Background to Earthquake Prone Building Classification

Notes of a talk by H. Adam to Hutt City Council Building Control Officers
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1. Buildings in General

When the English settlers first arrived in the 1840's they found New Zealand covered in bush, so timber became the material of choice with which to build. They also brought with them their masonry skills so, over time, brickwork buildings also started to appear.

During the following decades to about 1900, the choice of material chopped and changed. Following major fires in wooden buildings, brickwork became fashionable. Following earthquakes, people went back to timber structures which moved about but didn't tend to collapse in earthquakes.

From the 1900's onwards, cast iron, then structural steel, allowed spans to get bigger so more openness inside buildings came about. In the 1920's concrete started making an appearance as a building material, though not always containing reinforcing. Then in 1931, the Napier earthquake brought home the necessity to design for horizontal earthquake imposed loads upon buildings. From then onwards, reinforced concrete became the main structural building material for commercial type buildings. Structural steel was also used but as it had to be imported, riveted at joints (later welding replaced riveting), it was not so readily available or always economical to use.

2. Seismic Design in New Zealand

Thus, the history of seismic design in New Zealand begins in 1931 following the Napier Earthquake. The first formal design code was NZSS 95, first published in 1935, followed by the NZSS 1900 series code of 1965. The current modern design code is NZS 4203, first published in 1976, updated in 1984 and revised in 1992. It is shortly to be superseded by NZS 1170:2004.

During the period spanned by these codes, the design method and the philosophy upon which the codes were based also changed, meaning a straightforward strength coefficient comparison of structures built to the various codes is not possible. While most structures designed before the publication of the 1976 code have been designed to levels of strength similar to those given in the 1976 code, they typically do not have either the level of ductility or the appropriate hierarchy of failure required by the 1976 code or current design standards. Modification factors must therefore be introduced in order to compare structures designed to the various different codes with one another and finally to the current code.

3. Legislative History

In the 1960's, the Lower Hutt City Council tried to have a building in Lower High Street condemned due to its poor state and "Earthquake risk nature". However, the owners objected. I understand the case went to Court and Council lost because there was no piece of Legislation that allowed Council to condemn the building. This prompted a Law change.

The first piece of Legislation allowing condemnation of buildings as earthquake risks was the Municipal Corporations Act of 1968 which only related to unreinforced masonry or unreinforced concrete buildings. It set the classification trigger level at 50% of the 1965 Code – the code current at that time.

Subsequent legislation (Local Government Act 1974, and the Building Act 1991) didn't change anything. The 1965 Code is now some 40+ years out of date. We currently know a great deal more about how to design for earthquakes and how earthquakes affect buildings than we did in 1965. Hence the Building Act 2004 revised both the assessment trigger level and the buildings covered by Earthquake Prone Legislation (previously Earthquake Risk – now Earthquake Prone).

Earthquake prone buildings are defined as buildings which, having regard to their condition and to the ground on which they are built, and because of their construction, will

a) have their ultimate capacity exceeded in a 'moderate' earthquake and
b) would be likely to collapse causing
    (i) injury or death to persons in the building or to persons on any other property; or
    (ii) damage to any other property.

A 'moderate' earthquake has been defined in the 2005 regulations as *"an earthquake that would generate shaking at the site of the building that is of the same duration as, but that is **one third** as strong as, the earthquake shaking….that would be used to design a new building at that site"*.

To further assist assessors, the Department of Building and Housing (DHB) contracted the New Zealand Society of Earthquake Engineers (NZSEE) to prepare a relatively simple, straightforward and quick assessment procedure for the initial evaluation of the older building stock to be reviewed in the assessment. The NZSEE method has been used in compiling the HCC list of EQ Prone buildings. However, some comment upon the method is warranted.

4. The NZSEE Method

The NZSEE method attempts to put the various design codes on a level playing field, but it has its limitations/drawbacks as it covers the full spectrum of structures (from single storey to multistorey) built to the various codes and for the different soil types encountered throughout the country. This is done using a reduction coefficient with further modifications for structural shape, size, regularity, etc. The end result is a method which can be used by all Councils throughout the country. However, as mentioned, the method has its limitations and its anomalies, one of which results in all short period structures (of 4 storeys or higher) on soft soil sites (such as those on the Hutt Valley floor) designed prior to the 1965 code failing the earthquake prone building test, irrespective of how well they were designed or built. Many 2 and 3 storey buildings of the same era also fail the initial assessment, leading to the classification of most pre-1965 buildings as Earthquake prone.

Thus many owners of "reinforced concrete" buildings designed and built prior to 1965 will be surprised to learn that their building is now regarded as a potential earthquake prone building. Many significant older buildings within the city are thus caught in this initial assessment.

However, the NZSEE method is only an initial evaluation method designed to be able to relatively quickly sieve through the whole building stock so as to identify the most likely earthquake prone buildings. It is not intended to be the definitive answer on the issue. Owners do have the opportunity to have their building assessed in more detail in order to determine whether the initial evaluation stands or can be set aside. Thus not all buildings listed in the initial process will need to be strengthened. However, once listed, it then becomes the owner's responsibility to show the building may be removed from the list.

5. General

Previous assessments of earthquake risk buildings under former legislation were restricted to buildings built from unreinforced masonry or unreinforced concrete. Many of the earlier reinforced concrete buildings, whilst suspected of being at risk in an earthquake, could not be classified under the previous legislation. This time they are caught by the legislation and will now require assessing and, most probably, strengthening.

Buildings previously assessed and classified, but not yet strengthened, automatically transfer to the new list. If out of their allocated strengthening timeframe, they have been given a final two years in which to be strengthened (ending 30 June 2008). What will happen then depends upon the Council and how it

enforces its policy. All strengthening of buildings must now be to the Council's adopted strength value of 50% of current code, except for those buildings designated as "historic" on Council's historic buildings list. Historic buildings only need to be strengthened to 34% of current code. All buildings (except already classified buildings) will have a 10 year timeframe (until 31 December 2018) within which the strengthening is to occur.

As with the older brick buildings, most of these buildings were built on comparatively small sites. As such, they comprise solid walls along their boundaries perpendicular to the street, but have open frames parallel to the street. Experience from strengthening the brick buildings means that many of the current crop of earthquake prone buildings will only require strengthening in one direction (namely that parallel to the street), as their solid concrete side walls are likely to have sufficient capacity to resist earthquakes in an elastic manner in the plane of the walls.

The assessment concentrated on buildings of two or more storeys and, where used for residential purposes, contained three or more household units. Single storeyed commercial or industrial buildings generally have a lightweight roof, usually supported on structural steel framing. Thus they do not attract significant seismic loading and were therefore considered to be above the trigger level for classification purposes.

6. Building Consents for Buildings on the Earthquake Prone List

When confronted with a building consent application for a building on the Earthquake Prone List, Council's policy allows for the consent to be rejected unless the strengthening is also undertaken. However, some judgement is needed in these situations. If the consent is for minor work (say a few partition changes, or for plumbing work only), then full strengthening is probably not warranted. If it is for substantial remodelling of most, or large parts, of the building, then strengthening should also be undertaken.

Past experience with the Earthquake risk buildings has shown that most owners do nothing. They wait to be confronted by the Council, or go cap-in-hand back to Council claiming they have 'forgotten' or that they want/need more time. Generally, strengthening by itself is not too costly to undertake. Often the cosmetic renovation costs done following strengthening far exceed the actual strengthening costs.

Wellington City Council have adopted a procedure whereby when the cumulative cost of all building alterations over the last say 10 years equals one third of the capital value of the building, then strengthening must be undertaken irrespective of the value of the present consent. This is to stop owners renovating a building one floor at a time over a number of years then claiming it is now too difficult and costly to disrupt tenants to install a strengthening scheme.

Personally, I would encourage owners to undertake the work sooner, rather than later. This is because codes change (the 'current' code is scheduled to change before the end of this year) and that usually implies an increase in strength for the strengthening scheme. Secondly, costs increase with time, so it will never be as economic as it is right now. Thirdly, the requirements via legislation may also change. Owners who did their work years ago are now left alone while those who have procrastinated are faced with meeting newer, higher level and more expensive requirements.