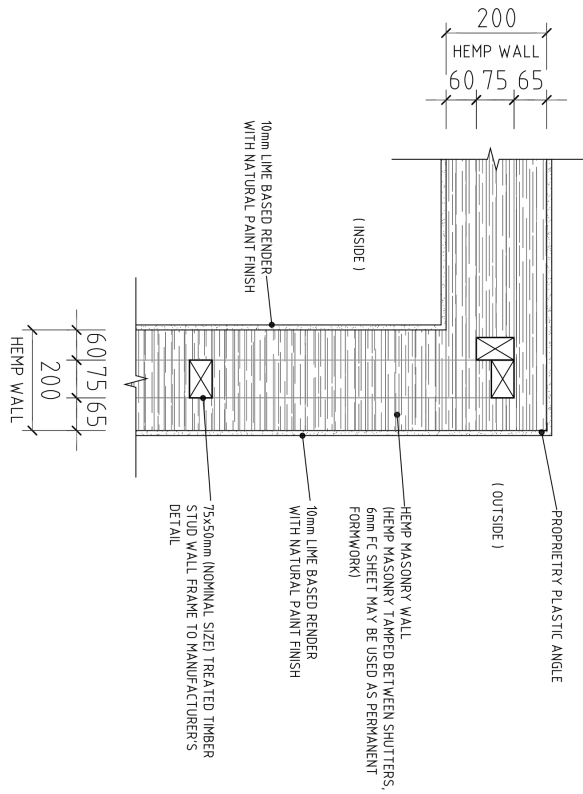
it has proven to be a robust building material with very little shrinkage. It adheres to steel, brick, concrete, wood and old plaster or render. It can be cast against old stone, brick or cob (earth) walls either on the inside or the outside, and readily goes onto uneven surfaces. Often used in conservation work in Europe and the UK, the material is demonstrating that it has major potential as an insulating plaster in renovation of buildings where other materials may not cope with the dampness in old walls. It can be used as infill for very small sections or for whole walls. The flexibility and the lack of cracking can ensure that the walls remain airtight.

Retrofitting is done by attaching temporary studs to the existing surface, as in new building. The shuttering is attached to these studs. Dependent on the thickness of the walls, if necessary once the wall section has been completed, the studs can be removed and the gaps filled with hemp lime material. On old buildings that do not have an attractive finish the material can be applied to external walling and then rendered. It insulates the existing thermal mass. It is equally effective when used instead of dry lining on damaged internal walls because it ensures that there are no cavities and retains breathability.



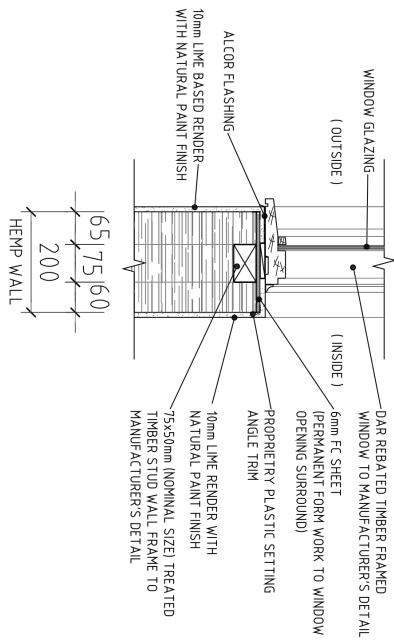
TECHNICAL DRAWINGS

Hemp Wall Detail



TYPICAL EXTERNAL WALL PLAN VIEW DETAIL

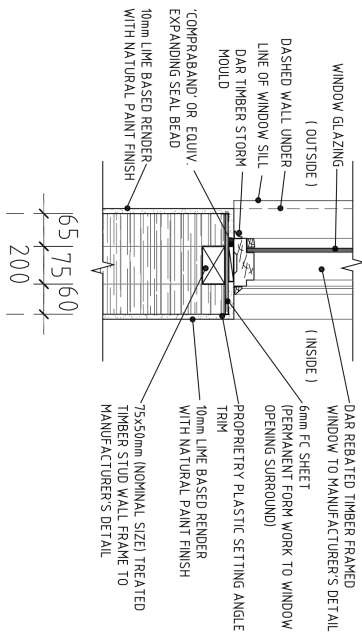
Hemp Window Sill Detail



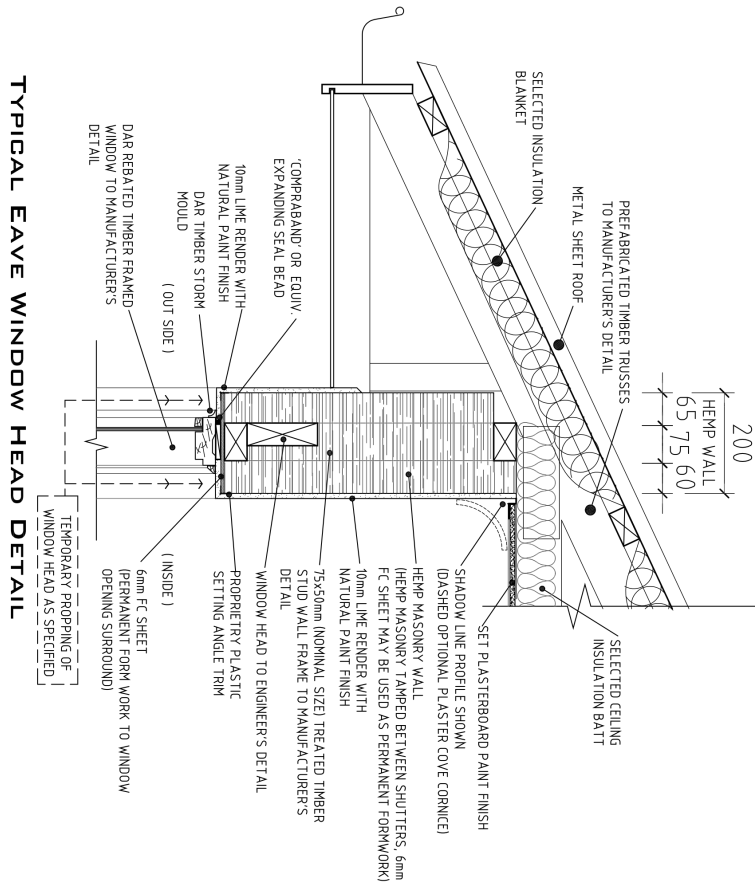
TYPICAL WINDOW SILL DETAIL

Hemp Window Jamb Detail

TYPICAL WINDOW JAMB DETAIL



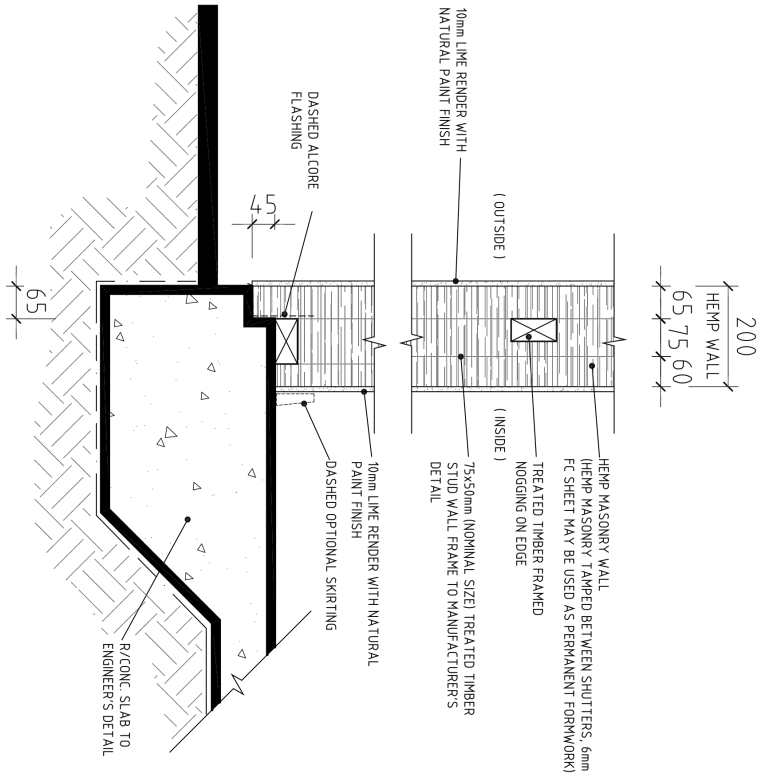
Hemp Eave Window Head Detail



TYPICAL EAVE WINDOW HEAD DETAIL

Hemp Bottom Plate On Slab Detail

TYPICAL BOTTOM PLATE ON SLAB DETAIL



	Hemp Lime	Straw bale	Brick veneer	Pise/mud brick
Thermal performance	Excellent R value 2.75 U value 0.36-0.37 W/m ² K See below	Excellent	Not as good	High thermal mass, slow to heat up and slow to cool down
Construction cost	= Brick Veneer (BV)	Lowest	BV benchmark	More expensive than BV
Workability, ease of construction	Light and easy to work with, relatively fast with right equipment, easy to build	Simple and quick, somewhat specialised	Requires several skilled trades to construct	Very heavy to work with
Vermin	Vermin proof, termite proof	Vermin a risk if they get into the walls, termites can eat out straw bale from the inside.	Vermin excluded with [proper details)	Termites bore straight through
Fireproof	Innately fireproof and protects wall timbers	Fire rating depends on thickness of render	Externally fireproof	Externally fireproof
Embodied energy	Low EE	Low EE	High EE	Low EE

Carbon footprint	Absorbs up to 10t carbon per ha during crop cycle and absorbs further carbon as a wall	Absorbs carbon as a crop	High footprint for kiln fired bricks	Neutral, especially if sourced on site
Damp rot	Rot resistant as Hemp lime masonry mineralises.	Core can rot out if water gains access	Damp proof	Damp proofness relies on roof overhang
Recycling	Can be fully recycled, simply break down, mix with new binder material and reconstruct, or use as a mulch	Unlikely to be reused, can be used as mulch	Bricks can be crushed and recycled, relatively high cost process	Dust to dust
	Hemp Lime	Straw bale	Brick veneer	Pise/mud brick

Thermal Performance of Hemp lime construction

Tests of the thermal conductivity of walls at Ralph Carpenter's house in Suffolk by Plymouth University led to an agreed reading of 0.08 w/mK. These were taken on a wall which was 200 mm thick and had been constructed a number of years ago so the walls could be assumed to have fully dried out and the lime carbonated. Based on this we calculated the "R" value (thermal resistance) to be 2.75 with plaster and surface resistances taken into account. The team at Plymouth University agreed that a "U" value derived from this would be in the region of 0.36-0.37 W/m²K. This empirical work confirmed a lambda value of 0.08-0.09 for hemp and lime and as this conservative figure has been repeated by so many authorities that it seems reasonable to accept this when making building regulation applications. (Bevan and Woolley 2008)

EQUIPMENT NEEDED ONSITE

PPE

The main irritant is the binder and avoiding contact is the main issue.

Minimum requirements:

Barrier cream for hands and arms

Goggles and face mask – the best solution is a full face respirator with filters suitable for lime dust.

Gloves

FOR CONSTRUCTION

Rotary drum mixers (where a pan mixer is unavailable the use of 2 drum mixers may improve the speed of construction)

Pan Mixer

(Mixers should be mounted to a height to discharge directly into wheelbarrows)

Tubs and barrows for moving the mix from the mixer to the shuttered area.

For large projects where a lot of material is to be moved, particularly to the higher shutters or where it is necessary to move the mixer to the other side of the site a forklift is recommended. This is not necessary for smaller projects.

Water pump with flow meter. Water dosing is critical to achieving consistent mixes. While this job can be done with buckets, a tank with a pump and flow meter is easier and more accurate.

Small Tools:

Stainless steel or galvanised nails.

Screws of suitable length to fit shuttering.

Preferably an impact driver but ordinary screw guns will work.

Spare timber for making up shuttering for awkward areas and propping pieces for lintel support

Pieces of wood for tamping the mix

Long and short levels, stringlines and plum bob

Tubular or square spacers e.g sections of dowel or square section cut to equal lengths to allow the shutter to be screwed to the frame at exact distances.

Hydraulicity of Hydrated lime may be obtained by the addition of cement, pozzolanes, etc. In such a case, the introduction of foreign chemical elements may have immediate or long range inauspicious consequences. It is not advised to use hybrid products with unknown performances.

SAFETY DATA

Composition: Calcium Hydroxide $\text{Ca}(\text{OH})_2$ and sand. Lesser quantities of calcium, carbonate, calcium silicates, silica and oxides of magnesium, aluminium and iron and other trace elements,

Hazard Identification: Gloves and goggles should be worn. Lime is irritating to the eyes and the skin. It can cause burns in the presence of moisture. It is advisable to ensure that eyewash facilities are available onsite.

First Aid Measures:

Eyes: Painful irritant to the eyes. Irrigate with eyewash or water immediately until free of any matter in the eye. Speed is essential. Seek medical attention. Wide vision full goggles with anti-mist for eye protection are recommended

Skin: May cause a mild burning sensation in the presence of moisture. Flush affected area with plenty of water. Remove and wash contaminated clothing. Prolonged or repeated contact with skin may cause dermatitis or severe irritation. Use barrier creams if necessary and wear rubber, leather or fabric/composite gloves. Long sleeved overalls and boots that resist dust penetration are recommended.

Ingestion: Wash out mouth with water and give copious amounts of water to drink. Larger doses may irritate intestinal tract. DO NOT induce vomiting. Seek medical advice if necessary.

Inhalation: Irrigate nose and throat with water for at least 20 minutes. It is advisable to seek medical attention. Repeated inhalations of high dust concentrations may cause pneumonitis and ulceration or perforation of the nasal septum.

No known delayed effects. The product is considered to be non-toxic.

HANDLING AND STORAGE

Keep out of reach of children.

Storage: Store in a cool dry environment. Minimise contact with air and moisture.

Handling: Keep dust levels to a minimum.

Ventilation: Ventilation equipment may be needed on some sites to ensure dust levels are below the occupational exposure limit.

Accidental release measures: In the case of a spillage or release, contain the spill. Remove it either by using a vacuum suction unit or shovel it into bags. Alternatively damp the material down and shovel it into bags. Avoid contamination of watercourses and drains. The binder material is strongly soluble in water and forms an alkaline solution. It has low mobility in moist ground conditions. It reacts with moisture to form calcium hydroxide and with atmospheric and dissolved carbon dioxide to form calcium

carbonate. Report any spillages that occur off site to the relevant statutory body.

Transportation: Not classified hazardous for transportation

Collecting Some Raw Materials



Material and Safety Data Sheet (MSDS) for Hemp Fibre

01	Material/production name	commercial product name: hemp fibers
02	Composition/Information on ingredients	chemical characterization: cellulose, hemi-cellulose, pectin, lignin, wax/fats
03	Prospective risks	not applicable
04	First aid measures	Inhalation: Move to fresh air. Eyes contact: Rinse with water.
05	Fire-fighting measures	suitable extinguishing agents: Water spray, foam, carbon dioxide, dry, chemical powder
06	Measures at unintentional liberation	not applicable
07	Handling and storage	Handling: usual precautionary measures have to be observed when working with all combustible materials containing dusty particles Storage: keep the material well closed and dry, Self life stability: at least 5 years
08	Exposure limit and personal protective equipment	additional information's about the construction of technical equipment: Avoid blowing of dust. Protection against Electrostatic charge during handling. Personal protective equipment: Respiratory protection: mask of nuisance dust (P1)
09	Physical and chemical properties	hypothetical postulate: Form: Fibrous Color: Gray -yellow Odor: Hay equivalent up to odorless safety relevant data: pH-value (at 100 g/l H ₂ O and 20°C): 6,5 +/- 1 thermal decomposition: 200° C Ignition Temperature: 320 ° C Explosion limits: Not applicable Vapor pressure: Not applicable further indications; Density: 1,45 g/cm ³ Solubility in water (20°C): Insoluble
10	Stability and reactivity	Neither danger reactions nor danger decomposition products Have been observed
11	Information on toxicity	The product is harmless
12	Information on ecology	natural resource, biodegradable.
13	Information on ecological effects	without any problems (landfill, combustion etc.)
14	Information about transport	non-hazardous goods according to the transport regulations
15	Regulations	Marking according to the hazardous product regulations: not necessary Water danger classification: 0
16	Further information	not applicable

91/155/EWG

The given particulars are based on our present knowledge and experiences. However, a legally binding guarantee of certain properties cannot be derived from our Statements.

Costings

Costings change all the time, so we have created a cost calculator which gives you approximate costings for you to use for free. Transport costs will vary according to distance. Please email us at info@thehempbuilder.com and we will supply you with a way to calculate the cost of building with hemp!

When you buy fibre and binder from the Australian Hemp Masonry Company we work with you to ensure your site specific recommendations are included.

Look forward to hearing from you.

HEMP & BINDER NOW AVAILABLE FOR HOUSING CONSTRUCTION

Currently hemp in Australia is limited in supply. Priority at this stage is being given to housing construction projects. It's anticipated there will readily available hemp in NSW in March/April 2011.

HEMP LIME BINDER

Australian Hemp Masonry Company's binder is available in 1 tonne orders. Smaller orders will be available from December 2010.

Detailed mix instructions will be provided specific for your site.

Contact www.hempmasonry.com to buy direct.

Why Australian Hemp Masonry Company Hemp Binder?

We are often asked why the hemp binder is proprietary. Over the past decade we have made a lot of mixes at the University at considerable expense. We determined what we have now to be the best mix to meet sustainability and usability criteria. You are of course welcome to undertake similar research. For us there is a responsibility attached to what we are doing because the purpose of determining the mix was also to meet the legislative requirements for building. The aim was to make hemp lime construction affordable, and to support the following goals:

- a) to give small to medium farmers the opportunity to process on site and earn a reasonable return by removing the further processing of the hemp i.e. to allow the hemp industry to spread so that further product development can occur
- b) to establish regionally based housing industries to allow hemp to be grown so that we can start to harvest carbon and clean up the mess we've made of the environment i.e. to bed sustainable hemp farming into regional land management models
- c) to significantly better the Aboriginal housing situation in Australia either through engaging successfully with them or if others buy it, by turning that money back into Aboriginal housing.

According to Tom Woolley, Professor of Architecture at the Graduate School of the Environment at the Centre for Alternative Technology and Professor of Sustainable Rural Architecture at the University of Gloucestershire, and

Rachel Bevan principal architect at Rachel Bevan Architects, County Down, Northern Ireland, experts in hemp lime construction:

“For small projects the savings in using non-proprietary lime binder products is likely to be marginal and the risks of making up your own mix can be great ... It is a serious mistake to assume that any hemp and any lime mixed together will produce good results. Hemp lime is a simple but high-technology product that requires high standards of quality control; if carried out correctly hemp lime construction may prove to be one of the most sustainable and successful building methods ever invented.”

This method of hemp lime construction and the binder recommended for use through this book, are the result of a project that was developed to make hemp lime construction available in Australia as an affordable building material. Currently hemp buildings being constructed in Australia are made from imported binder and in some cases imported hemp. This is not sustainable as the footprint from the associated freight is enormous.

As transport of hemp material is costly even within a state, the costings for the materials are based on a low profit model in the hope that this will support broad uptake of the material and further encourage a farming industry that can produce the many products that are required for us to develop a sustainable economy based on renewable resources in the near future.

While the material is suitable for commercial construction, the goals of the model are to maximise returns to small and medium sized farmers, rather than only to large farming

consortia and to create the possibility for owner builders to share farm on a small scale and grow hemp to build affordable sustainable homes. It is hoped that farmers and growers will grow hemp organically, given that the plant is so hardy and useful in crop rotation.

Interesting articles from Paul on...

Hemcrete

Creating a hemcrete wall, 3 m high, 3 m wide and 300mm thick with a imposed load of 135kN. The wall contained eight vertical timber studs and cast Hemcrete and the internal face was exposed to the fire. The test proved the integrity and load bearing capacity of Hemcrete for in excess of the one hour fire test.

Hemcrete thermal blocks have been available for some time, however an upgraded structural block has now been developed and is available for those who want to minimise the embodied carbon in their projects. The block is identical to a standard 440 x 215 x 100mm concrete block except it is carbon neutral through the use of hemp rather than aggregate. The hemp absorbs a similar amount of carbon dioxide in its growth as is emitted in manufacturing the binder, making this one of the first structural blocks in the UK market which is truly carbon neutral.

The blocks are available currently for use as a replacement to Dense, Lightweight and Aircrete blocks.

The blocks will cost more than traditional concrete blocks but for those customers living in the UK or close to the UK who care about embodied carbon, it is a small price to pay for a much reduced carbon footprint.



So called, Hemp Bricks



processed hemp fibres

www.thehempbuilder.com
www.startahempbusiness.com



loading processed hemp building materials

<http://www.limetechnology.co.uk/index.htm?pages/hemcrete.php>

BIOCORE- A 20 million Euro biorefinery project

A biorefinery concept for the transformation of biomass into 2nd-generation fuels and polymers

03.2010 - 02.2014

Guy-Riba, vice-president of INRA, Michael O'Donohue, research director (INRA) and scientific manager of BIOCORE, Bruno Schmitz and Philippe Schild (DG Research, European Commission) and Andreas Redl, Green Chemistry Project manager at Syral S.A.S. announced on the 4th March 2010 the launch of a FP7 EU project, BIOCORE (an acronym for BIOCOMmodity REfinery), which is focused on the development of a biorefinery concept for the transformation biomass into a variety of products, including 2nd generation fuel and polymers.

In this far-reaching project, the nova-Institut GmbH is taking over the task of the techno-economic evaluation of the whole BIOCORE processes as well as the analysis of feedstock availability and supply management, including sustainability aspects, and the market research for the whole range of BIOCORE products.

Today, concerns linked to climate change and Europe's excessive dependency on petrol are providing the driving force for the move towards the diversification of energetic resources and for the use of renewable carbon. In this regard, biomass is unique, because it is the only natural resource that can satisfy both needs, providing feedstock

for biofuel production and for the manufacture of chemicals and materials.

The EU project BIOCORE, managed by INRA, will conceive and demonstrate the industrial feasibility of a biorefinery concept that will allow the conversion of cereal by-products (straws etc), forestry residues and short rotation woody crops into a wide spectrum of products including 2nd generation biofuels, chemical intermediates, polymers and materials. Through the development of a range of polymer building blocks, BIOCORE will show how 70% of today's polymers can be derived from biomass.

To meet the challenge of developing a competitive biorefinery concept, BIOCORE will unite the forces of 24 partners who will work together over a 48 month period. Among its European partners, BIOCORE counts 10 companies, of which five are SME's (among these the nova-Institut), one NGO and 12 public R&D organizations (i.e. universities etc). Additionally, BIOCORE counts among its partners a world-class Indian R&D institute (TERI, New Delhi). The BIOCORE project will benefit from a budget of 20.3 million €, of which 13.9 million € represents aid from the European Union within the framework seven (FP7) research program.

Affordable housing workshops

Yes, it is time. With Klara's new technology we are now able to offer you the opportunity to grow your own home.

Of course, you can just buy in the fibre & Australian Hemp Masonry Company binder, which is affordable too!

You can learn how to incorporate hemp building techniques into any timber (or other approved) frame building.

You will leave this workshop feeling empowered to build your own home. We will supply sources for all the materials you require.

Theory and practical. Come along, learn about the hemp building and get your hands dirty (or watch others).

The workshop is suitable for beginners, self-build enthusiasts and professional builders looking for a more affordable product.

After 10 years of scientific research & development, this material may now be approved by your local council. Come and learn more at the one day workshop.

Learn more at www.hempmasonry.com

Eco Hemp Farm Tours

fun for all ages in
byron bay



DISCOVER THE WONDERS OF HEMP AT
THE HEMP FARM

BYRON BAY

2 HOUR ECO TOUR



With Hemp We Grow

Make Hemp Ice Cream
Hemp Chocolate
Hemp Jewellery Making
Visit Hemp Museum
See The Hemp Building

www.hempfarm.com.au

Eco Hemp Farm Tour in Byron Bay



Join us for a fun and educational tour of a working hemp farm.

- * make farm fresh **hemp ice-cream**
- * learn the benefits of eating **hemp chocolate**
- * watch how easy it is to make organic hemp milk
- * make your own **hemp jewellery**
- * see how a sustainable hemp farm works
- * free entry to **hemp museum** and **hemp shop**

WHAT? 2 hour hemp farm eco tour.
Taste unique foods and experience the true Byron Bay

WHERE? A sustainable permaculture farm, nursery and tea room just 5 mins. from the heart of Byron Bay.

WHEN? 11am most days. Pickup Byron Bay bus stop - look for hemp van

HOW? Bookings essential Tel: 02 8003 3032

www.hempfarm.com.au



hemp foods
AUSTRALIA

HEMP FOODS AUSTRALIA Pty Ltd. PO Box 1069
MULLUMBIMBY NSW 2482 WWW.HEMPFOODS.COM.AU

Australian Hemp Farmers
supplying healthy nutrition
direct to You

HULLED HEMP SEEDS

Claimed by many to be a superfood, hemp seeds provide an excellent source of protein (30%¹), beneficial fatty acids (omega-3, 6 and 9) and fibre. Used in both sweet and savoury recipes including hemp milk, hemp bread, hemp ice-cream, hemp seeds are both nutritious and very tasty!

The history of Hemp Foods in Australia has not been so sweet. A multi-million dollar and successful industry throughout Europe and North America, it is understandable why some may think hemp foods are flying high. Our hulled hemp seeds do not get you high and are in fact recommended in most countries for breast-feeding mums, world class athletes and those who realise quality food is a requirement for optimal health. It is our wish that in Australia hemp seeds and hemp foods will soon become commonplace in supermarkets and health food stores. In Australia we are proud to be the original hempfood company passionate in bringing you the best quality at most affordable prices.

Superfood Benefits

High in quality protein - 33% protein

High in Essential Fatty Acids - omega 3, 6 and 9

Tastes great - may be eaten alone

Recipes galore - we offer hundreds of free recipes

Hemp Foods Experts - 20 years experience in industry

Certified Organic | Raw | Vegan | Not Irradiated

The nutritional benefits of oil with longer shelf-life, wider appeal and thousands of uses in foods.

Free To Be Healthy

¹ please contact your representative for pricing structure
Wholesale, Bulk and Distributor and export welcome.
We are Australian Hemp Farmers and have growing friends on every continent of the world.

info@hempfoods.com.au



Hemp Shopping



Hemp Foods

Hemp Protein Powder

This Hemp Protein Powder has a gourmet nutty flavor that tastes so good you can eat it straight from the jar. Use it to create delicious shakes, add it to juices, smoothies and green drinks. Buy 100% raw, cold milled Hemp Protein Powder today!

Hemp Seed Nut

Otherwise known as shelled hemp seeds – these are the tastiest and most pure way to enjoy the drug-free nutritional qualities of hemp seeds. A complete protein (35%), omega 6 and omega 3 Essential Fatty Acids (35%) and is a source of GLA (1%). These are delicious sprinkled on salads, cereals, yogurt or cooked grains. I eat it straight from the bag! This hemp seed nut is cold mechanically pressed and packaged without additives or preservatives and grown without herbicides or pesticides from Non-GMO hemp seed. So what are you waiting for? Now available in Australia at www.hempfoods.com.au

Hemp Seed Nut Butter

Like peanut butter or tahini, but tastes better and is much better for you as nature's source of complete protein (35%) and Omega 6 & 3 Essential Fatty Acids (35%). May be spread on breads, bagels, crackers and croissants..

Hemp Seed Oil

Certified Organic Hemp Seed Oil is nature's richest source of the Essential Fatty Acids (75%) and is a rich source of GLA (3%). Hemp Seed Oil is preferable over flax seed oil as it offers a good balance of Omega 6 to Omega 3 fatty acids (3.75:1) so it is suitable for life long consumption. And you will have a long life. Tastes a lot better than fish oils with a mild nutty flavour. Can be eaten straight (I do) or added to juices, smoothies, soups and sauces. It is a great base to any salad dressings. Hemp Oil is not ideal for frying. Also available in capsule format.

www.hempfoods.com.au

Hemp Cosmetics

Hemp oil is used as the base of cosmetic products because it helps make the skin feel young, and smooth. Hemp Oil has been shown to improve eczema and other dry skin ailments. Hemp Oil in cosmetics is absorbed by the skin and after a short while of using such products I am sure you will notice the difference yourself. A great range of hemp cosmetics is available via www.hempowered.com - shipping worldwide.

Hemp Jewellery

Want to share something special and let them know you care about the planet as much as you do them? You will want to tell that to yourself when you find Phat Hemp's excellent range of Hemp Necklaces, Bracelets, Jewelry for men and women. Lots of one of a kind eco friendly jewelry found at www.hempowered.com

Cannabis Seeds

For growing medical marijuana – where legal only. One of the largest Dutch marijuana seed suppliers based in Amsterdam offers of 30 classic strains from the place where high quality breeding has always been an art.

Got a problem with smoking?

The cannabis coach is here to help you stop smoking cannabis. A 100% guaranteed risk-free program is available <http://bit.ly/cyTKvR> – please share with anyone that has a problem smoking cannabis.

Hemp Clothing

At the time of going to press we were updating our recommendations for hemp textiles and clothing. You may visit the relevant page at www.hempowered.com for more information or email info@hempowered.com directly to find what you are looking for.

Hemp Plastics

From the original www.hempplastic.com site you will find opportunities for access to hemp plastic materials, products and more. Go there now!

**Hemp Fibre, Industrial Hemp Growing Seeds, Hemp Stalk,
Hemp Mulch, Hemp Insulation, Hemp Building Products and
more**

All available from





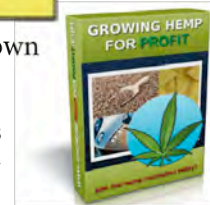
FIND MORE BOOKS ON DIFFERENT PARTS OF THE HEMP INDUSTRY

books to empower yourself & your community
to live sustainably in harmony with nature

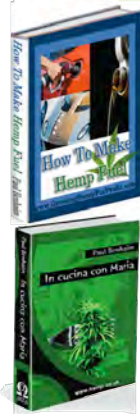


Learn how to **build a hemp house** - from locally grown unprocessed hemp. Affordable, sustainable and easy!

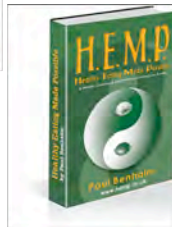
Grow hemp legally - all the facts, figures and secrets from the world's experts to help you live sustainably



clothing, bodycare, textiles, paper,
plastics & more delivered to your door!



more books
available from
the global hemp
website
great gifts!



all available from

