

MUD BRICK and COB, and EARTH BUILDING STANDARDS.

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Building with highly variable natural materials such as natural earth could be a daunting prospect - but we do it all the time with wood. Timber is used for structural and decorative uses, building standards are written for it, strengths are often assumed and seldom tested, yet we do this with few qualms.

However, not a great deal is written on how actually design and build with these materials so that they comply with the provisions of building codes.

New Zealand, fortunately, now has a comprehensive suite of earth building standards. This means that any building designed and built in accordance with them automatically meets many provisions of the NZ Building Code.

The Standards are:

NZS 4297:1998. Engineering Design of Earth Buildings (Specific Design)

NZS 4298:1998. Incl Amendment#1 2000 Materials and Workmanship for Earth Buildings

NZS 4299:1998. Incl Amendment#1 1999 Earth Buildings Not Requiring Specific Design.

They cover only those techniques that have been well investigated and used during the current 30 year long renaissance in earth building in NZ, namely mud brick, rammed earth, pressed earth brick, and to a limited degree, poured earth. Historic and rare methods are not covered although there is some information given on some new methods (in-situ adobe) or old methods (cob) currently under revival. There is also some information on earth floors, and plasters.

NZS 4297 “Engineering Design of Earth Buildings (Specific Design)” is for engineers and gives the data and formula required to successfully engineer earth walled buildings. It is a specialist document for use by structural engineers.

NZS 4299 “Earth Buildings Not Requiring Specific Design” is not a “cook book” as such, but is essential for earth building designers. It allows the design of relatively simple earth buildings that fall within its limits without requiring specialist engineering. There are many building details given, and bracing values for various types of earth walls from unreinforced through to totally reinforced earth walls, bond beam sizes and fixings, foundations, window jamb, head and sill details etc.

Because these materials are variable, tests are required on building products to check their suitability for building. The NZ Earth Building Standards describe tests which enable earthen materials to be assessed for strength, durability, and shrinkage, and also describe how to translate these test results into sturdy durable buildings. Most of these tests are very easy to do, and they give results that can be translated into NZ Building Code Compliance. As Chair of the Standards Committee I was determined that many of the tests would be taken from common field tests used around the world and which can often be done at home. For example, one strength test is a simple field test that drops an earth brick onto a hard surface from one meter high onto its corner. If a piece no larger than a fist (standardised as 100mm dia) breaks off, then a minimum standard grade strength is assumed for the material and design and quality control can proceed on that basis. If more sophisticated engineering is wanted that requires higher strength materials then more sophisticated test are proscribed for higher grade materials.

All earth building techniques in New Zealand have needed to be adapted to the severe seismic and weather conditions here, in particular the relatively high rainfall that is often wind driven horizontally onto buildings. Driving rain was such a concern to the Standards Committee that two sections that prescribe the minimum amount of roof overhang were included. One relates roof overhang to durability. The more exposed or the less durable the material, the greater the eaves that are required. To protect earth walls from driving rain wide eaves or verandahs are usually needed.

Most external wall systems in NZ are built with a cladding that allows water that penetrates the outer skin to be harmlessly directed out of the building again, or to evaporate before damage is caused. Those building systems that have not allowed this to happen are now in trouble with rotting timber walls. Earth walls are single skin construction, and are therefore vulnerable to water if care is not taken. Unfortunately coatings (which must breathe), although helpful, always seem to fail in the end. Therefore earth (and strawbale) buildings must be carefully designed to keep excessive moisture off the walls. Primary weather protection is crucial. Its simple really.

A table from NZS 4299 “Provision of Eaves to Protect Earth Walls from External Moisture”, is reproduced here.

Exterior moisture protection for earth walls.

Building Wind Zone	Ratio of exposed wall height : eaves width
Low	4:1
Medium	8:3
High	3:2 (See note below)
Very High	1:1

Note- This ratio may be reduced to 2:1 for earth walls not stabilised with cement or lime that have open exposure and face northerly between north east and north west.

In High wind zones this table recognises the improved waterproofing properties of natural clay surfaces (eg mud brick or cob) that are free to swell to form a waterproof layer when they get wet compared to the more porous matrices formed within the material by cement and lime stabilisers, especially when combined with the effect of the sun on the northern aspect of a building in helping keep those walls dried out.

The ratios above are minimums only. Lesser eaves combined with alternative weather protection measures such as fences, pergolas, or other permanent landscaping features may be possible in some cases but this is outside the scope of this standard and into the realm of specific design. The weather exposure on any particular wall must be carefully assessed and the Council satisfied that the walls will perform adequately.

Relying on surface coatings such as plasters, washes, solutions or slurries as the primary method of waterproofing earth walls was not considered good practice by the Standards Committee as these have often been found to be unreliable or inadequate in service, whether traditional or modern formulations are used. Designing to keep the water off is the way to go.

Once major weather impact is removed from earth walls, other details in the Standards deal with what water does get to the walls, thus giving a full means of compliance with external moisture requirements of the NZ Building Code.

The Standards generally do not distinguish between stabilised and unstabilised materials. They give performance levels that are to be met and how these are met is not proscribed. Stabilisers may be used to enhance properties such as strength or durability. For my opinion on the use of stabilisers please see the accompanying paper on Although the essentials of successful structural design of earth buildings are covered in the standards, other aspects that are essential to successful performance of a building such as passive solar design and good aesthetics are not assured.

Also of course, there is no obligation to follow the standards. However, if you do not, then you will need to be prepared to justify your proposal to the local council in order to obtain a building consent.

Earth floors are also a real possibility again in New Zealand and are included in the Standards. The best floors I have seen are made using unstabilised earth that have an oiled and waxed finish that is somewhat like leather and is very pleasant to walk on - it is the only flooring I have seen that makes people smile when they walk on it.

Earth roofs are not included in the Standards so need specialist design, but with adequate attention to water proofing and insulation (an earth roof without additional insulation does not perform very well) can be a wonderful addition to an earth or any other building.

Mud brick and cob using light-weight aggregates combined with heavier internal thermal mass of more traditional earthen materials has a great future helping produce energy efficient buildings with low embodied energy that will help reduce energy consumption and they have a great role to play in any sustainable design strategy.

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