



New Zealand Standard

Engineering design of earth buildings

Superseding NZS 4297:1998

NZS 4297:2020

COMMITTEE REPRESENTATION

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REFERENCED DOCUMENTS

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New Zealand standards

NZS 1170:---	Structural design actions
Part 5:2004	Earthquake actions – New Zealand
NZS 3101:2006	Concrete structures Standard
NZS 3109:1997	Concrete construction
NZS 3602:2003	Timber and wood-based products for use in building
NZS 4210:2001	Masonry construction: Materials and workmanship
NZS 4230:2004	Design of reinforced concrete masonry structures
NZS 4298:2020	Materials and construction for earth buildings
NZS 4299:2020	Earth buildings not requiring specific engineering design
NZS 7601:1978	Specification for polyethylene pipe (Type 3) for cold water services

Joint Australian/New Zealand standards

AS/NZS 1170:---	Structural design actions
Part 0:2002	General principles
Part 1:2002	Permanent, imposed and other actions
Part 2:2011	Wind actions
Part 3:2003	Snow and ice actions
AS/NZS 1530:---	Methods for fire tests on building materials, components and structures
Part 3:1999	Simultaneous determination of ignitability, flame propagation, heat release and smoke release
AS/NZS 1554:---	Structural steel welding
Part 3:2014	Welding of reinforcing steel
AS/NZS 2053:---	Conduits and fittings for electrical installations
Part 1:2001	(Reconfirmed 2016) General requirements
AS/NZS 4671:2001	Steel reinforcing materials

Australian standards/or of other national standards bodies

AS 1530: ---	Methods for fire tests on building materials, components and structures
Part 4: 1975	Fire-resistance tests for elements of construction
AS 3700:2018	Masonry structures

British standard

BS EN ISO 10319:2015 Geosynthetics. Wide-width tensile test

Other publications

CSIRO (1995), CSIRO Australia Bulletin 5: Earth-Wall Construction.

Acceptable Solutions and Verification Methods For New Zealand Building Code Clause B1 Structure; Clause B2 Durability, Ministry of Business, Innovation and Employment, 2019.

Ministry of Business, Innovation and Employment, Earthquake Commission, New Zealand Society for Earthquake Engineering, Structural Engineering Society, and New Zealand Geotechnical Society. *Seismic assessment existing buildings, Section C8: Unreinforced masonry buildings*. July 2017.

UBC. Uniform Building Code, International Conference of Building Officials, 1994.

Oliver, D. and Whybrid, D. 'Commercial Engineered Aggregate Construction'.

Proceedings of Economics in Building Conference, Brisbane, Australia, September 1991.

Bibliography

2013 Liu Y. *Adobe Performance and Dynamic Response for Seismic Resistance*. University of Auckland, Department of Civil and Environmental Engineering.

2011 Morris, H, and Walker, R. 'Observations of the Performance of Earth Buildings Following the February 2011 Christchurch Earthquake'. *Bulletin of the New Zealand Society of Earthquake Engineering*, 44 (4), 358 – 367.

2000 Morris, H, and Walker, R. 'Aseismic Design and Construction of Earth Buildings in New Zealand'. *World Conference on Earthquake Engineering*, Auckland 2000, Paper No 2193.

2011 Morris, H, Walker, R, Drupsteen, T. 'Modern and historic earth buildings: Observations of the 4th September 2010 Darfield Earthquake'. *Ninth Pacific Conference on Earthquake Engineering*, Auckland 2011. Paper No 133.

2010 Morris, H, Walker, R, Drupsteen, T. 'Observations of the Performance of Earth Buildings Following the September 2010 Darfield Earthquake'. *Bulletin of the New Zealand Society of Earthquake Engineering*, 43 (4), 393 – 403.

2017 Morris, H, Brooking, J; Walker, R. 'Out-of-plane adobe wall veneer performance from a novel quasi-static and dynamic tilt test'. *Next Generation of Low Damage and Resilient Structures*, NZ Society for Earthquake Engineering Conference 2017, Wellington.

1998 Walker, R, and Morris, H. 'Development of New Performance Based Standards for Earth Buildings'. *Australasian Structural Engineering Conference*, Auckland 1998, Proceedings Vol 1 477 – 484.

1985 Yttrup, P. 'Strength of Earth Masonry (Adobe) Walls Subjected to Lateral Wind Forces'. *Proceedings, 7th International Brick Masonry Conference*. Melbourne, February 1985.

New Zealand legislation

Building Act 2004

New Zealand Building Code