

Life cycle assessment of rammed earth made using alkaline activated industrial by-products

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Photo: Maree Clout



Photo: Getty Images

Perth, Western Australia



Photo: The West Australian

Rammed earth

Traditional



Modern (stabilised)



Photo: Ramtec

Castle of Baños de la Encina, Andalucía, constructed in 967AD!! (Jaquin et al., 2008)

- Climate Change / Paris Agreement



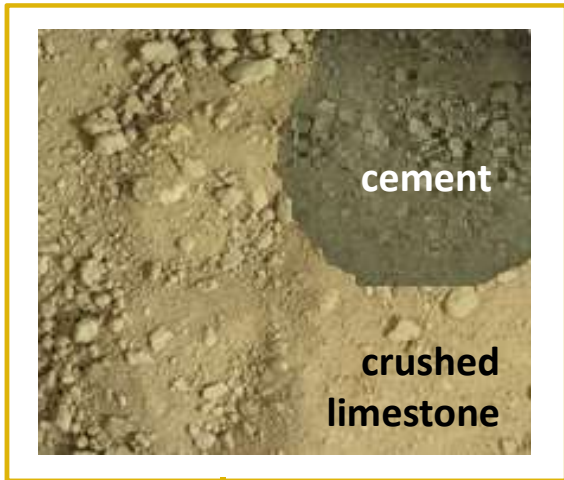
- Reduce CO₂ emissions

- Australia's National Waste Policy

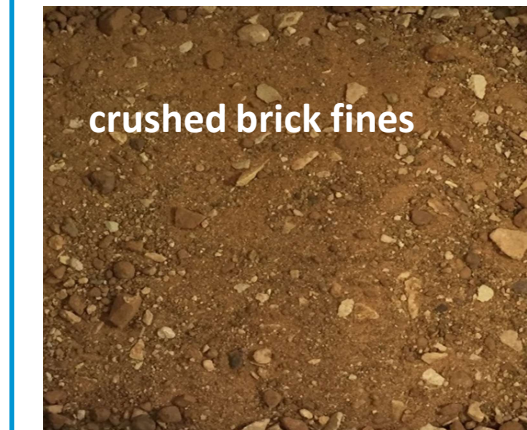


- Reduce waste

Materials and mechanical testing



RE base case: CL.C



RE alternatives:

base material

+

aluminosilicates

+

chemical activator

|

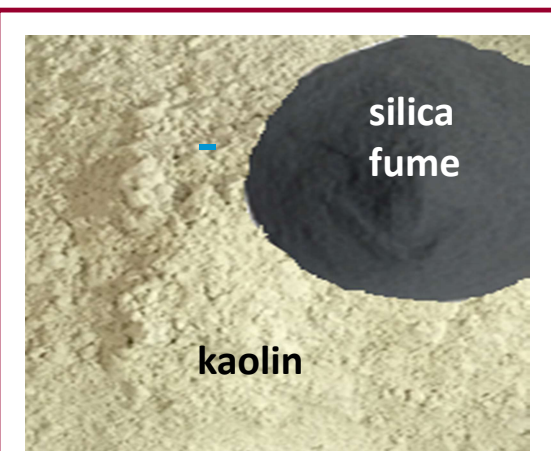
NaOH

BC.Na

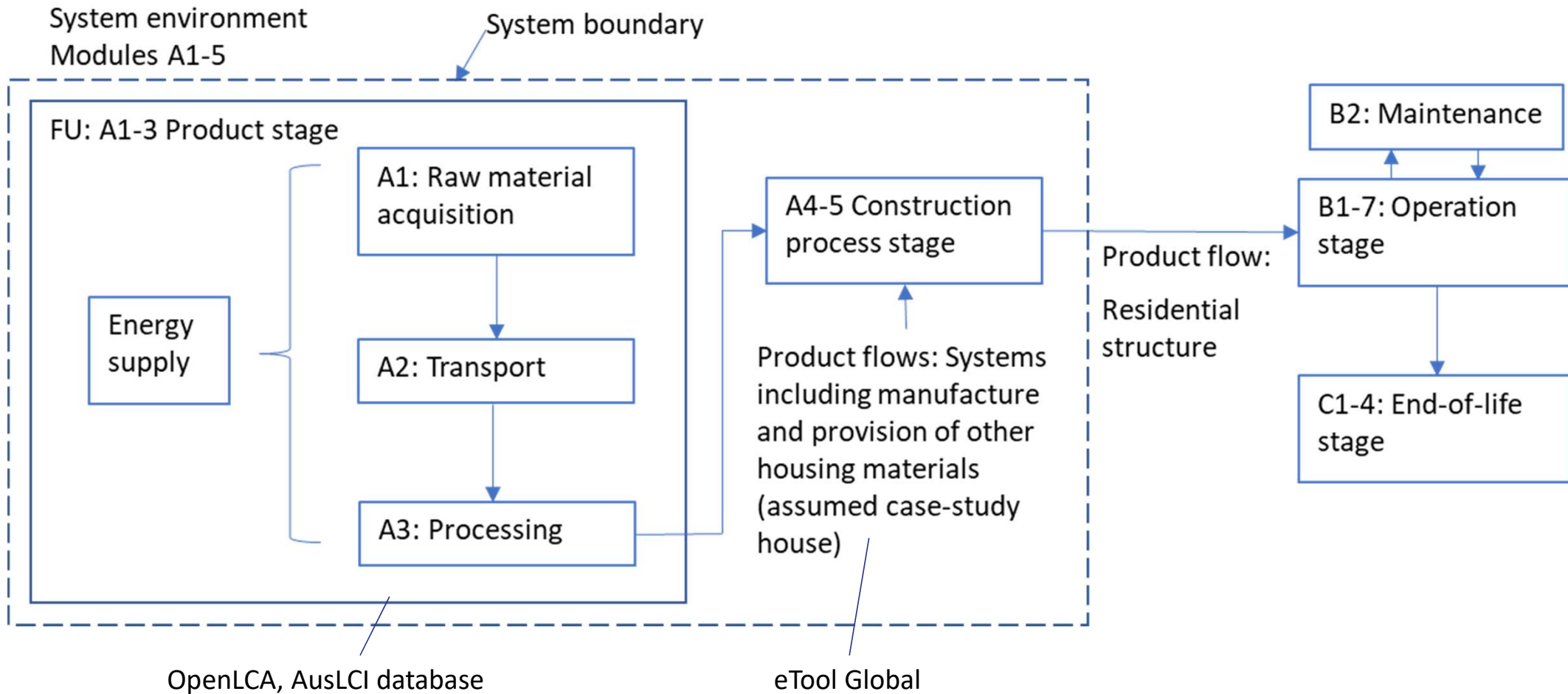
|

hydrated
lime

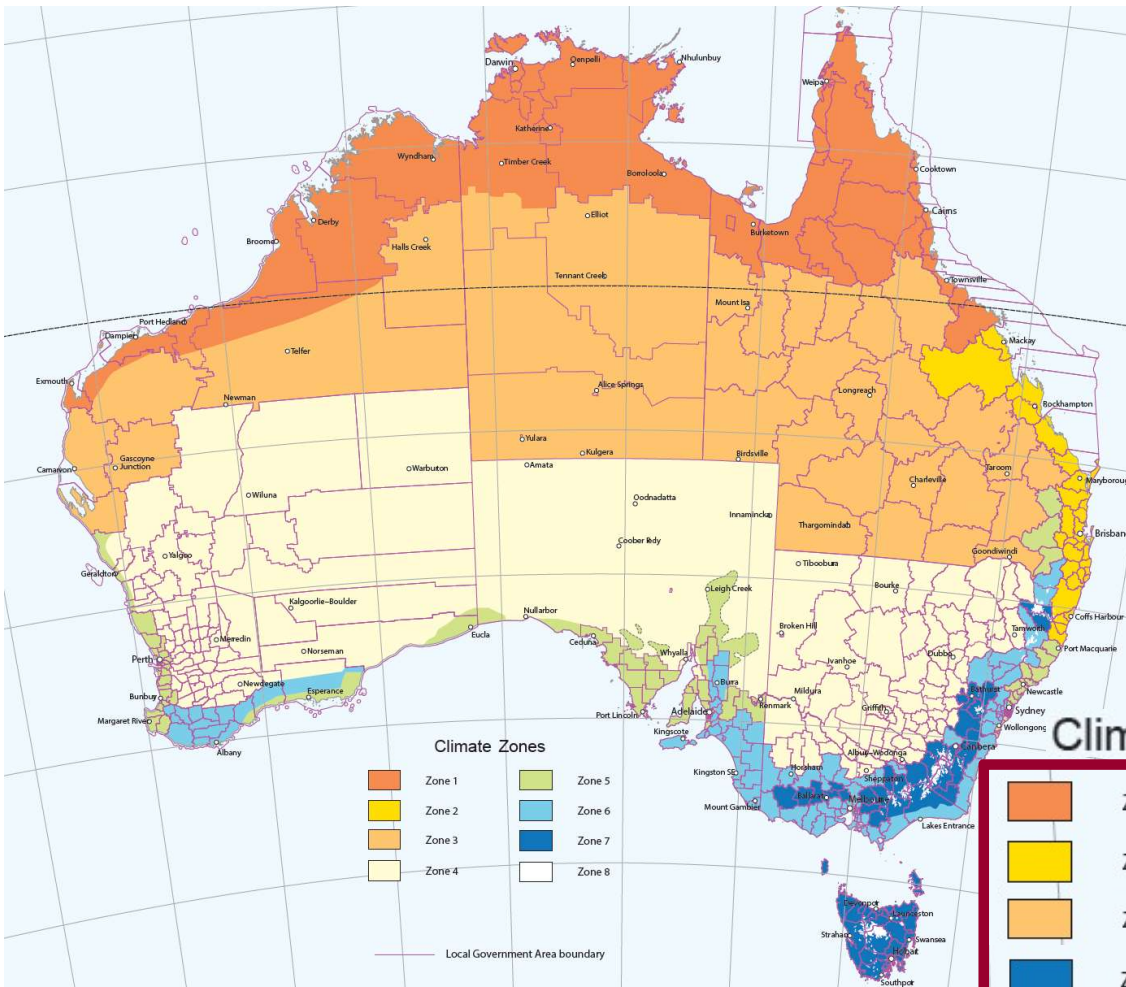
BC.L



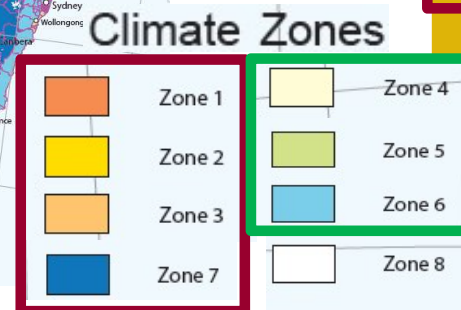
System boundary



Climate zones – insulation requirements

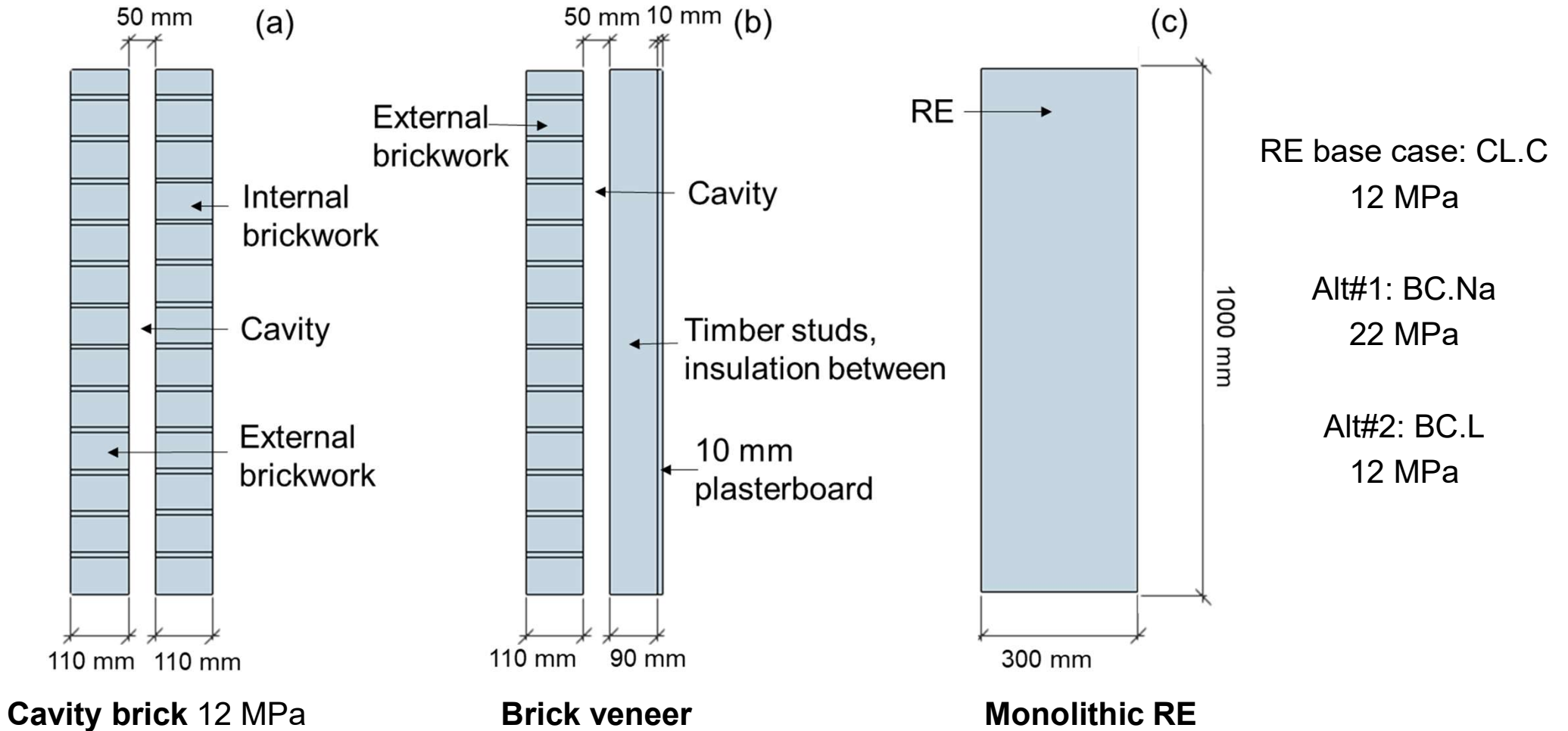


(ABCB, 2016)

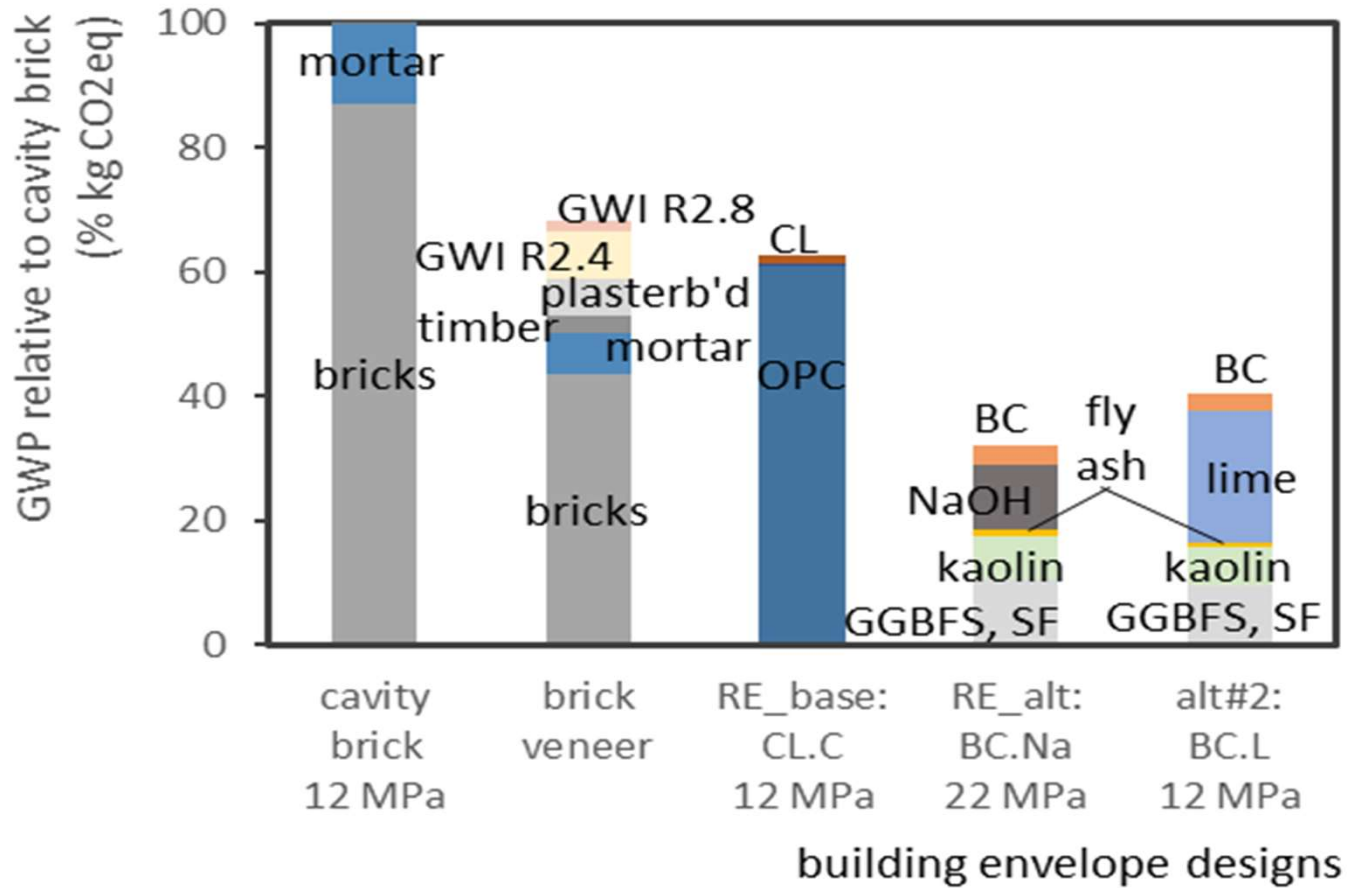


Climate zone	External wall (brick veneer)	External wall with surface density >220 kg/m ² (RE, cavity brick)
1	R2.4 total	R0.5 added
2	R2.4 total	R0.5 added
3	R2.4 total	R0.5 added
4	R2.4 total	None required
5	R2.4 total	None required
6	R2.8 total	None required
7	R2.8 total	R0.5 added
8	R3.8 total	R3.8 total

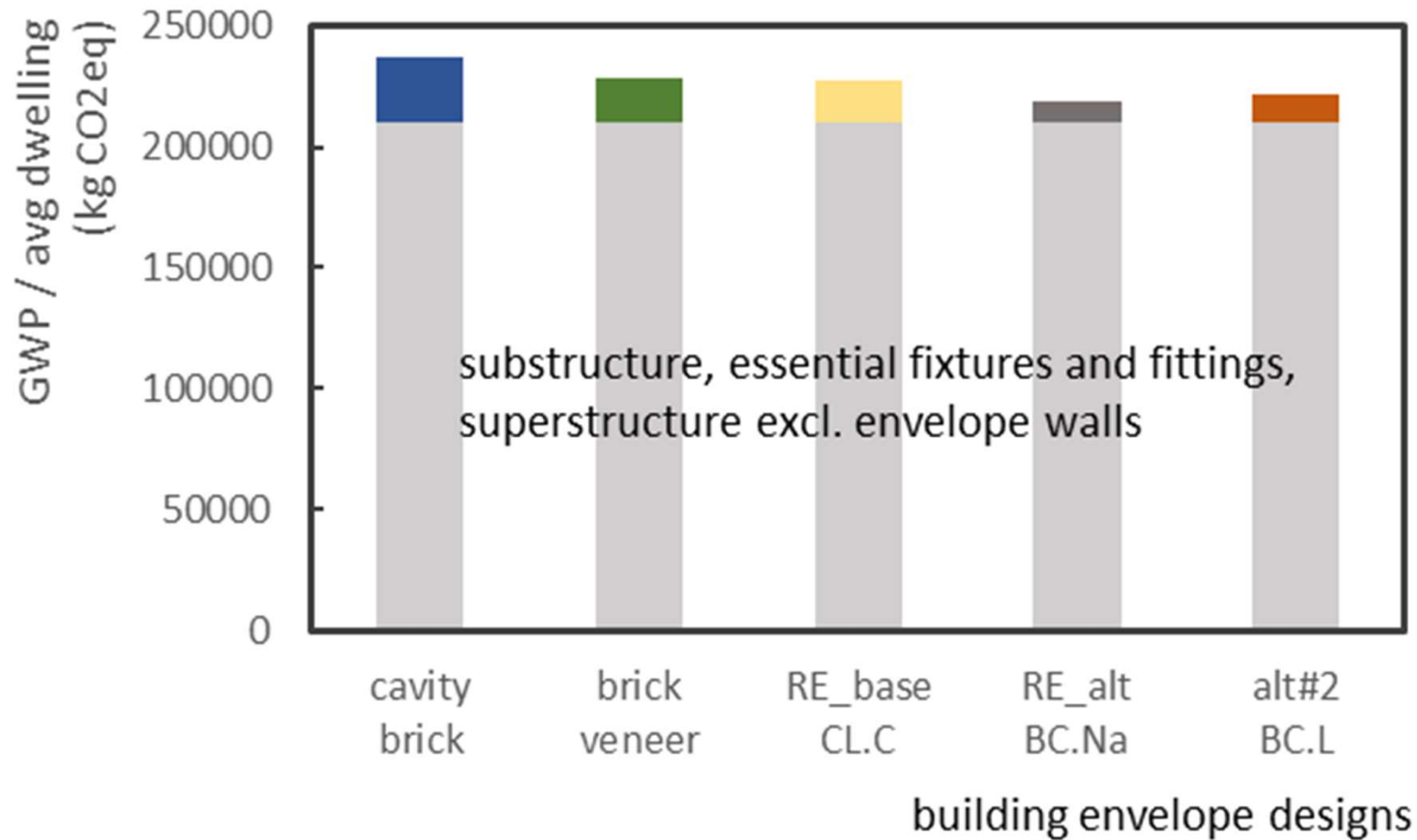
Building envelope types – climate zones 4, 5, 6



Reference unit results – climate zones 4, 5, 6



Relative results – entire house

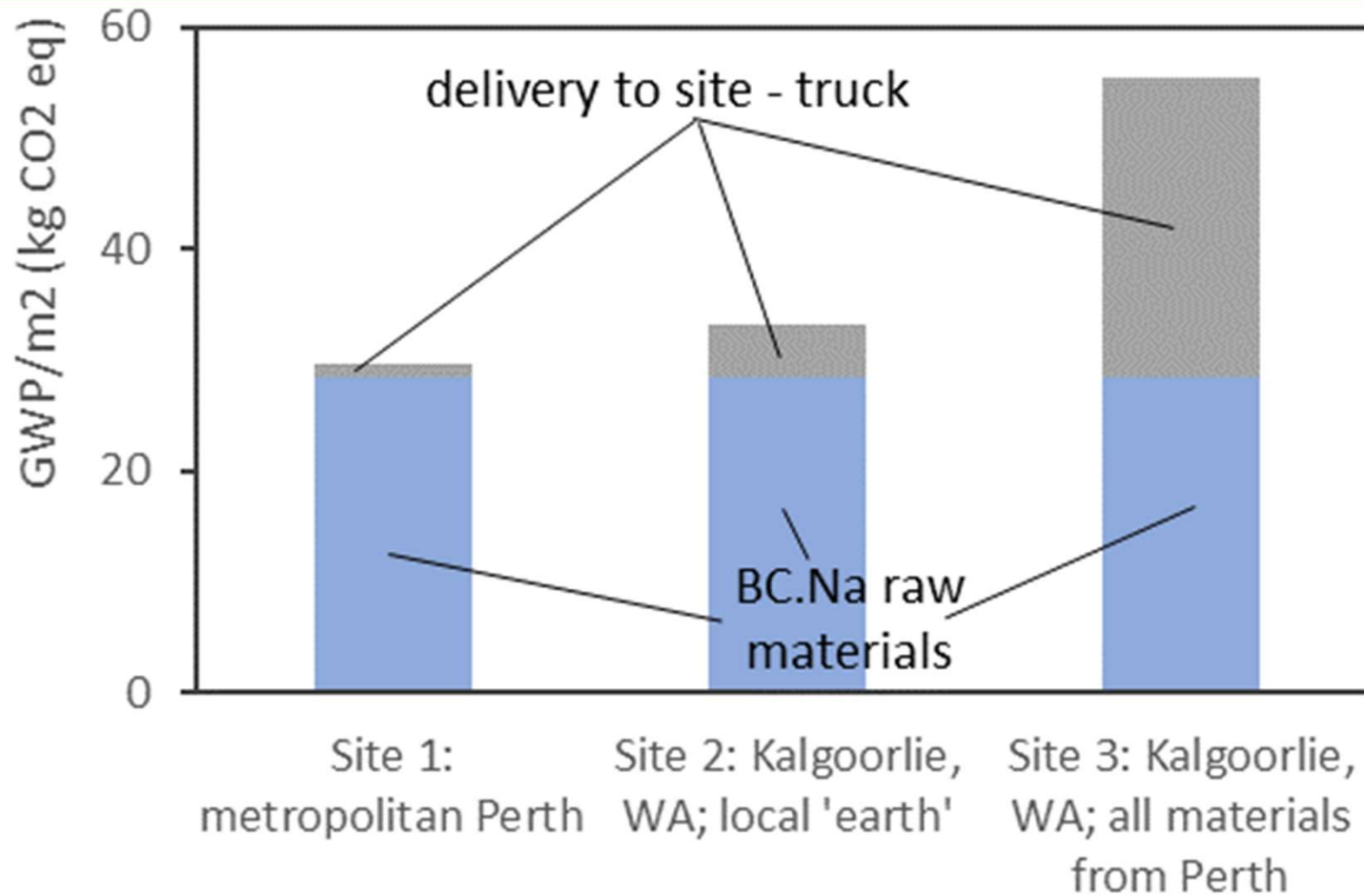


- average Australian detached dwelling 233 m² (Commonwealth Research, 2017)

Significance of results

- Paris Agreement 26-28% = 868-934 Mt CO₂eq
 - 107000 new detached dwellings per year 2021-2030 (ABS, 2019);
 - southern half of WA – replace cavity brick;
 - remainder of Australia – replace brick veneer;
 - same electricity generation breakdown as per current practise.
-
- Save 11.25 Mt CO₂eq = 1.25%

Delivery – effect of site location



site locations and transport options

Conclusions

- Alkali-activated RE using waste products has low GWP
- Reassess over time / location
- Consider consequential approach
- Recycling of brick & concrete reduces waste to landfill
- Use local base material
- Thermal analysis – full LCA
- Contribute 1.2-1.3% to CO₂ emissions reductions



References



ABCB (2016) Climate Zone Map for Australia, Australian Building Codes Board, 11 May 2016, <https://www.abcb.gov.au:443/Resources/Tools-Calculators/Climate-Zone-Map-Australia-Wide>

Australian Bureau of Statistics (ABS). (2019). 8731.0 - Building Approvals, Australia, Nov 2018, TABLE 08. Number of Private Sector Houses Approved - States and Territories 1983-2017. Retrieved February 1, 2018, from [http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8731.0Nov 2018](http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8731.0Nov%2018)

Commonwealth Research. (2017). *Australian home size hits 20-year low. Economic insights.*

Paul A. Jaquin, Charles E. Augarde & Christopher M. Gerrard (2008) Chronological Description of the Spatial Development of Rammed Earth Techniques, *International Journal of Architectural Heritage*, 2:4, 377-400, DOI: 10.1080/15583050801958826

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Thank you

Alexandra Meek