BUILDINGS STRUCTURAL PERFORMANCE

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GENERAL OVERVIEW

- **1935** first NZ Seismic Design Code NZSS 95 was published

- **1976** NZS 4203 Loading Standard (SNZ 1976) was published
  - Most buildings designed before the publication of NZS 4203 and associated materials have often been designed to a similar level of strength as modern structures, but typically they do not have the level of ductility or appropriate mechanism of failure
  - **1960 – early 1970 RC buildings** – generally taller, not well proportioned, with inappropriate seismic conformation and less redundancy
  - **Steel-framed buildings** (riveted up until 1940) – dependent on the joint detailing employed

- **2002 – 2011** AS/NZS Structural Design Actions was published/review
Collapsed Pyne Gould Guiness building (Mark Mitchell/AFP/Getty Images)
Destroyed house in Central Christchurch (AP Photo/Mark Baker)

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GENERAL OVERVIEW

- **New Zealand Building Act 2004** increase the awareness of earthquake risk
  *Earthquake Prone Buildings*

- **NZSEE Study Group publish in June 2006** *Assessment and Improvement of the Structural Performance of Building in Earthquakes*:
  - Recommend a two stage assessment process: ISA and DSA
  - Acknowledge that use of recommendations will promote consistency in assessing the structural performance of existing buildings in earthquakes
TERMINOLOGY

IEP - Initial Evaluation Procedure is the principal engineering “tool” to identify potentially Earthquake Prone Building

ISA - Initial Seismic Assessment

DSA - Detailed Seismic Assessment is a quantitative assessment and report by structural engineers, which involves calculations and potentially modelling of the structure

DDE - Detailed Damage Evaluation this evaluation is only undertaken in a post-earthquake (recovery) situation

%NBS - % of New Building Standard is a percentage which describes the seismic capacity of the building relative to NBS for a not less than 50 year design life
**TERMINOLOGY**

**CSW - Critical Structural Weakness** is any weakness in the structure that could potentially influence its performance/capacity at any level of earthquake shaking.

**EPB - Earthquake Prone Building** describe a building that has been assessed as having its ultimate capacity likely to be exceeded in a moderate earthquake.
INITIAL SEISMIC ASSESSMENT

ISA is intended to be a coarse evaluation and is recommended as first step in the overall assessment process.

ISA provide a board indication of the expected performance of a building taking into account:

- type and age of construction
- local seismicity and ground conditions

The output of an ISA is expressed as a %New Building Standard (NBS) or by a grading level.
DETAILED SEISMIC ASSESSMENT

DSA is a more detailed quantitative appraisal undertaken by structural engineers to establish the seismic performance of a building.

Engineers use a range of techniques to quantitatively assess the performance level of the building.

The output of an DSA is expressed as a %NBS or by a grading level.
Relationship between ISA and DSA (ISA Guide for TAs Owners Version 1: November 2013)
INITIAL EVALUATION PROCEDURE - IEP

IEP will help to identify, to an acceptable level of confidence and with as few resources as possible, all those building that fall below the EPB target

IEP have some limitations:

- IEP assume that the building have been designed and built in accordance with the building standards and good practice
- IEP can be undertaken with variable level of information: exterior only inspection, structural drawings available or not, interior inspection….
- IEP can not take into account aspects of the buildings that are unknown
- IEP is intended to be somewhat conservative
- IEP is an attribute based procedure where identified CSWs are penalised and the penalties are accumulated