

How to build a **HEMP** HOUSE

An ebook and
construction manual

By Paul Benhaim and Klara Marosszeky

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 used and promoted in the attached construction manual developed by Klara. They have NEVER been published before. 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 lime, hemp fibre 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 to decorticate (separating the fibre and hurd), 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 grow your hemp and live in it today.

If you were so inclined, you may even consider [Growing your own hemp](http://www.growinghempforprofit.com) for your home! (www.growinghempforprofit.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 forests in a much shorter time), it's capacity to remediate soils and sequester carbon, 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 also involves considerable expense and fuel consumption in floating the machinery to the site. 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 totaling 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 AHL binder and the builder will be advised about the amount of local *cleaned* 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.



ACKNOWLEDGMENTS

Thank-you to all who have made this book possible, including Toby Marosszeky for his great photo (above), Steve Allen for his pioneering Hemp Building work, Tom Woolley for the same, Marton Marosszeky 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.hemp.co.uk and www.hempplastic.com and
www.paulbenhaim.com



Klara Marosszeky 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 was developed in collaboration with her brother Marton Marosszeky 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 Paul.....	3
Introduction by Klara	4
About The Authors.....	9
Table of Contents	11
Interview with Klara.....	14
Hemp technology	32
Background.....	32
THE FRAMEWORK.....	41
GROUND FLOOR SLABS AND FOOTINGS	44
ROOF OVERHANG	45
SHUTTERING.....	46
PREPARING THE MIX	47
PLACING THE MIX	48
CURING.....	49
SHRINKAGE.....	49
AROUND DOORS AND WINDOWS.....	50
FIXINGS TO HEMP LIME	50
OPENINGS, ELECTRICAL WIRING AND ALTERATIONS.....	50
USE OF INSULATION WITH HEMP LIME CONSTRUCTION.....	51
RENDERING EXTERIOR AND OR INTERIOR WALLS	51
OTHER FINISHES	51
LONGEVITY.....	52
RETROFITTING AND RESTORATION	52
PPE	54
Minimum requirements:	54
FOR CONSTRUCTION	54
Small Tools:.....	55
First Aid Measures:.....	56
HANDLING AND STORAGE.....	57
Hemcrete	61
BIOCORE- A 20 million Euro biorefinery project.....	64
Affordable housing workshops.....	66
Hemp Foods.....	68
Hemp Protein Powder	68
Hemp Seed Nut.....	68
Hemp Seed Nut Butter.....	68

Hemp Seed Oil.....	68
Hemp Cosmetics.....	69
Hemp Jewelry.....	69
Cannabis Seeds	69
Hemp Clothing.....	69
Hemp Plastics	70
Hemp Fibre, Industrial Hemp Growing Seeds, Hemp Stalk, Hemp Mulch, Hemp Insulation, Hemp Building Products and more.....	70
The Hemp Network.....	71



Hemp Harvesting March 2010

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

Really, it can be done with a hectares of industrial hemp. Even if you have never grown before or have no equipment, it can be done! Yes, you can grow your hemp and live in 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 on a small and large scale. There is an interview with Klara, co-author of this book, on how she has grown by hand using implements virtually pre-industrial revolution! 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! Go to www.GrowingHempForProfit.com now!



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 a plan! The hemp is not load bearing. You need an adequate structure or frame to support the roof of whatever it is that you are building. The masonry material provides the racking strength to the uprights in the frame, so nogginns are not needed. You would also need to put down a slab. In the future we'd like to market a hemp/lime flooring mix as they do in Europe. You need to order the compatible amount of binder (in Australia) from www.thehempbuilder.com. You also need *clean* sand. The reason the sand is not in the binder is because it is cheaper for you to get locally and we save on energy use by not pre-drying it for bagging, and on freight in the overall processing. We want to make the process as cheap as possible. Make sure you have access to water on site and at the minimum a drum mixer – a standard concrete mixer. If you have enough helpers, then maybe two of those.

P: What kind of helpers?

K: If you had say 3 people, one person could 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. Your goal is to keep the air in the mix. You don't have the hard aggregate. The hemp is light and with the lime, you're after quite a fluffy, not too wet mix. An advantage of the mix is that it retains its handleability for longer than concrete.

The alternative is to use a pan mixer. These are available from us for hire. This is what is used overseas and the paddles work really well with this material, because they scrape the lime from the sides of drum and can take larger batches of material. These can be used both on small and larger commercial sites.

P: Great – affordable housing is the goal. What else?

K: A tamper, something that you can make readily from timber off-cuts. A few different sizes is a good idea. You use the tamper for lightly packing the material down around the edges of the shuttering and to get into tricky spots. 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 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 entirely in the wall so you have a monolithic construction. The reason that's the best way is because you get good airtightness. There are generally excellent energy savings

in heating and cooling with monolithic construction because of this. You greatly reduce the opportunity for gaps which often 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 is 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. Because it is not a heavy material the fixing of the shuttering can be done quite lightly, ie. clamped well to the formwork.

P: Keep going!

K: So you blend the binder, cleaned 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 unlike sand, sawdust and cement or rammed earth construction – it is the opposite effect we are looking for. With rammed earth you want to pack the material as solidly as possible, with hemp lime construction you want to pack as lightly as possible so you don't compress the hemp which gives you the insulation qualities.

There are few horizontal timbers 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 say cupboards, to the wall. If you do ram it too

much, you get a paste forming at the edge of the walls. The lime binder gets pushed out of the mixture and this gives a more unattractive looking wall surface. You also have a danger of the mix being uneven and carbonation* occurring on the outside surfaces, but not in the middle of the wall. Getting even mixes and regular mixes is vital. It's an important reason to work with a formulated binder like ours, rather than just one of those free recipes you can follow. Our 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 mix in which even carbonation occurs.

** carbonation is the chemical reaction that happens between lime and oxygen*

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

K: In your mixer goes your hemp, your chopped hemp and your binder, cleaned sand and water in the proportions we will supply and advise.

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 appearance and both early and longer term strength. Different lime hemp blends cure at different rates, have different kinds of strengths and have different weather resistance ... you may also find that the layers don't adhere to each other as well as they should. UK researchers, where hemp masonry is an established commercial industry, also caution that a poor quality mix can encounter

problems as water is drawn from the binder by the hemp in the mix, which is very absorbent, resulting in uneven carbonation and 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, and if you want to leave sections of wall unrendered, as you can when the material's 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. Rice hull building, mixing straw with binders I am guessing would make quite an adequate building material. 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 historic 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 a lot of curved and moulded sections. The internal framework which is supporting the roof, governs how high the building can be and other than that, 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 matters if it is extremely cold. It is not advisable to work with lime binders at temperatures as low as -5 to -10 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. 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. 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 limewash. 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. I've seen pictures of retrofitted buildings in France where the finished product looks nothing like hemp in any way, 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, pretty much anything, 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: Not really! I like tin. My dream roof would be a green roof. The Adnam's Brewery and Distribution Centre buildings in Suffolk, UK is an enormous commercial development built from hemp and it has a green roof. It's a living roof, like they're starting to build all over the world, planted with low growing vegetation and it 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 pelletised 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 outbuilding for my teenage daughter?

K: Once the frame is up, 3-4 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 they use quite high levels of cement and hydraulic lime. Only in France have I heard of a mix of hydraulic and hydrated lime being used. Hydrated lime is slower setting than hydraulic lime and you can't build a wall within 4 days 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 and you're trying to 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 then a portable mulcher as mentioned earlier, will help, though you will not be able to control the length of the cut very well. But you will get an adequate mix. On a larger scale, ie. for an eco-village, where hemp was grown on the site, you'd bring in a square baler and a chaffer to chop – that is the next step in mechanization.

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 a hemp or a very fine chop of hemp.

P: Can it be retrofitted?

K: The hemp building industry in Europe started this way. Hemp is used a lot 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. You could again use a lime based binder, 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 strawbale.

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 would be a secret about hemp masonry?

K: It's about the carbonation process, what occurs is 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: In English?!

K: 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 done a lot of research for this reason.

P: Any shrinkage?

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

P: Any other secrets for the would be builder?

K: Yes, 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: Great, yes one issue is in making the mix of your hemp and lime binder. Ideally you would use a pan mixer. Working with a drum mixer, which is what the average person's cement mixer is, you need to be much more mindful that the lime does not adhere to the sides of the barrel. If you are not careful, what happens is you will get balling of the hemp and the lime mixture instead of the lime mixing through evenly.

P: Great, is there anything else?

K: The other thing is to not over tamper the wall because you want to retain the air in the wall. Keeping driving rain

off the wall. Having a good overhang. Not making 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. This is a major bonus of hemp construction. There are likely to be noticeable health improvements for those living or working in hemp lime buildings. Oh, and avoid building in extreme cold.

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

K: Yes, I'd generally advise against having too much timber in the frame. I like forests too much and know the level of land clearing that's still going on to support the things we currently do. If you particularly like the look of Tudor style building, that is having exposed timber, you will have a lot of horizontal or diagonal timbers in it, and it will be more difficult to pack the mix underneath. You 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: As a concrete replacement for example for making things like 'flow forms', garden features etc. There's so much potential in hemp.

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: You'd know a lot about that! Well, hemp rugs on the floor, hemp techno board where you need a composite in your home. Hemp plastics?

P: Yes!

K: 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 molded furniture, cant you?

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.hemp.co.uk>

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

K: You are eliminating the noggins, and most of the horizontal timbers. Obviously windows still need to go in. Also, your uprights can be spaced slightly further apart. So there is quite a significant saving in the timber. You are also making savings if you have a building wall that is 200-250 wide which is what we recommend. Your internal and exterior walling is finished with one material and you have coincidentally probably eliminated a whole range of off gassing synthetic products including cladding materials and adhesives.

You can also expect to make savings in your heating and cooling bills. That's been monitored really well in Europe.

P: So you are saving the labour and complications on the usual three processes.

K: Yes, you are saving in labour all round. Hemp construction is a relatively simple process compared to brick or block work and using mortars or anything like that. It is an easy way to build a house.

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



Construction manual

HEMP LIME CONSTRUCTION IN AUSTRALIA

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 production, 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 is hemp masonry, as is 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 concrete in 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 many examples 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** binder is the **predictability** of the results providing instructions are followed. This is a simple but high technology product that requires high standards of **quality control**. Walls that are too damp 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.



NEW CONSTRUCTION

THE FRAMEWORK

The **framework** in hemp lime masonry construction can be **steel, concrete or timber**. 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 the timber and metal frame.

In the event of 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 and its high alkalinity protects the material and from **vermin** or infestation, 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. 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 if 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 story 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 may stabilise 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.

Where the timber is embedded within the wall, tubular spacers are used to attach the formwork or shuttering in such a way that the masonry mixture can be placed into the gap between the timber and the shutter and lightly tamped. When the shuttering and spacers are removed the resulting cavity can be filled with a small amount of hemp masonry mix.

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 the construction.



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



As hemp masonry is not as heavy as concrete, the shuttering can be much more lightly attached and clamps can be used for this job. 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.

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.

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, [mega-anchors](#), 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. Slate is a natural material which performs this function though it is critical that there are no gaps

between slates as moisture can then travel up the wall. 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.

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. Also observation over 4 years of a retrofitted wall with no roof overhang in northern NSW has similarly demonstrated no damage to the wall. However there are some additional risks that unprotected walls are exposed to in such situations, these include moisture ingress around windows and doors and water pooling at the base of 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 constructors 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.

SHUTTERING

Once the framework is completed 600cm high internal and external shuttering is attached 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 improve the speed of construction. If reusable shuttering is used the surface must be clean.

The shuttering can be removed from a cast wall the following day and any spacer holes filled with hemp masonry mix. The shuttering panels are removed by sliding them sideways. They 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 is then attached to the frame higher up to build up the next 600cm of walling.

Permanent shuttering 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

The aim is to obtain an **aerated mix** resembling sticky crumble in which the hemp particles are well covered by the binder and avoiding the formation of pellets or balls. 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 bales 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 rotary drum mixer**, a commercial builder would be advised to mix in larger batches using as a minimum a 180 litre pan mixer.

Lime based masonry needs thorough mixing so that a light fluffy mix is achieved. Drum mixers can cause some balling in the material resulting in less consistently mixed material, and in denser walls with reduced thermal and acoustic insulation properties. To improve work flow 2 drum mixers might be considered.

Allow the dry ingredients to mix for a few minutes till the mix is consistent, add the water and mix for 2 – 5 minutes until thoroughly mixed. Using a garbage bin lid to seal the mixer drum to reduce the dust during the dry mixing stage. Alternatively adding most of the water to the binder before adding the hemp can help to reduce dust.

For commercial construction 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.

Care should be taken not to make the masonry mixture too wet. Vary the water to suit the conditions i.e. weather and any time delays before placing. If the mixture is too wet or if it is tamped too firmly a paste is forced to the outside of the mix and the lime can leach out of the shuttering. 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.

PLACING 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**. It is recommended that a small trial section is made to determine the amount of tamping required. Conduct a density check or materials reconciliation. It is important not to over tamp the mix. If the material is too heavily tamped in shuttering then the

insulation value may not be as good. Small pieces of wood are ideal for tamping.

Hemp walls can be cast in stages. There is no need to cast a whole wall in one lift. 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 and another 600mm of hemp masonry can be placed on top of the initial layer. 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 10 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.

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.

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 material. 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**. When it dries out 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.



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

Hollow tubular spacers e.g sections of water pipe - 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

The Author Collects 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: Eyes contact:	Move to fresh air. 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: Storage:	usual precautionary measures have to be observed when working with all combustible materials containing dusty particles 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: Personal protective equipment:	Avoid blowing of dust. Protection against Electrostatic charge during handling. Respiratory protection: mask of nuisance dust (P1)
09	Physical and chemical properties	hypothetical postulate: safety relevant data: further indications;	Form: Fibrous Color: Gray -yellow Odor: Hay equivalent up to odorless 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 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 for you to use for free. Please email us at info@thehempbuilder.com and we will supply you with a way to calculate the cost of building with hemp!

Interesting articles 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 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



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, which is affordable too!

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

Learn to build a shed in a weekend.

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. ½ of your day you can get your hands dirty (or watch others).

The workshop will show how to build up a wall, including a window section and a powerpoint.

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.

If we are not running a workshop near you, then please find a group of willing people and let us know at info@TheHempBuilder.com and we hope to visit you soon!

Learn more at www.thehempbuilder.com



or a shed

BUILD A HOUSE OF HEMP

1 day practical workshop

Why pay for brick veneer when hemp is cheaper, less toxic, better insulator and easier to build?

Building with Hemp & Grow Your Own Home!

Come, learn and enjoy with Australia's experts:

- How to build a modern affordable eco house of hemp
- Sustainable design concepts & why council approved
- Source your Australian materials direct from the farmers

SUITABLE FOR EVERYONE FROM **BEGINNERS TO BUILDERS**

START YOUR OWN BUSINESS BUILDING ECO HOMES / SHEDS

- ✓ **AFFORDABLE**
- ✓ **100% LEGAL!**
- ✓ **EASY!**

Coming To A Town Near You!

yes, we will travel anywhere globally to share this technique

email: info@TheHempBuilder.com
www.thehempbuilder.com

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?

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.

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.hemp.co.uk - shipping worldwide.

Hemp Jewelry

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.hemp.co.uk

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.hemp.co.uk for more information or email info@hemp.co.uk 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



www.hemp.co.uk

The Hemp Network

Business Opportunity

The Time For Hemp Is Now... Join The Hemp Revolution!

The Hemp Network represents the first marketing distribution channel in history that will provide consumers with hemp products on a direct sales and a network marketing platform.

We are in an industry that has been around for thousands of years, with new uses for hemp being constantly developed. The use of hemp is growing dramatically and will continue as more recognized uses occur.

Over the past few years it has become apparent that with the increasing pace of new products hitting the market, there is a need to move those products throughout the world at a very fast rate.

The Hemp Network has been formed to provide a marketing vehicle for massive global distribution of these new products and services as they hit the market, which is imperative to capture market share.

Expectations are that our marketing team will become a major force in the exploding hemp product marketplace... and we are offering individuals like you the opportunity to capitalize on this exploding market.

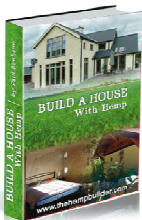
The Hemp Network offers the winning combination of product, people, management and vision to all work together to create a very large global marketing company with our agents earning income from people spread around the world.

There has never been a more perfect time to take advantage of an industry that has been around for thousands of years, with products derived from hemp being used by millions of people today. Over the past few years it has become apparent that with the increasing pace of new hemp products hitting the market, there is a need to move those products throughout the world at a very fast rate.

Join our very special team and get unique support for your new business! Find out more at www.hemp.co.uk or direct to: <http://bit.ly/dD5ZwW>

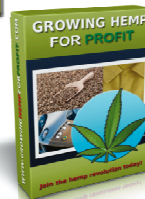
FIND MORE BOOKS ON DIFFERENT PARTS OF THE HEMP INDUSTRY

**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!

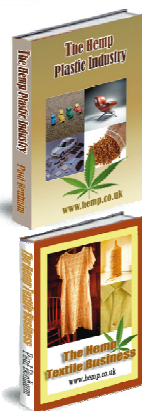
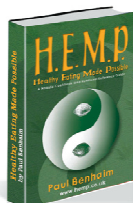
Grow hemp legally - all the facts, figures and secrets from the world's experts to help you live sustainably



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



more books
available from
the global hemp
website
great gifts!



all available from

