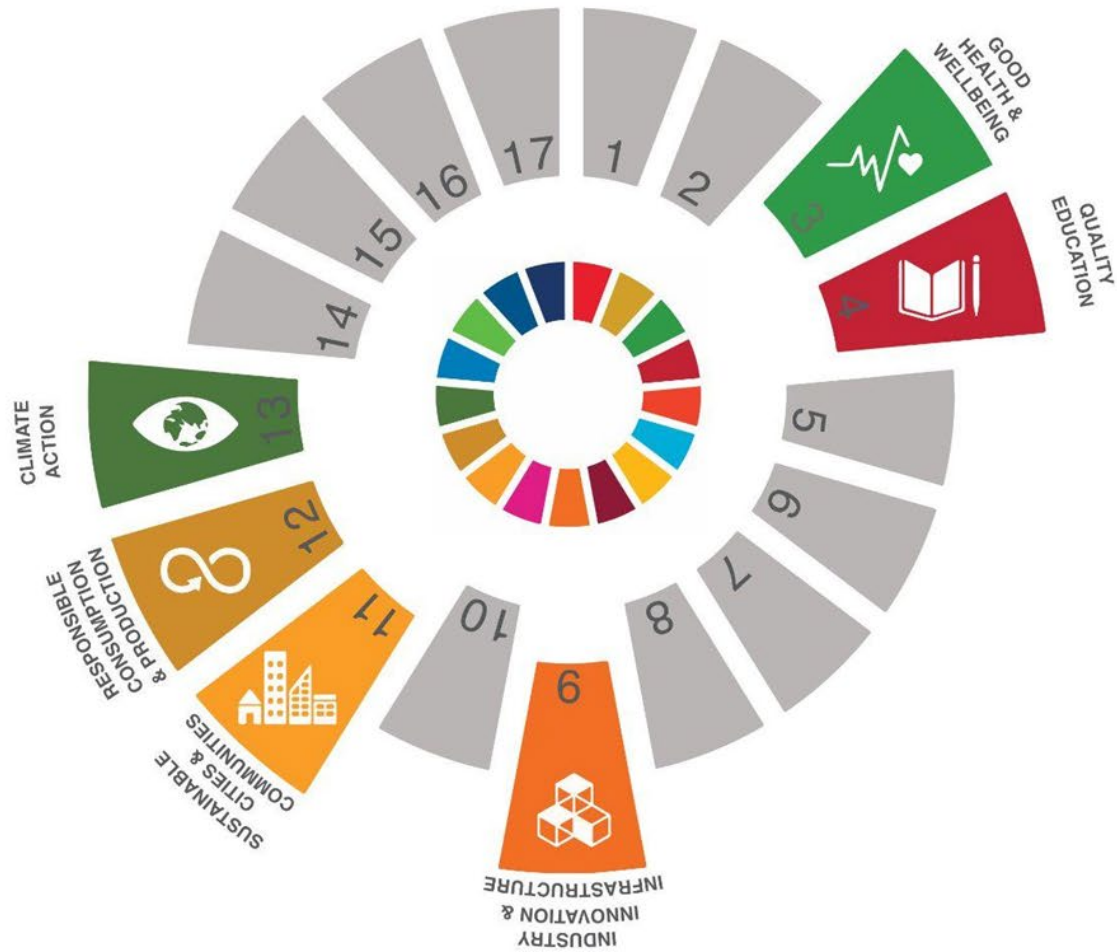
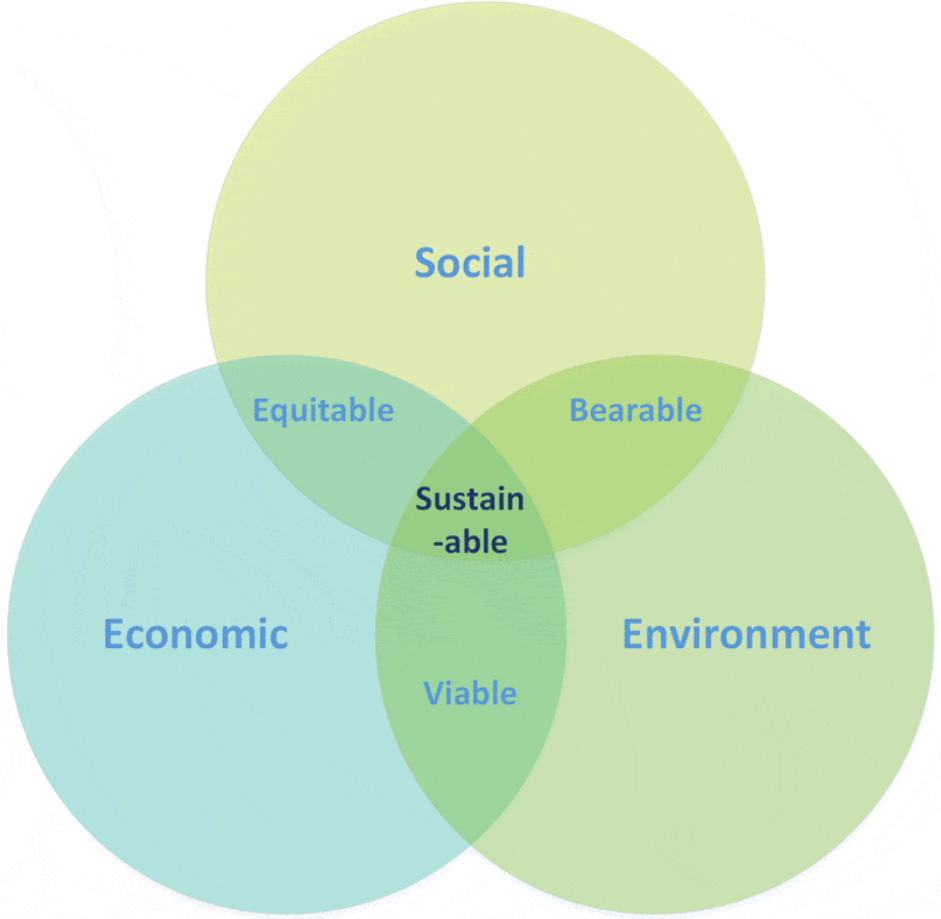


# Sustainable Development Goals



# Three Pillars of Sustainability



# WHY IS SUSTAINABLE BUILDING IMPORTANT?

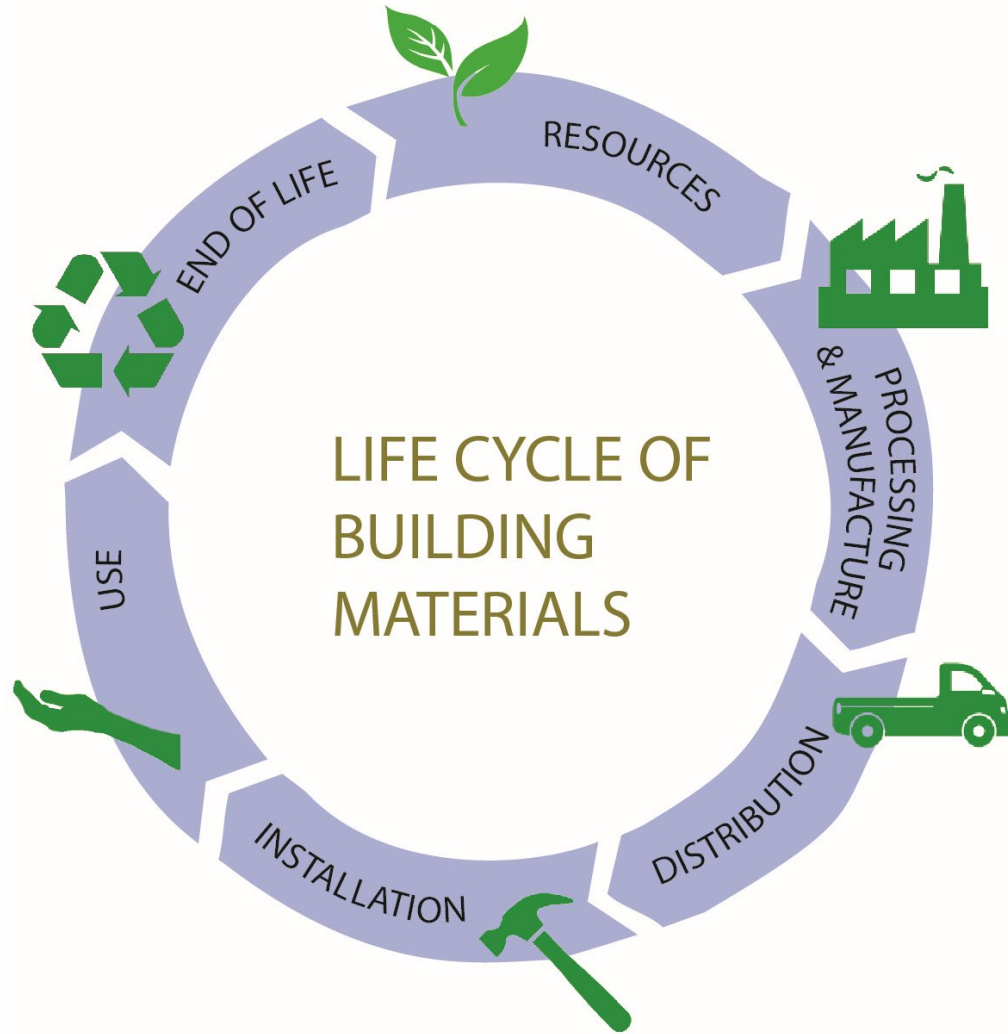
- Nearly 40% of global energy-related greenhouse gas emissions are attributable to buildings and construction
- Over 40% of landfill in New Zealand is attributable to buildings and construction (Some regions put the figure closer to 80%)
- There are roughly 255 billion m<sup>2</sup> of buildings in the world today – a number that grows by around 5.5 billion m<sup>2</sup> every year. We are building the equivalent of a new city the size of Paris every week.

The need for action grows ever more urgent.

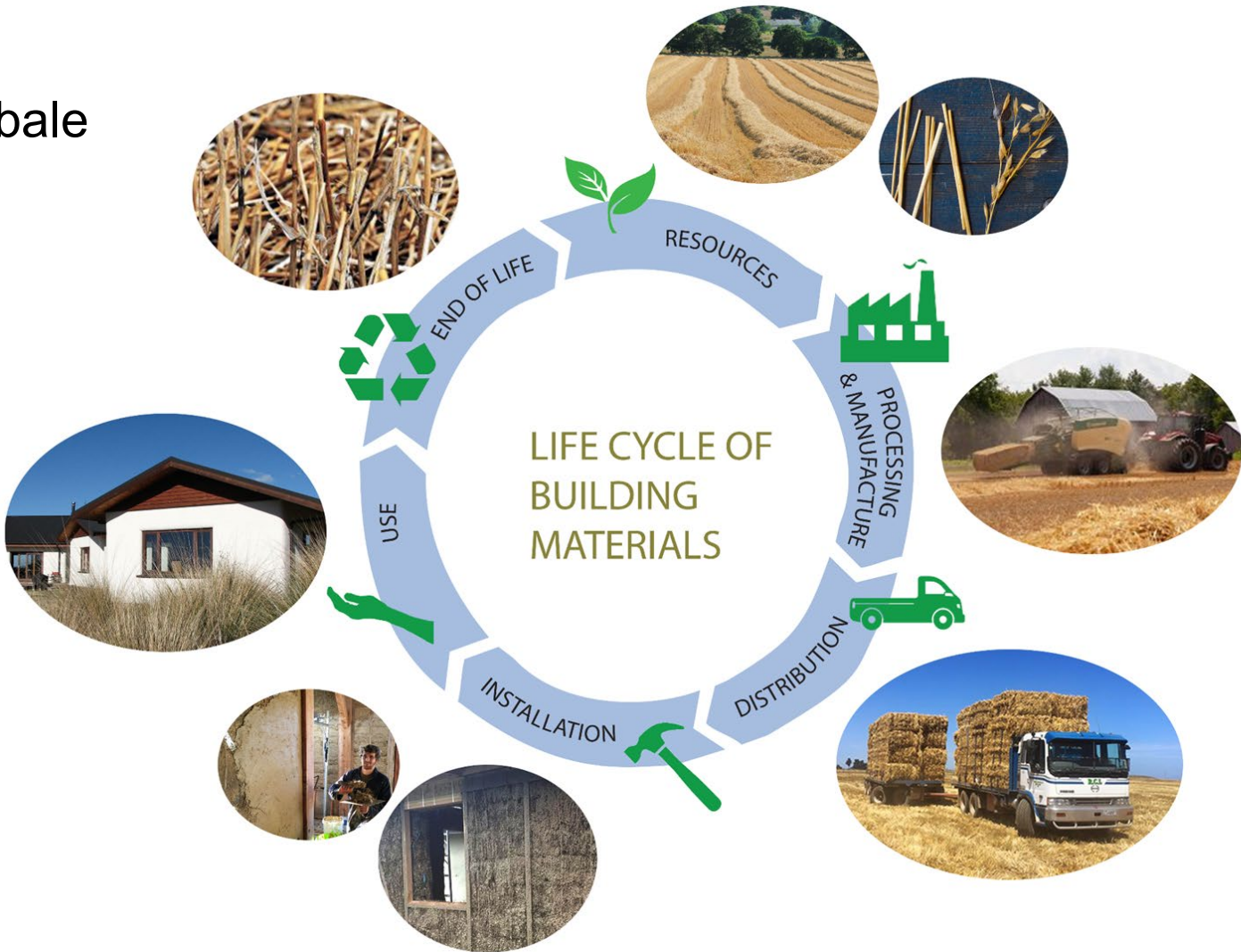
The Royal Institute of Architects recent Built for the Environment Report states that:

‘If the goal of the built environment is to create safe, comfortable habitats that facilitate individual and community health and wellbeing, then addressing the climate and biodiversity emergencies is firmly within the remit of all those operating within this sector, including design teams, contractors, investors, developers, asset managers, educators, regulators, and building users.

[Built for the Environment report \(architecture.com\)](https://www.architecture.com/press-and-media/press-releases/2022/built-for-the-environment-report)



# Strawbale



# Key ingredients used in earth building techniques

## Fibre (light)

Straw /  
Cellulose  
Hemp



## Binder

Clay /  
Lime



## Aggregate (heavy)

Sand  
Gravel



# Natural Building options overview

Light to



Heavy

Straw bale



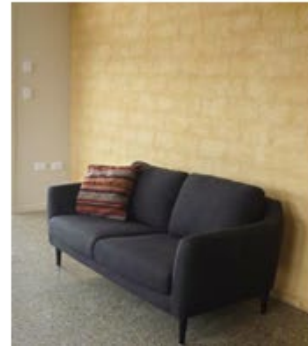
Light Earth Mix  
/ Straw clay



Low density  
Earth Bricks



Adobe / Cob  
Mud Brick



Rammed Earth &  
pressed earth brick



Increased R-Value

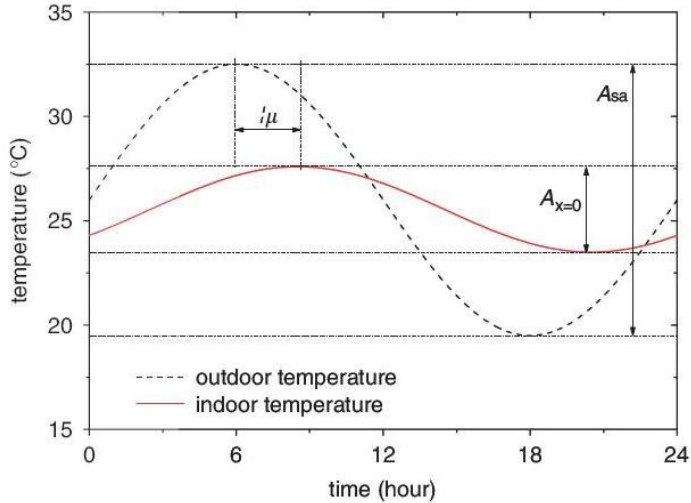
Decreased R-Value

Decreased Thermal Mass

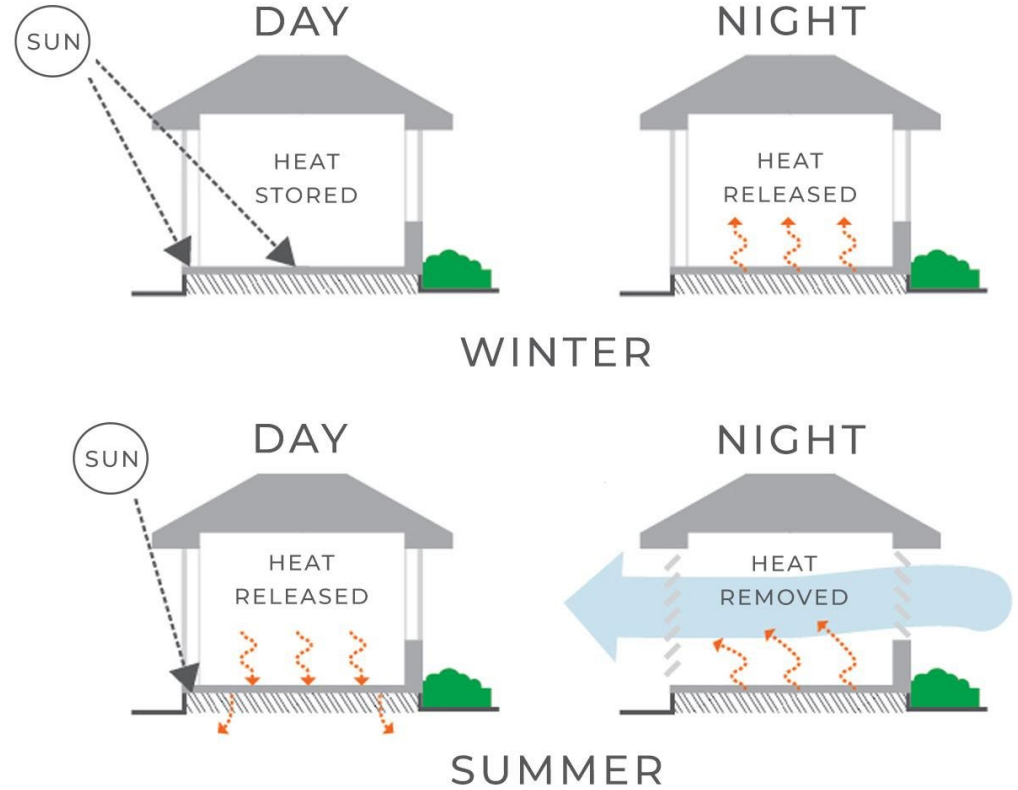
Increased Thermal Mass



# Benefits of earth building

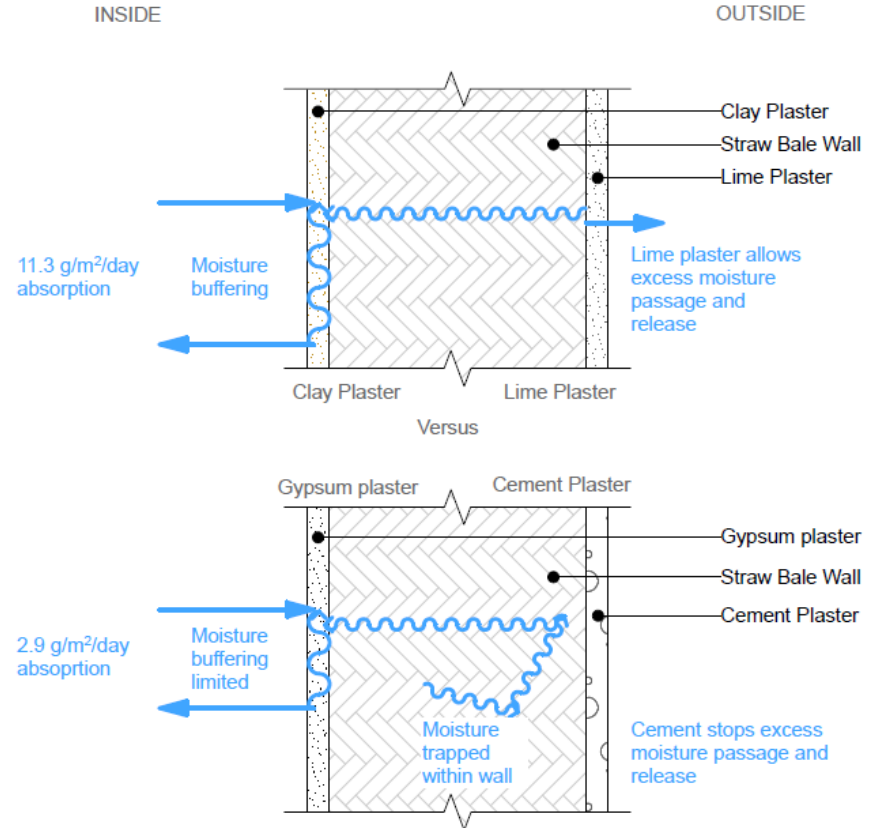
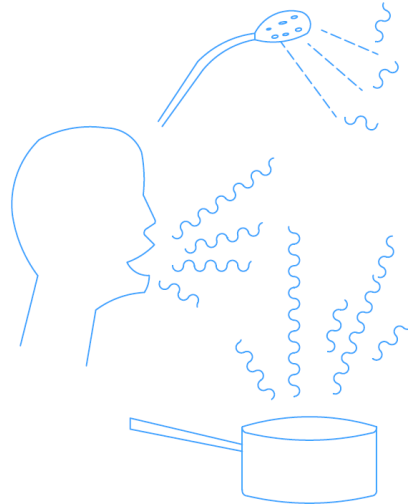


## Thermal Mass



Natural clay based plasters better regulate humidity indoors; which is important for better respiratory health and warmth. Clay wall finishes have good hygroscopic behaviour compared to other wall finishes. Clay based plasters also release moisture when air moisture levels drop, to maintain optimum humidity levels

## Humidity Control



Cobb



**Cob Building  
Toto's Café,  
Wainui Bay**



# Adobe earth brick

'Solid Earth'.  
Verena  
Maeder.  
Nelson EBANZ  
member and  
earth builder.



# Rammed Earth

Charles Sturt, University Campus,  
Albury-Wodonga, NSW.co



Rammed earth houses in NZ



# Adobe Veneer

## Humidity control

## Thermal mass

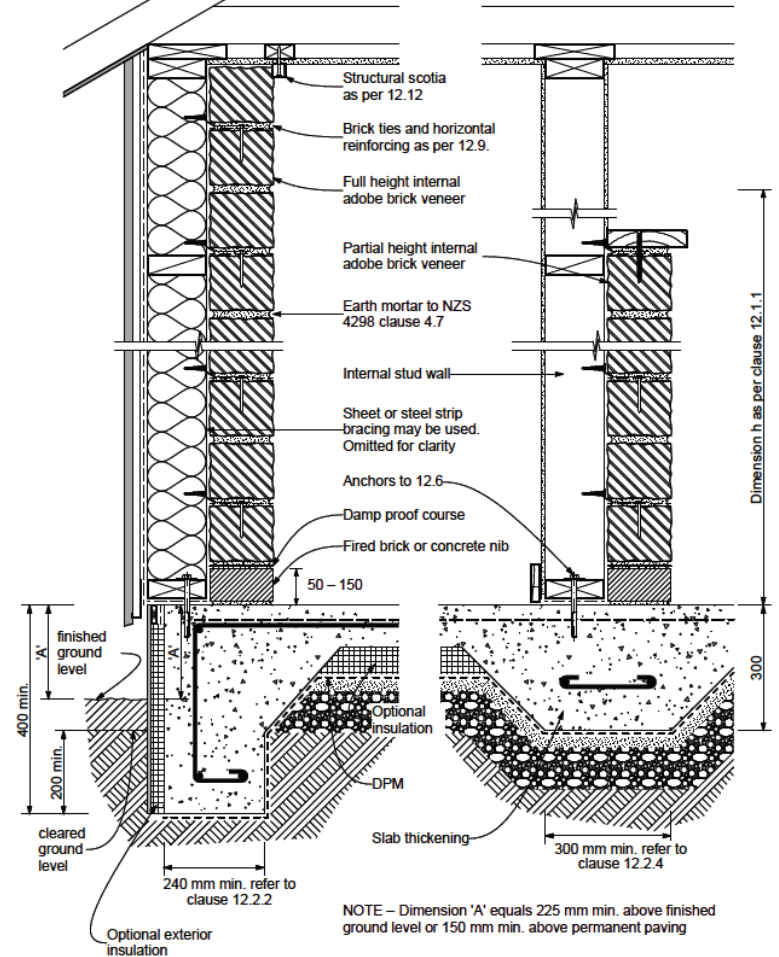


Figure 12.1-Internal veneer details

# Strawbale



# Straw as a building material





# Straw is NOT Hay!



Dried stalks of grain, left over from grain production



Dried grass, cut and baled to feed animals

# From clay to interior plaster

From the  
Ground



To the finished  
wall lining



Clay in the  
ground



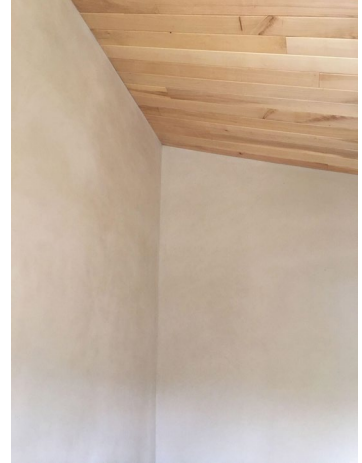
Clay being  
soaked



Clay mixed with  
some sand and  
small pieces of  
chopped straw



Clay plaster  
on the  
strawbale  
walls



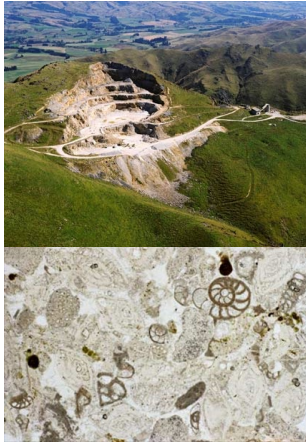
Final finish  
plaster on  
the interior  
walls

# From limestone to exterior plaster

From the  
Ground



To the finished  
wall exterior



Limestone in  
the ground



Traditional burning of  
the limestone to  
change the chemical  
properties



Hydrated lime  
mixed with some  
water



Lime putty  
ready to  
apply to  
walls



Final finish  
plaster on  
the interior  
walls

# Earth finishes

- Used for interiors of earth buildings
- Clay-rich earth 'soft-skins'
- Flexible and vapour permeable
- Retain moisture within its pore structure (hygroscopic)
- Less durable, yet a self sealing ability
- Less water resistant

# Lime finishes

- Used on exteriors and interiors of low density earth buildings
- Finished with silicate paint (preferred option), or
- Lime wash applied again every few years for maintenance.

# Structural aspects of strawbale or straw clay building



# Straw bale building - fire resistance

- Fire resistance – straw bales are encapsulated in a thick layer of plaster.
- Straw bales are compressed straw “a dense block dramatically decreases the oxygen’s ability to feed a fire at the straw” (King, B. “Design of Strawbale Buildings” p 173. 2006). Similar to the reason why thick timber chars for quite a while before burning.
- Test case studies “the un-plastered bale wall withstood the heat and flames of the furnace for 30 minutes before flames penetrated a joint between bales”. (King, B. p 174. 2006).
- A plastered straw bale wall achieved a 90 minute fire rating.
- Lesson: get the initial plaster coat on the bales ASAP on a building site, and remove the biggest danger; any loose straw.



# Strawbale - detailing design

NZS 4299:2020

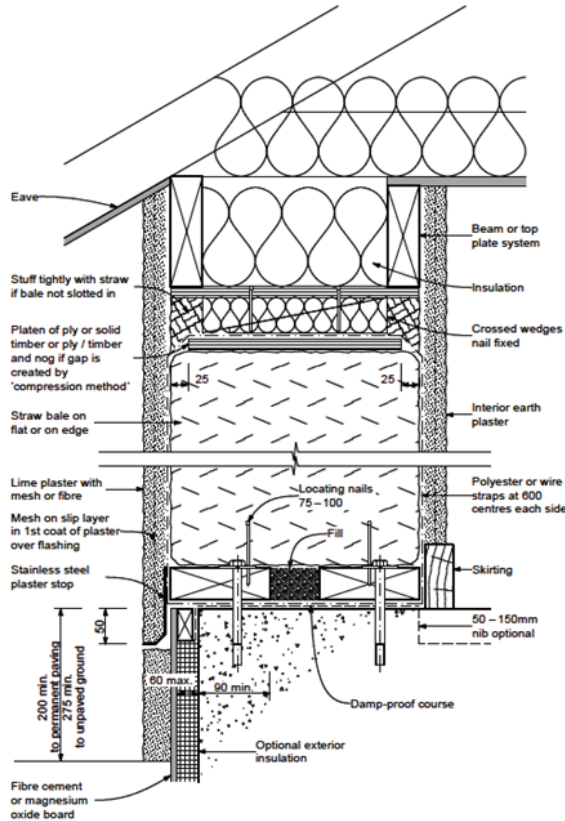
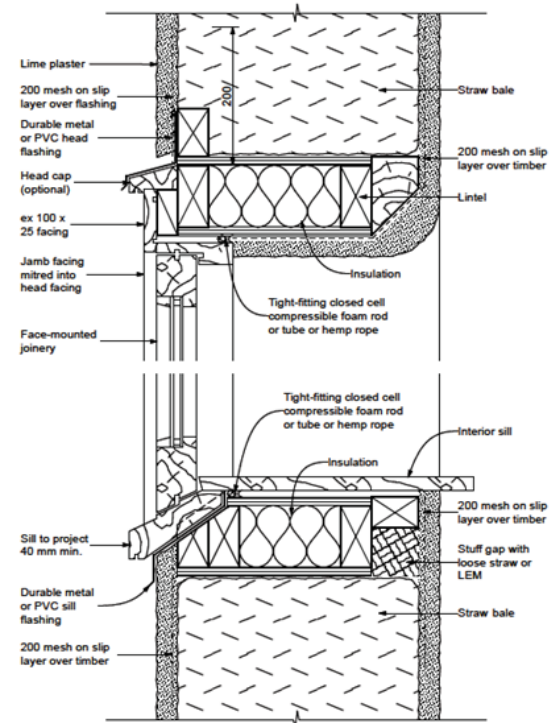


Figure E.7- Strawbale wall with direct plaster

NZS



NOTE -  
 Head flashing to have 15° fall, 35 min. upstand behind plaster and 10 cover to head cap. Extend flashing and head cap 20 min. beyond outer edge of facing boards and form stop ends. Sill flashing to have 20 stop-ends and 35 min. cover to plaster.

Figure E.2- Head & Sill for sheltered walls with direct plaster

# Straw clay building methods



# Restoration of old straw clay buildings in Germany





# Straw clay

IS 4299:2020

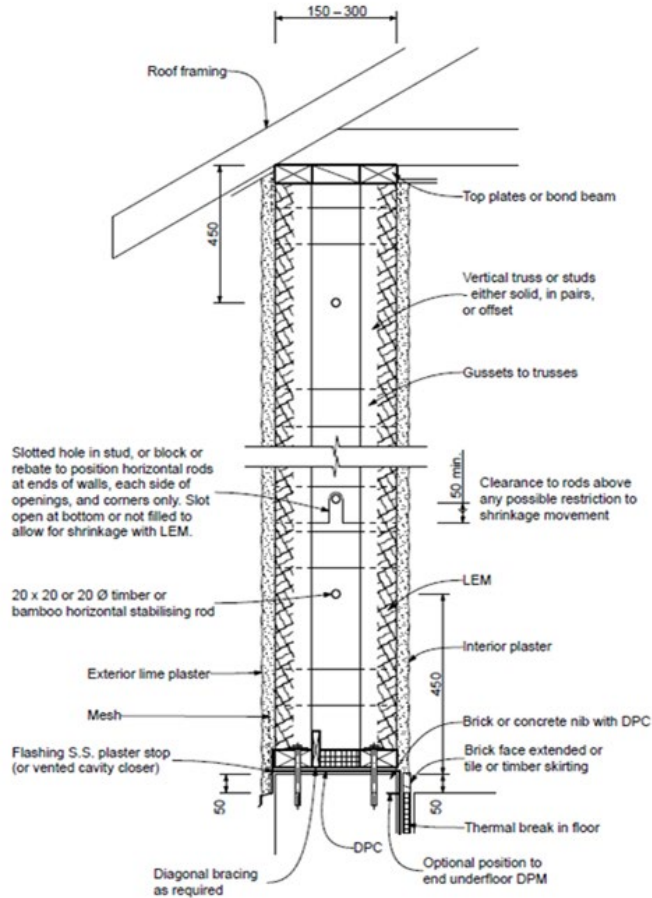


Figure D.4- LEM wall section

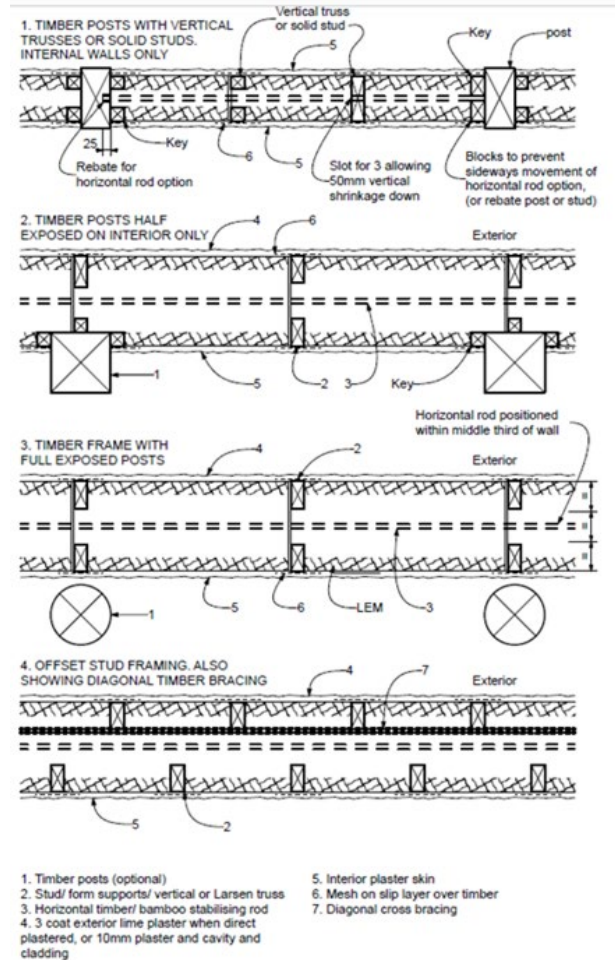


Figure D.1- Diagrammatic framing options for LEM

# Earthen Floors

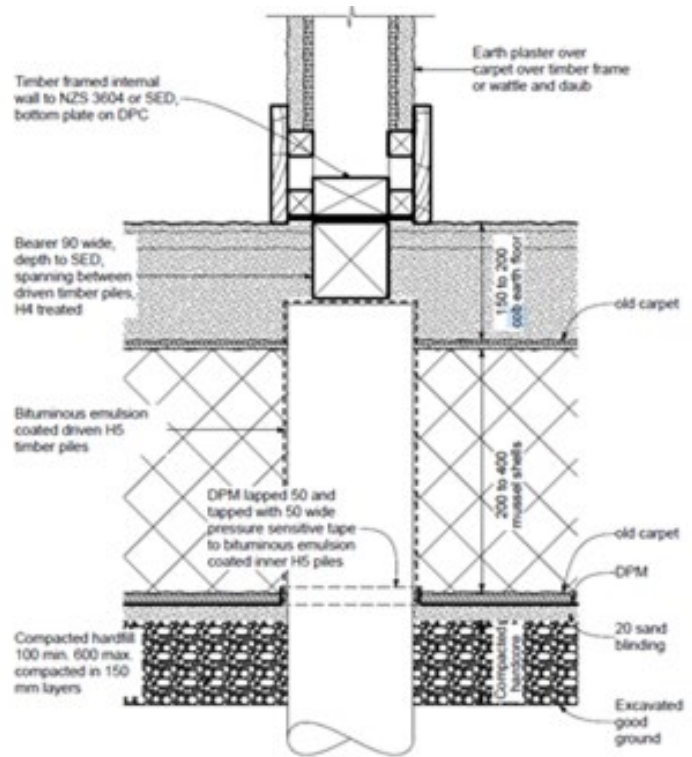


Figure E.9- Internal wall on driven timber piles (SED)

# Standards available

- Engineering design of Earth Buildings NZS 4297 – 2020
- Earth building not requiring specific engineering design - NZS 4299 – 2020
- Materials and construction for earth buildings– NZS 4298 – 2020
  
- Now includes ordinary dense earth, ie: rammed earth, pressed earth brick, mud brick, cob, earth plasters and earth floors, and internal earth brick veneers along with lower density earth techniques for mud brick and cob, as well as advisory appendices on LEM and straw bale and more robust guidelines for the design of earth walled buildings.

# EBANZ, Earth Building Association of New Zealand

- EBANZ primary mission is to promote the art and science of earth and natural building.
- EBANZ is a network group for those interested in natural building methods such as adobe, cob, rammed earth, poured earth, pressed earth, light earth, straw bale and straw clay.
- Members include architects, engineers, builders, people interested in the topic, owner builders, and people involved in the building industry.

[www.earthbuilding.org.nz](http://www.earthbuilding.org.nz)

# Other resources- Books

## General:

Minke. G., (2013) Building with Earth: Design and Technology of a Sustainable Architecture. Basel, Switzerland.

## Strawbale:

Jones, B., (2015). Building with Straw Bales: A step-by-step Guide

CASBA., (2019). Straw Bale Building Details: An Illustrated Guide for Design and Construction. New Society Publishers

King, B., (2006). Design of Straw Bale Buildings. Green Building Press, USA

Magwood. C., Mack. P. (2005). More Straw Bale Building: A Complete Guide to Designing and Building with Straw. New Society Publishers, USA

Minke. G., (2020). Straw Bale Construction Manual. Basel, Switzerland.

## Light Earth Method:

Volhard. F., (2016). Light Earth Building: A handbook for Building with Wood & Earth. Birkhauser, Basel, Switzerland.

Doleman. L (2017). Light straw clay construction. New Society Publishers. Gabriola Island, USA

## Cobb:

Weismann. A, Bryce, K., (2006). Building with Cob: A Step-by-Step Guide. New Society Publishers. Gabriola Island, USA

Evans. I., Smith. G. M., Smiley. L., (2002) The Hand-Sculpted House. Chelsea Green Publishing.

## Rammed Earth:

Krahn. T. J., (2019). Rammed Earth Construction: The complete step-by-step guide. New Society Publishers. Gabriola Island, USA

Keable. J., Keable. Rowland., (2012) Rammed Earth Structures: A Code of Practice. Practical Action Publishing, Rugby, UK

# Other resources- Websites

<https://www.earthbuilding.org.nz/>

<https://www.strawbuilding.org/>

<https://www.solidearth.co.nz/earthbuilding-information/building-with-adobe-brick-technique/>

<http://ebuki.co/resources.htm>