

Earth

Earth building methods include:

- structural walls of rammed earth or pisé, where the earth is progressively compacted into removable formwork
- earth bricks (adobe) as a veneer tied back to a structural frame of timber or steel
- rammed earth or earth brick as an infill to a structural timber post and beam structure
- structural walls of earth bricks (adobe) – though this is uncommon.

There are three New Zealand standards covering earth building. Updated versions of each were published in February 2020:

- NZS 4297:2020 - Engineering design of earth buildings
- NZS 4298:2020 - Materials and workmanship for earth buildings
- NZS 4299:2020 - Earth building not requiring specific design

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Extraction and manufacture	
Impact of extraction	Removal of earth has visual impacts, and there is the potential for damage to local ecosystems during extraction. Cement and/or organic matter can be used as a binder. Waste from manufacturing or installation can also be used. Earth used for building must comply with NZS 4298 Materials and workmanship for earth buildings.
Energy use	Only a very small amount of energy is needed to manufacture earth building materials. Embodied energy is quoted ¹ as 0.15 MJ/kg for straw stabilised adobe Energy use will increase where materials must be transported to site.
By-products/emissions	Earth is inert. . Lower density earthen materials with high amounts of organic fibre have negative CO ₂ emissions (absorb CO ₂) and those containing cement have positive CO ₂ emissions (emit CO ₂). CO ₂ emissions for adobe with straw are: -12 g/kg; or -20 kg/m ³
Sourcing	
Material sources	Earth or earth bricks can be obtained locally – including on the building site – if the earth is suitable for use.
Availability	Availability varies – depends on suitability.
Cost	Material costs are low but a significant amount of labour is required.
Transport to site	Transport costs are high if raw or finished materials need to be transported.
Construction/installation	
Health and safety during construction/installation	There is a risk of sunburn during construction.
Ease of construction	Materials can sometimes be sourced on site. Earth building takes a relatively low skill level.
Adaptability	Earth buildings can be readily cut and repaired.
Performance	
Health and safety during life of building	Earth is inert, non-toxic and not generally prone to off-gassing of volatile materials. There is potential for off-gassing from earth mixes that contain bitumen. Earth may have to be sealed to prevent dusting or have an earth plaster finish.

Structural capability	Earth buildings must comply with NZS 4298 <i>Materials and workmanship for earth buildings</i> .
Expected durability (assuming correct installation and maintenance)	80+ years – but this depends significantly on the climate, building design, construction and finish applied. To be durable, earth must be protected from moisture.
Maintenance rating	Earth is relatively high maintenance because of the importance of protecting it from moisture.
Moisture resistance	Resistance to moisture is good when used in accordance with the New Zealand earth building standards. Adherence to NZS4299:1998 <i>Earth buildings not requiring specific design</i> and NZS4298:1998 <i>Materials and workmanship for earth buildings</i> gives compliance with Building Code clauses B2, E1, E2 and E3. Earth may be susceptible to excessive rain wetting or rising damp. Natural earth materials moderate interior humidity.
Rot, mould and corrosion	Earth may be attacked by burrowing insects. Material will disintegrate when wet.
Thermal performance	Lower density earthen mixes have higher R-values. The R-value of higher density earth is low. Earth walls, floors or internal earth brick veneers provide useful thermal mass if they are exposed to the interior and/or to direct sunlight through windows/doors.
Sound insulation	The high mass of earth walls gives good sound deadening/insulation.
Fire performance	Earth won't burn.
Waste disposal/recycling/re-use	
Re-use	Earth building materials can be re-used.
Recycling	Earth building materials can be recycled provided they do not contain cement.
Waste disposal	Earth is biodegradable and non-toxic when no additives such as bitumen are used.

1. Embodied energy figures taken from work © J. Andrew Alcorn, 2010. (Alcorn, J. Andrew, *Global Sustainability and the New Zealand House*, a thesis submitted to Victoria University of Wellington in fulfillment of the requirements for the degree of Doctor of Philosophy in Architecture, Wellington, 2010.)