VICTORIAN BUILDING AUTHORITY

BUILDING CONFIDENCE

Industry Update
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Earthquake Design & Construction

This Industry Update outlines the requirements for earthquake design, construction and post-earthquake maintenance of buildings

The recent earthquake near Mansfield should remind the building industry of the importance of ensuring buildings are designed and constructed to comply with the requirements of the National Construction Code (NCC), Volume One and Volume Two.

In addition, building owners and facility managers should consider an out of cycle, post-earthquake ESM maintenance inspection to ensure all safety systems required for the building are maintained and working at the required operational level.

The content below provides guidance on the following matters:

- Compliance requirements
- Design considerations
- Practitioner responsibilities
- Existing buildings
- Following an earthquake

Abbreviations & Definitions

The definitions and acronyms set out below are for guidance only. They are not intended to vary those set out in the Building Act 1993 (the Act), Building Regulations 2018 or the National Construction Code (NCC).

- **AS** – Australian Standard
- **Building –** a building as classified under the NCC
- **ESM –** Essential Safety Measures
- **Structure –** organized combination of connected structural elements designed to provide some measure of resistance

Compliance Requirements

The Performance Requirements for structure in the BCA Volume One and Two requires buildings to perform adequately under all reasonable expected and extreme design actions, including earthquake actions.

The Deemed-to-Satisfy Provisions of the National Construction Code (NCC) require buildings to be designed and constructed in accordance with AS 1170.4 – 2007, Structural design actions - Earthquake actions in Australia.
All buildings must comply with AS 1170.4, except for some domestic Class 1a or 1b buildings less than 8.5m in height that comply with the applicable design standards and Appendix A, or for Importance Level 1 buildings (minor isolated structures that rarely contain people).

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Design considerations

Structural components

All structures must be configured with a seismic force resisting system that has a clearly defined load path, or paths that will transfer the earthquake actions generated in the earthquake, together with gravity loads, to the supporting foundation soil.

All parts of the structure must be tied together both in the horizontal and vertical planes so that forces generated by an earthquake from all parts of the structure, including structural and other parts of the components are carried to the foundation.

Non-structural components

Non-structural components and their fastenings must be designed for horizontal and vertical earthquake forces in accordance with AS 1170.4 Clause 8.

The following architectural components are required to be designed for earthquake loads:

- Walls not part of the seismic-force-resisting system;
- Appendages, including parapets, gables, verandas, awnings, canopies, chimneys, roofing components, containers and miscellaneous components;
- Connections for wall attachments, curtain walls, exterior non-loadbearing walls;
- Partitions;
- Floors;
- Ceilings;
- Architectural equipment including storage racks and library shelves with a height over 2.0m.

The following mechanical and electrical components are required to be designed for earthquake loads:

- Smoke control systems;
- Emergency electrical systems;
- Fire and smoke detection systems;
- Fire suppression systems
- Life safety system components
- Boilers, furnaces, incinerators, water heaters and other equipment using combustible energy sources or high energy sources.
- Communication systems.
- Reciprocating or rotating equipment.
- Utility and services interfaces.
- Anchorage of lift machinery and controllers.
- Lift and hoist components including structural frames.
- Escalators.
- Machinery.
- Lighting fixtures.

- Electrical panel boards and dimmers.
- Conveyor systems.
- Ducts and piping distribution systems.

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The Australian Building Codes Board (ABCB) also cover this topic at https://www.abcb.gov.au/news/2019/design-non-structural-building-elements-earthquake-forces

Practitioner responsibilities

All parties involved in the design and construction of buildings have a responsibility to ensure compliance with the building regulations.

Designers need to consider appropriate detailing and specification. Builders are responsible for ensuring that the buildings they construct comply with the requirements of AS1170.4 and all non-structural elements have been properly considered for earthquake loads in their design and to manage complying installation on site.

Structural engineering input is required to allow for inter-storey drift on multi storey buildings and engagement with manufacturers and suppliers on architectural, electrical and mechanical components and systems to ensure they have the required performance characteristics to accommodate expected earthquake actions.

Building surveyors should be considering that the design addresses seismic action and documentation adequately specifies components and covers detailing to AS1170.4.

Existing buildings

Earthquake standards were first introduced in 1979. Since then, design requirements have increased with research and increased understanding.

The most vulnerable building stock in Australia are considered as unreinforced masonry buildings (particularly parapets, chimneys and gables), buildings with large discontinuities that are designed to create open spaces at ground floor level (known as soft storey buildings), some precast constructions (depending on the detailing of the connections), brittle façade systems (such as glass and masonry). Areas with soft soils are also likely to experience stronger seismic action on buildings.

Building alterations may also affect the ability of a building to resist seismic loads where internal bracing walls are removed without providing replacement bracing. This is of particular concern where openings and wall removal occur in a piecemeal manner over the life of a building, with designers not considering the cumulative potential impact.

Building practitioners should have an understanding of these risks when working on existing buildings and consider any additional design or construction requirements to improve the building's safety. Recommendations should be provided to the building owner for their considered action and in cases of great concern the Council Municipal Building Surveyor should be advised.

Typical upgrade requirements on an existing building include support of unrestrained or unreinforced masonry parapets and chimneys and upgrade of connections between roof and floor structure and building

bracing. Owners should consider review of existing masonry parapets, gable and chimneys by an endorsed building engineer for any strengthening requirements to mitigate the risk of failure in an earthquake.

Heritage Victoria has collated a number of useful resources for disaster preparedness more broadly. Although the resources are focused on heritage buildings the information applies equally to other existing buildings.

https://www.heritage.vic.gov.au/about-us/our-programs-and-initiatives/disasters-and-heritage-

Following an earthquake

Post-earthquake, it is important that building owners review any signs of damage to their building. Where damage is severe and occupant safety is a concern, re-entry to a building should be avoided and the State Emergency Service should be contacted. Where damage is not severe but cracks or bowing of walls or ceilings are observed it is recommended that an appropriate endorsed building engineer is engaged to inspect and report on any remedial works. It is recommended that connections between the roof and wall framing and between structural members is inspected as they also may be affected.

For commercial buildings ESMs are critical to the ongoing fire safety of a building. Building owners or facility managers should consider out of cycle ESM maintenance inspections post-earthquake especially in high rise buildings and/or where there are complex ESMs. Maintaining the ESM will ensure that the building's important safety systems are working at the required operational level throughout the life of the building.

Further guidance on essential safety measures is available on the VBA website at https://www.vba.vic.gov.au/consumers/guides/essential-safety-measures

Related Documentation

- Building Act 1993 (VIC)
- Building Regulations 2018 (VIC)
- National Construction Code 2019
- AS 1170.0 – 2002 Structural design actions – General principles
- AS 1170.4 – 2007 Structural design actions - Earthquake actions in Australia

Contact Us

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