SEISMIC DESIGN ACTIONS ON NON-STRUCTURAL COMPONENTS

INTRODUCTION

This TECHnote examines the statutory requirements for seismic restraint which must be considered for non-structural components and internal fixings, and the relevant provisions within NATSPEC.

Although seismic design actions are generally considered the sole responsibility of the structural engineer, the National Construction Code (NCC), through the citation of the AS/NZS 1170 series of standards, also requires architects, building services engineers and contractors to take seismic design actions into account.

The requirements for non-structural elements exposed to external conditions, including wind, snow and ice are not included in this TECHnote.

CONSEQUENCES

The failure of non-structural architectural and services components to resist seismic forces from earthquakes can result in serious damage to buildings and their contents, and injury or death to occupants.

The 1989 Newcastle earthquake may have been a moderate 5.6 on the Richter scale but it killed 13 people, hospitalised 160, damaged 50,000 buildings and caused billions of dollars damage. Based on this and a similar earthquake in Adelaide, the CSIRO has concluded that "almost certainly within the next hundred years there will be at least another Adelaide/Newcastle event, but the chances are that it will be another city that is affected".^[1]

NCC REQUIREMENTS

The NCC mandates the AS/NZS 1170 series of standards in the Building Code of Australia (BCA) Part B1. Structural design actions covered by the series include permanent, imposed, earthquake, wind, snow and ice. For this reason, aspects of a building and its environment, not designed by structural engineers, must also be designed to conform to these standards.

While seismic actions may not be a critical load case for the design of the structure of a particular building (because, for example, wind actions may be greater) seismic restraint may still be required for non-structural architectural and services components.

SEISMIC ACTIONS RESTRAINT

AS 1170.4 Section 8 contains specific requirements for non-structural architectural and services components including:

- Architectural: Partitions, floors, walls, ceilings, appendages (e.g. awnings, parapets, verandas) connections (fasteners) and storage racks.
- Electrical: Emergency power systems, communications systems and light fixtures.
- **Hydraulic**: Life safety systems, fire suppression systems (including sprinklers) and hot water heaters.
- **Mechanical**: Smoke control systems, boilers, flues, reciprocating and rotating equipment (e.g. chillers, pumps and fans), ducts and piping systems, and their supports.
- Transportation: Lifts, escalators, conveyors and hoists.

Significantly, it adds to this list, "All other components similar to those listed", which greatly expands the scope of application. Examples of additional items that would meet this description include shelving, items installed in ceiling voids, cranes, building maintenance units, water storage tanks, systems involving hazardous materials, pressure vessels and heat exchangers, solid fuel heaters, cooling towers and water treatment equipment, waste disposal equipment, air handling plant and fans, automatic control systems and BMS, cable trays, ladders, busbars, conduits, catenaries, plinths, fuel storage systems, batteries and UPS.



Compressor mounts failed due to insufficient uplift resistance.



Panel overturned due to absence of fixing to floor.



Piping separated at flanges.



Suspended air handling unit fell through ceiling.



Ductwork and ceiling tile collapse in earthquake.

[1] G.R.Walker, 'Lessons from the 1989 Newcastle earthquake', in What we have learnt from the Newcastle earthquake: lessons in building design Brisbane, 1991.

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DESIGN CONSIDERATIONS

Seismic restraint is largely a design issue, the specification serving primarily to define parameters and the quality of components. Fortunately for designers, there is a large amount of material (see right column) on the effects of earthquakes on building services, design provisions relating to seismic restraint and practical information on prevention of damage due to seismic activity. While NATSPEC deals with seismic restraint for common items, designers must detail project specific provisions on the drawings or in the specification. New Zealand Standard NZS 4219 includes some typical details for pipework restraint, flexible couplings and plinth connections, which could be considered, if appropriate.

NATSPEC PROVISIONS

0171 General requirements deals with seismic restraint generically in the **SEISMIC RESTRAINT OF NON-STRUCTURAL COMPONENTS** clause. Service specific requirements are dealt with in the respective worksections.

The designer of the non-structural components or the contractor must select and detail components to resist the specific seismic requirements. For example, such detailing may require the inclusion of anti-vibration mounts to equipment.

DESIGNER'S AND SPECIFIER'S RESPONSIBILITIES

- The professional responsible for the design of non-structural components must:
- Review NATSPEC default text and amend if necessary to suit project requirements.
- Make sure that the proposed design of non-structural components will resist the structural design actions of the AS/NZS 1170 series and detail specific seismic restraint where required.



The earthquake hazard map ^[2] indicates potential areas of seismic activity risk.

Relevant reference documents

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), Practical Guide To Seismic Restraint.

Federal Emergency Management Agency (FEMA), *E-74: Reducing the Risks of Nonstructural Earthquake Damage* – A Practical Guide. www.fema.gov

Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA), Seismic Restraint Manual, Guidelines for Mechanical Systems Third Edition - 2008.

Relevant standards

AS/NZS 1170 Structural design actions Part 1 Permanent, imposed and other actions. Part 2 Wind actions. Part 3 Snow and ice actions. Part 4 Earthquake actions in Australia. NZS 4219 Seismic performance of engineering systems in buildings.

Relevant subgroups

017 General requirements 033 Masonrv 034 Steel 036 Earth 042 Roofina 043 Cladding 045 Doors and windows 046 Glass 052 Partitions 053 Ceilings 054 Access floors 055 Fixtures 070 Mechanical general 074 Ductwork and components 075 Piping 093 Power supply equipment

[2] The 2012 Australian Earthquake Hazard Map – Geoscience Australia.