EBAA 2009
Earth Building Conference by the Earth Building Association of Australia.
Eltham 14 August 2009 :
Sustainability, Energy Efficiency and Bushfires.

Keynote Speech.
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Topic: Rammed Earth Building in (western) Australia and Earthbuilding worldwide.

Welcome to the Earth Building Association of Australia (EBAA) conference on Sustainability, Energy Efficiency and Bushfires.
Let me offer a special vote of thanks to Rob Freeland, his staff , the EBAA organising committee, and all those that have contributed to make this event possible.
Whilst there are specialist speakers to come who will cover the subjects of this conference in detail, I do wish to mention each of the topics of Sustainability, Energy Efficiency and Bushfires briefly in relation to building in unfired earth. I wish to impart some preliminary background information.
Eltham is the centre for mud brick buildings in Australia. I am from Western Australia which is the centre in Australia for rammed earth buildings. In Australia unfired earth walls, or earth walls for brevity, are made from earth bricks (puddled mud brick or pressed earth brick) and rammed earth. Also used in Australian earth building is cob, wattle and daub and poured earth, but to lesser extents.

Rammed earth can be defined as a precisely controlled mixture of gravel, sand, silt, clay, water and sometimes cement, lime or chemical admixtures which is carefully proportioned, mixed to the correct moisture content, and then compacted in removable formwork to yield a dense, hard, stone-like wall. The walls are massive, fireproof, waterproof, load bearing, durable, long lasting and above all, quite beautiful.

Rammed earth walls have a very strong "presence " or "sense of place " and a sense of security, all of which can be equated to " a true feeling of home", and which have been described in the past as "having a good vibe". It is a positive feeling you get just being inside. It is difficult to describe the feeling of entering a rammed earth home but a builder once told me that he could sense it even if he was led blindfolded into a rammed earth home. In other words he felt he could tell the feeling of the internal space of a rammed earth home as being quite different from a conventional home. There is a certain calmness and tranquility that simply can't be duplicated with

lightweight building materials. Professor Alan Rodgers, the Patron if EBAA, once described earth buildings in general as having "a higher quality of internal space". There is something special about an earth building.

Bushfires:
Today we are in the Victorian bushfire area where amidst the destruction, the exceptionally good performance of the mud brick buildings can be seen and learned from. I shall mention bushfires first.

Unfired earth has a good reputation in fires, going back many years. I am aware of several earth buildings that have been through bushfires and the walls have remained intact and have been used again, without any rebuilding of them being needed, despite the associated metal roof, sheetmetal / timber framing and glass and aluminium windows having melted or distorted and failed and requiring total replacement.

It is necessary to publicise the outstanding success shown in resisting bushfires by earth wall materials. Particularly as evidenced by the recent tragic Victorian fires. Many local areas affected by the recent bushfires had high concentrations of earth wall buildings due to the efforts over many years of a large number of architects, mud brick makers, tradesmen, builders, writers and others. The broad areas of the bushfires have previously been described as the " mud brick capital of Australia ". I see no reason why the rebuilding efforts, yet to come, should not contain an even higher proportion of earth walled buildings, as their outstandingly good performance in bushfires becomes more widely known.
It is hoped that this conference will generate a far higher awareness of the benefits of building in earth in bushfire areas. It is hoped that this awareness will be instilled in all attendees here and that it will reach not only the press, but also the administrators, rule makers and bureaucrats who should be giving positive encouragement to favour the use of unfired earth over most other materials in the rebuilding effort that lies ahead. Safety of rebuilding must favour unfired earth.

Whilst it is necessary to publicise the successes of unfired earth in bushfires, it may be necessary to make more clearly known some of the potential problems of some conventional materials. So that people are more aware of the comparative benefits of earthwalls in a fire situation. Potential problems with conventional materials include information recorded after the recent Victorian Bushfires of incidences of the following :
Total annihilation of lightweight framed houses, both timber and steel framed and including those clad in sheetmetal, timber and light cement sheet products.
Spalling of concrete panels in places.
Disintegration of concrete blocks occurred.
Delamination of fired clay bricks and cement based mortars ie conventional brickwork, suffering a structural disconnection of the mortar and the brick itself. Caused by the heat of the fire. This can leave the wall as a dry pile of unconnected bricks, exposed and with little strength to resist loads such as high winds that can occur in times of bushfires.
Thin walls of conventional masonry performing badly in serious fires:
This can and has occurred along the following lines:
When any masonry wall is subjected to fire, which is usually only on one side, a thermal gradient is created through the thickness of the wall and the expansion of the

material causes bowing of the wall. If the temperature rise into the wall is enough then the bowing can become enough to cause collapse of the wall. If it is a cavity wall and if the temperature rise through the thin outer skin of brickwork is sufficient to cause significant bowing then it is sometimes only the brick cavity ties, acting in direct tension that stop the outer leaf of brickwork from pulling away from the building and collapsing. Should this occur then it exposes another thin skin of brickwork which theoretically could suffer a similar fate. Thereby, a thick monolithic earth wall can have significantly better fire resisting properties than a cavity brick wall of the same overall dimensions.
Also: If the temperature passes through a thin masonry wall (or any thin wall) sufficiently then it can ignite materials on the inside of the wall. This occurred with conventional thin masonry materials. This can occur with unfired earthen materials however it is far less likely to occur due to:
Earthen walls are seldom thin. Typically earthwalls are thick and slow to heat up. Rapid temperature rises passing through thick earth walls at the time of the fire front passing is unlikely. Bowing and collapse of thick eathwalls is far less likely than in thin conventional masonry walls. In earth brick walls when like materials are used for both the earth brick itself and the mortar (as is generally recommended) then delamination and loss of bond between the bricks and mortar is far less likely to occur. I am not aware of any evidence of delamination of earthbrick walls in the bushfires. In rammed earth, the walls are monolithic and there are no mortar joints. In cob there is one material used throughout and no mortars of different materials. High outside temperatures of a bushfire transmitting rapidly through a thick earthen wall to ignite materials inside is also far less likely than through a thin conventional masonry wall.
There were recorded instances in the recent Victorian bushfires of people saved by earthwalls due to the survivable low temperatures inside earth buildings, yet with an inferno outside. The thermal mass or time lag of the earthwalls made the inside slow to heat up whilst extreme high temperatures outside, passed within a few hours.
Conventional masonry walls generally are thin eg hollow concrete block eg brick veneer eg cavity brick which is two leaves of thin masonry separated by an air gap.
I am aware of the brick cavity being filled with sand in desert Australia to get the desired high thermal mass in housing, however this could not be done in areas outside the desert without the likely problem arising of water penetrating the walls, and entering the house. Generally earth walls do not have or need a cavity as they are monolithic and waterproof.

The exact properties of earthwalls in a fire test are as follows:
CSIRO Bulletin 5, Fourth edition, Page 22, Clause 3.4.1, Fire Rating, states:
Quote
"National Building Technology Centre at Ryde in Sydney carried out a fire resistance test on a load bearing 250 MM thick Adobe block wall.
The result of that test was that the wall achieved a fire resistance rating of four hours in terms of AS1530, part 4-1975. The test is fully reported in experimental building station technical record 490.
National Building Technology Centre also carried out a pilot fire test on 150 mm thick thick Cinva Ram block wall (a pressed earth block wall). This failed by permitting excessive heating of the cold face at three hours 41 minutes.
On this evidence all forms of earth wall construction could be assumed to have a fire rating of two hours.

If fire ratings in excess of two hours are required the specific type of construction should be tested."
Unquote.
The new bushfire code is Australian Standard AS 3959-2009 Construction in Bushfire Prone Areas. This is law in Victoria and will soon become law over all of Australia, once it is called up in the next edition of the Building Code of Australia (BCA).
Types of earth walls and their fire resistance:
In Australia earth wall buildings are constructed using various techniques. The most common techniques are earth bricks (puddled mud bricks and pressed earth bricks), rammed earth and cob. All of these materials are routinely used to build fireplaces in earthen houses and in conventional houses.
In Europe, rammed earth is used to make fire places and furnaces that are often part of the home's central heating system to maintain comfort conditions inside with snow outside for months. Rammed earth house walls are also widely used in such cold countries where the thick walls and the fireplace or furnace itself is all made from rammed earth. In USA where adobe (puddled mud brick) is historically used, fireplaces are often made in the houses from the same adobe blocks used for the walls.
I personally have built many fireplaces from rammed earth, including the flame contact hearth areas.
I personally have also built new rammed earth houses in places where conventional houses were totally destroyed by bushfires, and also at the suggestion of the insurers.
The new bushfire standard AS 3959-2009 approves "mud brick" as one of the approved materials of construction for Zone 6, the highest category of risk, Bushfire Attack Level - Flame Zone (BAL- FZ).
Earth building has the potential to build fire refuges having walls and roof made of thick earthen materials. Mud brick roofs in the form of domes, barrel vaults and such like are extremely common outside Australia and there is immensely well proven technology available for this type of construction for shelter spaces and for whole homes. I have built several rammed earth roofs using barrel vaults where the walls and roof of a small room is all 300mm thick fireproof rammed earth. Additionally a small water pond or tank can be placed atop such a room.
I repeat, that when the bushfire rebuilding is underway in earnest, that earth wall construction should be actively approved and promoted by the authorities. As a preferred material. To do this is in the national interest.

Sustainability
The briefest definition of sustainability is "capable of being sustained".
Sustainable development relative to the performance of buildings, is: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
The World Commission on Environment and Development says that “Environmental sustainability refers to the environmental actions or impacts of what we do. In moving towards sustainability, we are attempting to reduce our ecological footprint".
The three general principles associated with sustainability are environmental, economic, and social.
In building ,sustainability must cover water savings, energy efficiency, materials selection, indoor environmental quality, costs and other aspects, even as broad as gainful employment, health issues and quality of life (both for the homeowners and for the home builders) . As for the rammed earth wall builders:

It should be noted that most people who build a lot of rammed earth do in fact love the fact that they start the day with a pile of dirt and end the day with finished walls. The excitement of removing the forms (stripping) and exposing a new rammed earth wall for the first time is a joy that never ceases. No matter how many times you do it. I have done it /seen it thousands of times and it is always a buzz. Few building methods can match rammed earth for pure satisfaction during construction. Whilst handling liquid concrete and seeing it harden is good, building rammed earth walls is great. I am certain of this! Rammed earth is hard and has strength immediately after it is compacted and densified. It goes from a damp loose earthen mix to a dense firm material instantly upon compaction. Few other building systems can match this. Some rammed earth mixes are still able to be worked upon after early removal of formwork thereby opening sculptural and artistic possibilities. In Europe, with the mixes commonly employed, rammed earth contractors find that the transition from construction to artistic expression is seamless. i.e. the walls can and are sculpted after stripping of forms.
Additionally rammed earth can fairly easily be made with multiple layers of different colours and textures in ways that are beautiful and which cannot readily be replicated in other building materials. Rammed earth can be built in almost any thickness, to almost any height, in almost any climate externally or internally, in almost any colour, and texture. Texture comes from the materials themselves, and how they are mixed, placed and compacted together with surface patterning from the formwork. The face of the rammed earth wall generally records precisely the history of it's construction.

Rammed earth has a unique combination of properties, being structurally strong, able to be built to resist earthquakes, cyclones and problem clay sites, having a beautiful appearance from both the colour and texture and the interplay of the two, together with excellent acoustic properties meaning a lack of reverberated sound and a high level of acoustic attenuation when sound tries to pass through a thick wall. Rammed earth is reasonably cost-effective and it has high thermal mass.
Earth walls are certainly the most cost effective method of getting high thermal mass into a building in Australia.

The green building industry, in chasing sustainability (and it is a chase, it is ongoing - the classic "race with no finishing line") it needs to include not just environmental aspects but also social and economic aspects. Sustainability ropes in professionals in building design, construction and operations. As the building industry is one of the largest industries in the world, the impacts of any transformation from building with conventional materials to unfired earth are tremendous.
Some figures:
The existing building industry is a major employer worldwide and building annually accounts for an estimated 40 percent of the world's energy usage, 16 percent of the world's water usage, three billion tons of raw materials (~40 percent of the global total) and 15-20 percent of the waste stream. Changes in an industry so large are significant.

Earth building rates very well as regards sustainability. Earth has been described as the ultimate sustainable building material. Sustainability can be considered from many aspects. Some more follow:
Rammed earth can be a near waste less process with no surplus left on site and no off cuts or unused product remaining. Carefully planned and executed rammed earth can

leave no waste upon completion. Whilst other materials can sometimes achieve this, rammed earth regularly achieves this.

Water usage:

Water used in building rammed earth, because it is a dry packing process, is substantially less than in most other building systems. We use a curing and waterproofing admixture at a rate of 0.5 liters per ton of dry mix which makes wetting during curing (a major user of water for some other masonry based building systems) totally unnecessary. So rammed earth, with little (and sometimes zero in winter) water addition needed during construction and none thereafter, is a major saver of water compared to many conventional products in the general building industry. This is not widely recognised nor measured. This is a big plus in a dry country like Australia with currently existing water shortages and more extreme water shortages predicted.

To repeat, it is possible and I have done it, to build rammed earth walls from natural materials (in winter) with no added water and no water used for curing.

Furthermore, I have heard of skilled rammed earth wall builders in France who choose the time of year when to excavate the soil, so that it is at the correct moisture content to be rammed straight in to the walls with no added water. Their walls contain no cement and being built in a cool climate they require no water addition for curing. In fact curing to them is letting the walls dry out and they seldom, if ever, intentionally make the walls wetter after they have been rammed.

I am also aware of rammed earth being used for construction in Africa for dwellings, and having been chosen as the construction technique totally because of the low water used, due to the difficulty of getting water to the construction site.

Carbon Reduction:

As regards Carbon Trading Schemes. Many of the developed countries, including Australia are planning to tax high carbon polluters in order to reduce carbon pollution and to lessen global warming. In Australia there is proposed the Carbon Pollution Reduction Scheme. It's form and content is being considered by the Federal Australian Government right now, as in today, mid August 2009.

A fair and well planned Federal Government scheme to reduce carbon emissions could favour earth buildings and at the same time penalise competitors in the shape of high carbon emitting industries producing some conventional mainstream building products. Earth building should be recognised for the benefits that it can provide now as an established low carbon emitter and additionally earth building should actually receive federal research funds for further streamlining and improving of earth building production methods to lower costs and to ensure that it is more efficiently and widely used.

Ross Garnaut ,the Federal Government's independent climate change adviser recommended spending $3 billion per year of the Carbon Pollution Reduction Scheme revenue (or taxes if you like) to subsidise the research, development and initial deployment of the low emmissions technologies so essential to meeting a target in the least cost manner. This now seems unlikely to be funded at all from the expected revenue (from the latest political news).

The fired clay brick industry, a large greenhouse gas producer (generally much larger than the earth building industry per unit of wall), is reputedly attempting to justify their product because it has a long life. Well, if this becomes law then it should help the earth building industry too. Some of the fired clay brick industry information shows fired clay bricks on the Great Wall of China as evidence of long life yet Professor Gernot Minke of Germany states that all of the Great Wall of China is

made of rammed earth (and all built before cement was invented and before fired clay bricks existed) and that it was only later clad in parts with fired clay bricks.

Embodied Energy:
The Australian Greenhouse Office states that "The single most important factor in reducing the impact of embodied energy is to design long life, durable and adaptable buildings." This helps to give legitimacy to materials with high embodied energy and long life. I disagree with this. I would say that the absolute best way to reduce the impact of embodied energy in building is to use materials that have inherently low embodied energy and which have a long life and which are totally recyclable at the end of that life . This material is unquestionably unfired earth. Unquestionably.

Specifically, in the building industry, the Federal Government must take this opportunity (under this Carbon Pollution Reduction Scheme) to lessen carbon emissions by a 3 pronged approach of taxing high polluters, and rewarding low emitters like the earth building industry, and using some of the carbon taxes reaped by the scheme to improve and promote the lesser known low carbon producing building methods of which earth building is at the forefront. The earthbuilding industry is too small, too fragile and too fragmented to make all the running on this. Hopefully the press can help. It is a big task. It is in the national interest.

Small carbon footprint earthwall, example:
The lowest (to my knowledge) carbon footprint of a Sydney home was described by Ray Trappel, a past EBAA president, as intercepting excavated soil from a site, on it's way to distant landfill and using it to make mud bricks for a home. Actually negative embodied energy. How to extend and expand this concept:
Mass earthen materials available for sustainable construction:
Whenever large excavations are underway, with big quantities of fill being carted distances to dump it, it is worth looking at the suitabilty of the earth for future earth wall construction.
In France when the Paris high speed train track, set in deep cuttings within towns, needed major excavation plus carting and dumping of millions of tons of material, all ideal for rammed earth construction or for "pise de terre" as the French say, it was a major disappointment to Craterre (French Government Endorsed Earthbuilding Experts) that they could not arrange for it to be stockpiled for future major earth wall construction activity. They missed a golden opportunity.
In Melbourne there are major roadworks planned requiring millions of tons of earthen material to be dug, carted and dumped. It is hoped that it could be tested, approved and then diverted from distant landfill and into nearby earthen building projects. It could then start life as a contributor to "less than zero" embodied energy earth walled buildings. It is possible. This possibility exists in many cities. It needs to be reallised, somehow!

The low embodied energy, the long life of earthwall buildings and their complete recyclabity at the end of their life adds to their sustainability.
I have seen thousands of rammed earth buildings that are centuries old. I have seen complete villages constructed of earth in the southern parts of France and Italy where the soil is ideal, that are centuries old and still occupied and look to have centuries more of life left in them. There are over 100,000 occupied cob buildings in the county of Devon in the United Kingdom, mostly centuries old and surviving well in a wet,

cold climate. In Africa and the Americas the complete towns of earthwall buildings, including multi storey rammed earth buildings that are numerous, large and amazing. There is a mosque in Yemen that has a minaret made of handmade adobe bricks 38m high.
Palaces, towns, forts, a pyramid (containing 2 million tones of rammed earth, according to Prof Minke), and 8 storey buildings exist, all made from rammed earth many of which are still in use and centuries old.
Throughout the world rammed earth has been used to build probably every type of building possible other than glass skyscrapers. We have built internal office partitions of rammed earth inside high rise concrete office buildings, on the second and third floors. The highest rammed earth walls that we have been involved in building is 4 stories.
Earth walls are as old as humanity itself and fully recyclable. Nearly every country in the world has a history of earth wall buildings and it often just takes effort to find them.
Not every country in the world has a current earth wall construction industry, but we are trying to change that!

Energy Efficiency.
There are many aspects to this topic.
The thermal efficiency of earthen buildings will be covered in detail by other speakers. However I wish to cover a few items.

1. Energy content (embodied energy) of earth building is low.
There is however a range of embodied energy possible.
a. The lowest is "negative embodied energy" possible with intercepted fill, destined to be carted away but instead made into an earth building closer to the source of the excavation.
b. A high embodied transport energy was in a Perth rammed earth house we built for a master pearler from Broome that had to match the red rammed earth walls that we had built in Broome, some 2500km away and we shipped down some of that raw material for the mix. The Client was delighted with his rich red walls, the ship was coming down empty anyway and by the way, it is not our common company practice!
c. The highest embodied energy that I have heard of in mud brick building, matching or even surpassing that of fired clay bricks, was in fact the firing of complete mud brick buildings in the middle east. It was done by Nadir Kahil, an Iranian Architect and earth builder who wrote a book "Racing Alone ". He built small houses from sundried puddled mud bricks and then fired the wood free, completed building. The floors walls and roofs were totally made from mud brick and then several semi trailers of fuel oil were connected to enormous burners which were placed inside each home to raise the temperature to fire them like very large pieces of pottery. The energy consumed was enormous. The beauty was intense as pottery glazes were applied to the walls to give a glazed sculptural building. The cost, at low middle east fuel prices was barely manageable. The energy efficiency was not good!
So there is a range of embodied energy for earth buildings that can range from nil (or even negative) to that equal to fired clay bricks, brought about by the actual firing of completed mud brick homes and done to achieve a beautiful glazed pottery look.
These are the extremes and most earth buildings are low embodied energy with the actual embodied energy primarily dependent on the system used plus the type and location of material plus the type and quantity of stabiliser used.

Stabilisation is the process of modifying the properties of the earth. Mechanical stabilisation can be from seiving, crushing and blending of different soils or by the addition of fibres etc. Chemical stabilisation can be the addition of lime, cement, chemical admixtures (including silicone type admixtures in Australia and in America bitumen and infrequently such natural additives as the juice of the Nopal Cactus, etc) Stabilised earth is, in Australia, earth with generally 5% to 10% cement in it. We have built hundreds of rammed earth houses stabilized with just 2.5% cement, in near perfect earth mixes. Each method of earth building can be constructed unstabilised, where the clay binds the particles together. This lowers the embodied energy and improves the sustainability. The welsh earthbuilding phrase applies of " a good hat and stout boots and it'll last forever".

2. Thermal mass.
A high thermal mass wall can reduce the transfer of heat by absorbing the energy attempting to flow through it. This process is slow and results in a time delay called thermal lag.
Earthwalls can even out the temperature fluctuations and keep indoor conditions within comfort conditions when outside conditions range beyond this. The fluctuating energy stored in thick earth walls is known as the thermal flywheel.
Thick earthwalls are temperature moderators /thermal regulators and they harvest the benefits of good passive solar design.
There has been ongoing thermal debate over R value of earthen walls. The debate is about the relevance of R value, with discussion ranging from R value is irrelevant to highly relevant. But few would now argue that only R value is relevant in seeking housing thermal comfort conditions. Thankfully those days are past and the discussion is now on how important is thermal mass, and how to calculate /assess/accredit the benefits of high thermal mass. The R value of most earth building forms are generally considered poor against something good like say polystyrene foam. Then on the other hand, for thermal mass, all earth walls excell and lightweight materials, such as say polystyrene foam are so very poor. So which is best? Well that depends on the climate and other factors.
The R value of walls may be described as resistive insulation. The thermal mass may be described as capacitive insulation. These are electrical analogies and are likening wall properties to an electrical resistor which slows/lessens the flow of electricity/energy ,and to an electrical capacitor which stores energy and then releases it at a later time. In general building terms, all walling systems need some resistive insulation and some capacitive insulation. It is not best to have all of one and none of the other. Example:
It is interesting that the big European chemical company BASF have developed phase change chemicals to go into thin lightweight plasterboard sheeting to increase it's thermal mass. It only operates as a high themal mass material over a very small temperature range, and as regular plasterboard outside this range. The product is not available in Australia and is extremely expensive where it is available.

Rammed earth has moderate resistive insulation and has very high capacitive insulation or thermal mass and it has a good balance of the two. Which is the more important is a complex argument. Good passive solar design should be employed in all house design including earth house design. Rammed earth has the added benefit that installation can be placed either on the inside or the outside face of the rammed earth wall or in the centre of the wall. This generally is not necessary but it is

technically possible. It does increase the cost of the rammed earth wall slightly (by 20% approx. and also the common wall of 300mm thick becomes 400mm thick in Australia, with 50 mm of Styrofoam in the middle of the wall). This is a modern development in the developing technology and science of rammed earth wall construction. Structural aspects of the composite wall need to be carefully considered.

Emphasising R values alone in California USA destroyed the adobe making and adobe homebuilding industry, some years ago. The worlds largest adobe manufacturer, the Hans Sumpf Company was pretty well destroyed by legislation requiring higher R vales than adobes produced. The myriads of past happy customers were ignored. Had the high R value legislation been made retrospective then hundreds of millions of dollars of adobe housing would have needed rebuilding against the owners wishes and needs, just to meet an unnecessary high R value set into well meaning but flawed legislation.

In the past little recognition was given to thermal mass in the Australian 5 star approval process required for a building licence. To assume , for the approval process, that a home will be airconditioned in summer and will be heated in winter and to then, on that basis to legislate that good insulation is needed in the external walls to lessen the energy demands of that building is often grossly wrong. Using as a basis the thought that the building will be closed up is often wrong. Whilst in the bitterly cold European conditions it may need high R value and airtight building regulations, not so in Australia. Except perhaps in Australia's small Alpine areas.

A survey of 1600 buildings showed that 99% of earth buildings in Australia don't have air conditioners and so they aren't using high cooling energy in summer, which would tend to fault an R value based model.

Perth ,and most of the more populated part of the west coast of Australia is Climate Zone 5 as set out in the Building Code of Australia. It is a pleasant Mediterranean Climate and it is very easy to design a passive solar home with earth walls that requires no supplementary heating or cooling. This has resulted in rammed earth homes in WA, having an excellent reputation for providing year round comfortable living conditions. This climate Zone 5 covers many of the well populated coastal strips of Australia. Free running houses often open to the mild weather do not need high levels of resitive insulation in the walls if well designed.

The Government of Western Australia, Sustainable Energy Development Office, estimates that 26% of all the household energy used goes to heating and cooling. This is outrageous given the mild climate and the ease with which earthwall "free running" houses can be built. Clearly there is room for major increase in the number of rammed earth houses to be built, of all the new houses built in WA each year.

3. Reduction in peak elecrical demand from a diversity of thick earth wall buildings:

One way of reducing electrical generation and distribution "peak loads" which are generally the determining loads in the electricity supply business, is delaying the peak time in some of the nations building stock, by building in earth, with thick walls. One overlooked benefit of thick earthen walls is that they can lessen widespread electrical demand and save on the associated electrical infrastructure. This is either not known to the electrical authorities or not acted on by them. Many electrical authorities around the world, but certainly in highly developed countries such as Australia, and USA face their highest electrical demand in summer caused by air conditioning at peak summer conditions when enormous numbers of people turn on their air-conditioners to cool their houses, all at approximately the same time.

It goes like this: On a classic hot summer's day, if the peak temperature is say at 1 p.m. then that is when the electrical load "peaks". The "spike " in demand is at or very soon after 1pm. This peak demand is the design consideration for operating all generating capacity, transmission lines, electrical switch yards and everything that it takes to get the electricity from the power station to the homeowner's air conditioner. It is expensive infrastructure as it is only needed for a few hours on those very few hot days. But it is required, as the consumers demand it. How can this be overcome? Answer: By building homes with thick earthen walls. How does this solve the problem? Because it takes some hours for the heat to pass through the thick earthen walls. Remember that they do have some resistive insulation and they do have an enormously good capacitive insulation, and they are thick and massive and it takes time for heat to pass through them. So in an earthwall house it takes some hours for the outside peak temperature at say one o'clock (lunchtime), to reach the inside of the thick massive walls and by then the outside temperature has generally reduced... but more importantly the peak electrical demand has passed. So the peak electrical demand still occurs at soon after 1pm, when the bulk of people turn on their air-conditioners, but all those with rammed earth homes (assuming they all have air conditioners which is historically not the fact) do not turn on their air-conditioners until some hours later, by which time conditions have changed...so the peak around 1 p.m. is reduced by all those having thick massive earth walled houses.
This logical argument was studied by Pacific Power and Gas, an Electricity Supply Authority in California some years ago and as a result they promoted thick rammed earth walls as the answer to lessening the requirement for more power stations, more high-voltage distribution lines, more electrical infrastructure and all the factors which were not wanted by Californian voters...they hoped to avoid the huge electrical infrastructure costs (needed for the peak load, only for a few hours on the hottest days) just by promoting thick walled rammed earth houses. The rammed earth walls lessened the peak or spike electrical demand in summer. The electricity Supply authority was able to claim government funding of intelligent saving of electricity that would otherwise have required expenditure (the so-called Negawatt) so that the government and the power co and the homeowners all benefited.... and more people were destined to live in comfortable rammed earth homes. The saving was made whether the occupiers of the rammed earth homes turned on any air conditioners or not as the real saving was in the electrical supply infrastructure.

Future:

Earthbuilding in Australia now needs to focus more on strategy than on tactics. Tactics is doing the thousands of things right that go into a successful earth building. I can say for sure that the rammed earth industry in Australia has well and truly got this right, nearly everywhere. Strategy is doing the right things. The policy issues. In Australia the earth building industry needs to focus on doing the right things. These things are many and varied and EBAA is undertaking as many as it can manage. They include the following:
Some of these issues require worldwide solutions/ co-operations. The internet can assist this.
More publicity for earth buildings. More displays of earthwalls and earth buildings at the myriad building exhibitions etc. More entries of earth buildings into the myriads of competitions. Maybe competitions specifically for earth buildings. For example, if Bluescope and Boral and James Hardie, to name a few, can run and promote and

publicise competitions for preferred (or even sole) use of their products then so can we.
More public buildings, with earth walls.
Better technical data for the properties, characteristics and abilities of earthwalls. To include fire, flood, earthquake, cyclone, thermal, acoustic, environmental etc. Also the detailed properties of the materials such as compressive, tensile, shear, bending strengths, shrinkage characteristics, durability, water proofness, hygroscopy, humidy equalisation properties and so forth.
Earth building has a history of successful use going back thousands of years. Unfired earth is humanity's oldest building material. It is a very successful building material, but to ensure a more rapid uptake of earth walls now, in a modern industrial world, it is essential to measure the detailed properties of a highly complex and highly variable material. Measurements need to be taken of old earth buildings and current and proposed. To learn from the past to forge the future. To use the best science, engineering, trade-skill, hands on and other historical or current experience available. Additionally these measurements (of the properties of earth walls and their constituents) often need to be in units of measurement or in a format that allows simple comparison of earth with other non earthen materials and also with standards, codes and the like, some of which are written for non earthen materials. This is sometimes involved and complex. In non or semi- industrialised (developing) countries where the bulk of the reported 40% of the world population presently live in houses of earth, they may well know how to build exceptionally successful earth houses and with little approval needed, little need for science and a successful history of just doing it. An example of rammed earth technology that is this well proven is in France where they know that in certain areas at certain times of the year, when the moisture content is precisely correct, that they can dig material out of the ground and straight into formwork and build rammed earth walls (pise de terre walls) to a height of up to 3 stories and all with total success, as evidenced by centuries of doing it.
In industrialised countries, including Australia, with a near infinite choice of building materials available, approvals from Authorities are harder. The EBAA publication " Building with Earth Bricks and Rammed Earth in Australia" is in widespread use but it has not been accepted by the Australian Building Codes Board.
It has widespread acceptance , but it does not presently have the force of Australian law behind it, which is what acceptance by the Australian Building Codes Board would confer. EBAA's intention was to describe methods of building in earth that have been proven successful historically in Australia, but futher "codification" of the publication is necessary before acceptance by the Australian Building Codes Board.

Future uses of rammed earth:
Building types:
In Europe several major recent rammed earth projects include places of worship, hospitals, cemetaries and such like, which are places where peoples feelings, thoughts and levels of consciousness are deeply considered.
Some modern rammed earth walls in hospitals have made the spaces more human and healing. Rammed earth has been used extensively for places of worship throughout the world for centuries and is ongoing. It seems to have the right properties for relaxation and healing.
In Australia several modern prisons have used a lot of rammed earth to provide not only an attractive, secure, safe, comfortable environment, but also a calming and relaxing atmosphere.

Many old peoples homes and retirement facilities have successfully been built of rammed earth around the world to give the sense of calmness and relaxation desired by more mature people seeking a better ambiance in their built surroundings.
Rammed earth for housing is on the increase worldwide.
In many first world countries (including Australia) rammed earth sits at the top of the list of the many materials available and is often considered "most desirable of all". In other words, it is often the preferred choice of the wealthy, the innovators/leaders and those able to choose "anything they want". Rammed earth often is more expensive than conventional building, but not generally much more expensive than comparable building.
Feature for feature rammed earth wins over most other building materials especially where it is given due note and respect for it's wider ranging properties which include:
a relaxing, calming, feel / ambiance.
attractive colour and texture.
the ability to include features such as niches, inserts, architecturally formed walls, multiple colours and textures and layering effects at small additional cost that are very very expensive (or even impossible) to achieve in other materials.
humidity equalisation properties, breathing walls.
the ability to use local materials in some cases.
the ability to use the same material for footings, floors, walls and roofs.
fireproof.
low transmitted and reverberated sound characteristics.
low embodied energy.
high thermal mass.
R value is lower than some other materials, but it can be augmented by the insertion of excellent R Value materials onto or within the walls.
reasonable cost if well designed.
ideal for utilizing passive solar designs.

There are no technical reasons why rammed earth cannot be widely used and become the preferred material of choice for most new building.
Numbers of rammed earth buildings being built:
In Margaret River, the capital of modern rammed earth in Australia, several years ago 20% of all new buildings were being constructed of rammed earth. Currently, builder's in that Shire consider that 10% of all new homes are of rammed earth and the Shire advise that it is more than 5%. This is of a dramatically larger number of homes now being built and includes all the project home builders now operating in the Shire, who were not there before, and the increased numbers of people building under the Government grants available to first home owners.
This can be replicated elsewhere.
There is no reason why 5 to 10 or even 20% of all new homes cannot be rammed earth in each corner of Australia.
In Western Australia 16,000 new homes approx. are built each year. Less than 1% of them (less than 160) are built in rammed earth each year. I believe that there are more rammed earth homes built each year in Western Australia than the rest of Australia but together.
I estimate that there are not that many more than 250 homes per year built in rammed earth Australia wide. This is the housing market and excludes the occasional big rammed earth commercial or industrial project.

Australia wide I consider that all earth wall housing accounts for less than 1% of all new housing.
It should be noted that the rammed earth industry and the general earth building industries turn over millions of dollars every year and are increasing.

There are now attempts starting to be made to get rammed earth into the mainstream of volume building. Neither rammed earth, nor any form of earth building is presently represented in the mainstream of building in Australia, but I believe that it is only a matter of time and persistence until this occurs. It is at present a marketing exercise since there are no significant technical impediments (to the well informed) and most customers who are fully informed, will choose rammed earth over conventional building materials. Price is of course always a determinant and lower prices can come with volume building, from economies of scale. Volume initially comes from marketing.
Separate to this there are large improvements potentially able to be made in the field of rammed earth construction. Improvements which could lower production costs and potentially tip rammed earth into a preferred status material on the basis of cost, notwithstanding the other substantial benefits. In both the USA, Australia and Europe, highly mechanised production of rammed earth has produced enormous daily outputs.

In Australia rammed earth has been widely used for Aboriginal housing and other facilities including cultural centres and such. Aboriginals have a very close affinity with the land and also with earth wall buildings that are in effect made from that land and can appear to have grown out of that land.
Summary:
Earth building in most countries and certainly in Australia:
Is proven technology (i.e. very little if any technical risk, so long as professionals are involved)
There are professionals available to build in earth in many mediums and in nearly every corner of Australia. Some of Australia's leading professionals in this field are active outside Australia.
The technology is desirable (sustainable, low carbon etc) and is becoming more so as the consciousness and awareness of such things is increasing rapidly.
Earthbuilding projects can be financed and insured OK as well as conventional buildings.
The regulatory environment allows earthbuilding throughout Australia (albeit some approvals much harder in Australia now, than was the case before).
Is generally accepted and in fact generally desired.
Cost can vary from cheap to expensive but generally costs are reasonable and very reasonable if one analyses the multiple benefits achieved.
It is necesary to promote not only the benefits of unfired earth in absolute terms but it is also sometimes necessary to compare it objectively with conventional building materials and systems and to point out some of the inadequacies of the latter.

The Future.
Earth building worldwide is a giant awakening, and particularly so in Australia.
With environmental and sustainability and such issues now at the forefront of enlightened thinking, it is unthinkable that unfired earth could be held back from massive increases. Increases in unfired earth construction shall come from absolute numbers of buildings needed to house the increasing population in Australia and

elsewhere and also increases in unfired earth construction will arise from replacement of conventional building methods with lesser credentials.

Conclusion.

EBAA Conference.

The Earth Building association of Australia was formed, many years ago, largely through the efforts of Russell Andrews who sadly passed away a short time ago. EBAA was formed to promote the use of unfired earth as a building medium throughout Australia. To promote the art and science of earth building. To codify and to give official acceptance and approval to the successful existing use of unfired earth and to see the expansion of its use from code endorsement of proven technologies in the fields of mud brick and rammed earth.

The vision has advanced from the founding days of EBAA but remains incomplete. I think that EBAA needs more members, and EBAA needs more contributors to the tasks ahead.

Additionally I consider that we, the members of EBAA need to expand EBAA operations to ensure that unfired earth is recognised as the outstanding medium that it is, so that it becomes the pre-eminent building material for Australia. In my view it has the potential to do this.

We, the people at this conference, have the opportunity to change the course of building in Australia, toward unfired earth. Let us make this conference a strong step in that direction. It is the right direction.

I wish everyone a successful conference.