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	<h1 style="text-align: center;">Assessment of Existing Building Structures for Global Stability</h1>			

1. Introduction

Designing new buildings and structures for earthquake actions has been a requirement for Structural Engineers in Australia for many years. The current Australian Standard AS1170.4 – 2007: Structural Design Actions Part 4 – Earthquake Actions in Australia, gives guidance on the earthquake actions and general detailing requirements for the use in the design of structures subject to earthquake.

The requirements for the assessment and strengthening of existing buildings is undefined in the current Building Code of Australia (BCA) or other current Australian Standards with the basis and parameters of any assessment left up to the individual Structural Engineer reviewing the building and any works that are proposed to it.

This Practice Note aims to give guidance on requirements for assessment of existing building structures and procedures that are available for assessment of their ability to withstand earthquake loads during a design event that can be used as a basis for reporting on possible strengthening requirements to building owners, developers and other stakeholders for consideration in the initial stages of a project.

2. Design Codes and Requirements

New buildings are designed and constructed in Australia in accordance with the relevant revision of the BCA – National Construction Code (NCC). This Code sets out the “technical provisions for the design and construction of buildings and other structures”. Design and construction may be carried by a performance-based solution or by deemed-to-satisfy solution. Commonly the building structure is designed using the deemed-to-satisfy requirements, incorporating the requirements of the various Australian Standards eg Loading AS1170, Concrete AS3600 etc.

In the case of existing buildings subject to alterations and additions, the structural requirements of new works are covered by the requirements of the BCA, however existing building structure compliance is not required.

Alteration and addition works subject to a Development Approval (DA) may be subject to conditions in the approval with respect to structural adequacy of the existing structure or upgrade works – each Council/ Approval authority has differing requirements, but the most onerous condition requires a full upgrade to the building to BCA compliance and this potentially requires full compliance with AS1170.4. In this case the requirement of the structural engineer with regards to earthquake compliance is quite prescriptive.


City of Sydney Council sometimes however only requires structural certifications that “the proposed additional loads and/or alterations must not cause a decrease in the existing structural performance of the building including its performance under earthquake actions (AS1170.4)”.

Sometimes there are no DA conditions requiring any checks or certifications of the structural capacity of existing buildings subject to new works, even if the works are quite substantial. A common condition limits certification to “verifying that the existing structure can adequately support the proposed new loads...”.

While these types of DA conditions could imply that no assessment of a buildings adequacy is required in some cases, there may be an obligation to carry out a basic risk assessment as part of an engineer’s obligations under the safety in design provisions of the current WHS legislation.

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Work Place Health and Safety (WHS) requirements (Safety in Design), set outs the legal requirements and duties of designers to carry out risk assessments of any designs they are involved with and take steps to mitigate these risks where practicable.

It may be therefore that, “where practicable”, a structural assessment is required regardless of any authority requirements or development approval conditions.

In identifying any risks associated with structural inadequacies in an existing building, and reporting those risks/ deficiencies to the client/ building owner should be sufficient to discharge the designer’s obligations with respect to Safety in Design and the WHS requirements. Whether the building owner/ client acts to mitigate the residual risk highlighted in any report is beyond the control of the Structural Engineer.

Obviously, the level of assessment will vary from project to project, and will depend on the age, size and construction type of the project, the nature of the works and type of building structure involved.

It is common knowledge that unreinforced masonry buildings (URM's) are particularly susceptible to earthquake damage, and this is compounded in those with timber floors where there is often little engagement between the walls and floors to generate suitable load paths.

Alternatively it is likely that a properly designed modern multi-storey building has been designed for wind loads at least and therefore has some inherent capacity to withstand lateral loads.

For example, it would be unreasonable and impracticable to expect a structural engineer to carry out an assessment of a large multi-storey reinforced concrete building when only small localised modifications are being made on one floor say, but it would not be unreasonable for a structural engineer to consider and report on the adequacies of a low rise URM undergoing a major re-fit, even with limited structural works.

3. Guidelines for Assessments


The process below can be used when considering the need for strengthening an existing building structure for seismic and other lateral load. It includes a number of excerpts from the BCA and standards that the BCA references:

It is a legal requirement that all new Structures in Australia should be built in accordance with the BCA.

BCA Conformance:

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NCC 2015 BCA Volume 1, part B1 clause B1.1 states that *“The resistance of structure must be greater than the most critical action effect resulting from different combinations of actions where;*

- a) *The most critical action..... contained in AS/NZS 1170*
- b) *The resistance of a building or structure is determined in accordance with B1.4.*

Note: NNC 2015 BCA Volume 1, part B1 clause B1.4 discusses Australian Materials codes

AS1170 Conformance:

AS1170.0: General principals – Commentary (supplement to AS/NZS 1170.0:2002, Section C1 SCOPE AND GENERAL, C1.1 SCOPE, item (E) references AS3826, ISO 13822 as the publication to reference for *“assessment of existing structures”*

AS3826 Conformance:

AS3826-1998- Appendix B2.1 deems an assessment be made if:

1. An alteration, which will reduce the strength or performance characteristics of the building
2. An addition, which will add mass and increase the earthquake response
3. A change in use, which will increase the occupant density of the building
4. Other changes due to the building in its unaltered condition being considered unsafe.

ACSE Discussion on AS3826 conformance:

1. An alteration, which will reduce the strength or performance characteristics of the building:

Constitutes: removal of any core structure, structural bracing, perimeter framing or any proposed structural element

Does not constitute: alteration/ modification to an individual element if existing strength and stiffness are maintained. Cutting of holes in diaphragms if general load paths maintained.

2. An addition, which will add mass and increase the earthquake response

ACSE suggest that the engineer calculate the building mass before and after intended modification, If changes by more than 5% (floor by floor and overall) then it could be deemed to trigger this requirement.

3. A change in use which will increase the occupant density of the building

An assessment is made into the structure use to determine if this clause is triggered, if general use remains the same then this is deemed not to be triggered.

4. Other changes due to the building in its unaltered condition being considered unsafe.”...

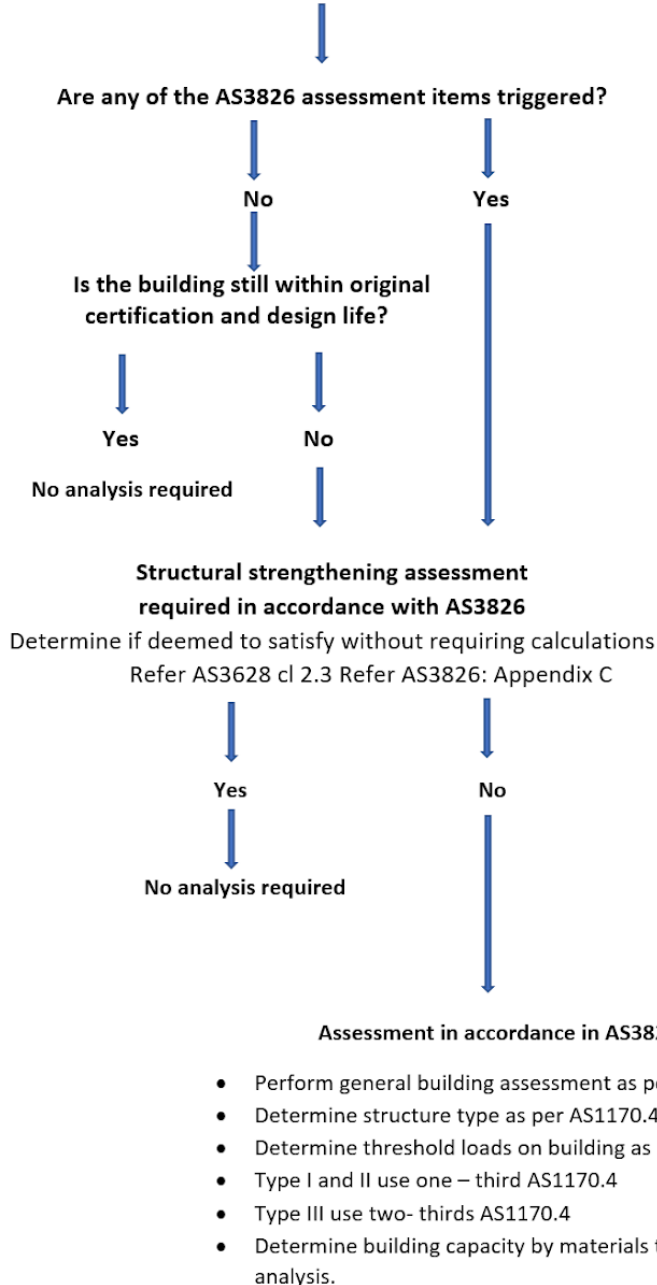
Assessment if building is inherently unsafe in unaltered state. The engineer needs to follow a systematic review of the building to highlight any potential issue with the structure.

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ASSESSMENT FLOWCHART




More detailed information on building assessments, procedures and strengthening options can be found in the following documents and publications.

AS ISO 13822- 2005 – Basis for design of structures – Assessment of Existing Structures is a Standard that gives general guidance on the assessment of existing structures for safety and

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serviceability. The Standard gives advice on procedures to be adopted in any assessment, and these could be modified for earthquake assessments of existing structures.

AS3826 – 1998 – Strengthening Existing Buildings for Earthquake is not referenced in the BCA as it is not applicable to new buildings, but is a good basis for an assessment procedure, and specifically deals with earthquake. The code provides guidance on methodologies for assessment of existing buildings, and highlights the types of buildings that are particularly at risk (e.g. multi-storey masonry structures), and types of structural deficiencies that may affect the buildings ability to withstand earthquake loads (eg lack of defined load path, poor floor/ wall connection/ soft storeys).

New Zealand - MBIE – The Seismic Assessment of Existing buildings B – This document has been produced as part of the new system for managing earthquake-prone buildings in NZ. It gives a procedures for the seismic assessment of buildings <http://www.eq-assess.org.nz/>

ASCE/SEI 41-17 – Seismic Evaluation and Retrofit of Existing Buildings – This large ACSE Standard (576p) give requirements for seismic evaluation, acceptance and retrofit of most building types and materials. <http://www.asce.org/booksandjournals>

The NZ and American standards provide a tiered approach to carrying out assessments, ranging from initial assessment to a detailed and exhaustive building analysis incorporating material testing and verification.

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