Risk Issues Discussion Paper following Canterbury Earthquakes

22nd June 2011

This document provides risk perspectives on some of the complex issues raised by the recent earthquakes in Canterbury. This document is not intended for public release but is more of a discussion backgrounder for those particularly involved with the evaluation and management of seismic risk for commercial buildings.

Operating in the absence of clearly articulated recovery objectives

In life there are very few risk free options, and decisions are often needed over which course of action to take, when all of the options available have undesirable risks associated with them. It is relatively easy to make these sorts of decisions when you are comparing apples with apples (i.e. both options have life safety risks, and therefore it is simply a matter of selecting the option with the *least* life safety risk). Unfortunately the real world is never that simple and there are often many types of risk associated with any particular course of action (life safety, financial, social, reputational risk etc). So all of a sudden the choice is between different types of risk and in different proportions. The problem is that different stakeholders will want to weight different types of risk differently. An example of this type of conflict could be seen in the growing discontent (prior to the June 13th earthquakes!) over the cordons. The explanations over why the cordons needed to remain in place focused predominantly on the life safety risks for anyone entering the cordon, while the letters to the editor predominantly focused on the social (emotional recovery) and economic risks of the continued closure of the CBD area. Unfortunately the discussion hasn't really matured (at least in the public arena) about how we might make decisions that balance these risks. Talking with people such as David Elms about how we might overcome this impasse, the missing piece seems to be a clearly articulated set of recovery objectives.

All of risk management is premised around having a clear set of objectives for what it is you want to achieve - the new ISO definition of risk is "the effect of uncertainty on objectives". The very first step in the risk management process is called "establishing the context" which is all about understanding those objectives and the risk landscape that impact their potential achievement, which types of risks and whose risks, and from which perspectives are to be considered in the assessment, and what criteria are therefore appropriate for evaluating 'risk acceptability'.

Ever since the Sept earthquake, the research community have been promoting in Recovery Best Practice seminars held for various key decision makers the importance of clearly articulating a vision and objectives for this recovery (i.e. what it is exactly that we are trying to achieve). Unfortunately these have still not been articulated anywhere and this is starting to hamper effort to effectively manage recovery risks in a holistic and balanced way. It is important to keep pushing for CERA and CCC to spend time developing and articulating the recovery objectives that we are trying to achieve.

Confusion over what a green tag represents

We still have a perception problem in that many building owners, tenants and the public in general don't have a good understanding of what a green tag does and does not mean. There is lots of information on website etc clarifying this, but the bottom line is that if you went and asked a random member of the public they would most likely be under the impression that if a building has a green sticker then it is good to reoccupy.

Following the Feb earthquake there was a lot of discussion about the fact that green stickered buildings subsequently collapsed and some explanation about what the green sticker meant, but this discussion was pretty much suspended with the announcement of the Royal Commission - the discussion will no doubt increase again once the public part of the Commission is underway.

In the meantime we have a lot of work to do to get both building owners and the general public to understand that the green sticker on its own does not imply a building is safe enough to reoccupy – until people get this, it will be a hard sell to get them to undertake Detailed Engineering Evaluations. An ongoing comms effort is needed - not just for building owners but also for the general public around this.

The Feb earthquake made a dent in the credibility of the engineering community with several unexpected (unexpected from the Public's perspective) building collapses. If, before we get this issue resolved, we have another major earthquake that results in 'green tagged' buildings collapsing, then the structural engineering profession, CERA and the Council could well have a major problem on their hands in terms of credibility.

Will changes to the building code fix the problem?

Whilst following a major disaster such as we have just experienced, there is often a call to improve the building code and processes to make sure that 'this doesn't happen again' it is really important that we take a good hard look at whether the changes currently proposed will actually be effective in managing the main sources of risk exposed during the September and February earthquakes.

Simplifying here, but there were three main issues raised by these two big earthquakes:

1. **A legacy risk issue** –whereby many of our older building were much lower strength than required by the building code for new buildings, and little real momentum (pre-earthquake) for strengthening these buildings.
2. **A resilience issue** – whereby some buildings had critical structural weaknesses, such that once their strength was exceeded (demand vs. capacity) they failed in a catastrophic way.
3. **Adequacy of the Design Earthquake** – the Feb earthquake in particular raised questions over whether the design earthquake for the Canterbury region was adequate, but also raises more fundamental questions as to whether our base assumptions in the code of a 10% chance in 50 years that buildings may be pushed to their Ultimate Limit State is really optimal given the social and economic consequences of widespread damage.

Dealing with each of these in turn:

As a society we do tend to deal with legacy/existing risk issues differently to how we would deal with new risks. This discontinuity in risk acceptability is reflected within our building code regulations, where we will tolerate an older building having much lower strength than we will allow newer buildings to be built to. The Canterbury earthquakes exposed our vulnerability to legacy risk issues – whilst there were some issues with newer buildings, the vast majority of problems occurred in buildings not built to the latest building codes. Whilst increasing the z factor for the Canterbury region will go some way to addressing the legacy risk issue (in that more buildings will fall into the category of Earthquake Prone), it will not address all the issues for buildings that are between 33%NBS and 66%NBS, and there is also the issue of timeframes given to building owners to strengthen buildings. In Christchurch this issue is being fast -tracked by requiring strengthening for any building needing a Consent to repair, but this risk issue goes far beyond Christchurch. A question needs to be asked nationally on what timeframes are acceptable for bringing buildings up to a minimum level.

The resilience issue relates to how a building performs once it is pushed past its Ultimate Limit State; what its failure mechanisms are and whether it would maintain its life safety objective in a maximum credible event scenario. There is more discussion provided on the MCE and its implications below, suffice to say here that although design for the MCE is implied in the codes, there does not appear to be an explicit stage in the design process whereby the building performance is evaluated against a maximum credible event scenario. The proposed Detailed Evaluation Procedure seeks to address this issue by requiring an evaluation of Critical Structural Weaknesses, but for the rest of the country this still remains a gap in the Design Code and engineering practice.

The Design Earthquake in the loading code equates to shaking with a 10% chance of occurring over a 50 year design life for a building. Further discussion is given below on how well building owners and the public in general understand what this means in practice. This means that a building, if designed to meet the code (with no fat in the system), should be at or very close to its Ultimate Limit State at the design shaking. At the Ultimate Limit State the building should maintain its life safety objective (i.e. it should not collapse or fail in other catastrophic ways), but may be damaged and in some cases could be an economic write-off. From an economic perspective there probably needs to be a debate (involving Treasury etc) as to whether this is optimal. This debate has no doubt been had previously during code development, but may be worth reviewing now that it is real to people that damaging earthquakes actually can happen...

At some point we also need to step back and review what changes are proposed to the Building Code, Council Earthquake Prone Buildings Policy, and the seismic loadings for Canterbury) and use this as a lens to ask the question: *"if these policies had have been applied in Christchurch 15 years ago, how would that have changed the outcome of the events of Feb 22nd? Would we have prevented many of the problems that we see today, or are we just tackling the easy bits of the risk to manage and not really getting to the core of it?"* I don't have a feel for how our current responses would measure up against this kind of analysis – but do think it is a really important question to be asking.

What does the MCE mean?

It would be fair to say that the Building Code is fairly difficult to understand for non-engineers, but from my discussions with lots of people about the severity of the Feb 22nd earthquake and how it marries up against the design and MCE earthquakes, there is also not a coherent picture emerging from the engineering community. From a non practicing engineer's perspective these are a couple of issues that I have struggled to make sense of:

- People talk about the MCE – but where is the MCE actually referred to in the Building Code? I have hunted and asked a few people, but the actual reference seems elusive. Given the debates even amongst engineers as to what MCE stands for (is it Maximum Credible Event, Maximum Considered Event or something else?) it seems that its location cannot have a particularly prominent position in the codes. For such an important concept this seems a bit strange.
- When talking with engineers about the use of the MCE in design, people generally talk about it being criteria such that the building maintains its life-safety objective even in an MCE event. However during the design process there aren't any actual checks done to confirm that the building actually will maintain its life-safety objective in an MCE event – we use a Design earthquake and other criteria, and then it is assumed to be implicit in the code that the MCE criteria are also met. Again, for such an important concept this seems a bit odd.
- There is general confusion over what MCE actually stands for. Many engineers think that the MCE represents the most severe potential shaking that the site might be exposed to. Others refer to it being the 1 in 2500 year event. From a seismologist's perspective, my understanding is that the MCE is the <u>largest</u> credible earthquake that may affect a region. In Canterbury the fault that can generate the largest earthquakes is the Alpine Fault and so the Alpine Fault dominates our MCE. However at a particular location, the most severe shaking may actually come from a much smaller earthquake that is located much closer. This point is illustrated by the fact that the Feb 22nd earthquake exceeded the MCE in many ways, but even with this knowledge, there is no modification planned to the MCE assumed for the Canterbury region as our largest credible earthquake (as opposed to shaking) remains the Alpine Fault.
- Many people when you talk with them will describe the design earthquake as a 1 in 500 year event (or to be more technically correct a 10% chance of occurring in a 50 year period) and the MCE to be the 1 in 2500 year event (or 2% chance of occurring in a 50 year period). However, this doesn't seem to translate when you consider that Canterbury's MCE is dominated by the Alpine Fault which has an annual probability of approx 0.5% each year (i.e. a 1 in 200 year event).

Who decides what is Acceptable Risk

Risk acceptability is significantly influenced by context and different stakeholders will have different criteria against which they are evaluating the acceptability of particular risks. Risk assessment is only

one piece in the risk management puzzle; the art of risk management comes in evaluating whether that level of risk is acceptable or not and what can be done about it if isn't deemed acceptable. Whilst there are precedents out there for determining thresholds for acceptable/tolerable/unacceptable risk – it is important to note that these cannot always be translated into a different community context or applied to risks of a different nature for which they were developed. I guess what I am saying is the obvious – that making decisions on the acceptability of complex risks is not easy; there are basic principles that apply, but there are also many exceptions to these. The most important trap to avoid is one where it is left to 'experts' (e.g. the engineers) to decide what is acceptable or not - a far richer discussion needs to take place involving the full spectrum of stakeholders for the decisions made to be widely accepted and enduring.

Risk for those at the front line

A big issue for the engineering and construction communities at this time is the safety of their staff who are inevitably going into buildings that are less than ideal to evaluate their safety.

From a risk management perspective there are clear precedents for it to be more acceptable for people with a greater knowledge and understanding of the risk to be exposed to higher levels of that risk, than say the general public. The basis being that their greater knowledge and understanding allows them to personally evaluate the level of risk to which they are exposed to (more individual control) and also to decide for themselves if the building is too dangerous to enter (voluntary exposure to the risk).

This is all well and good though until there is our first fatality of an engineer or construction worker, in which case a Department of Labour investigation will inevitably be launched and all that that entails. The big firms will no doubt be doing things right, ensuring regular safety briefings, dotting the i's and crossing the t's in terms of explaining (and documenting) safety procedures, but there may well be smaller firms that don't have this covered off so well. Some advice put out to the industry (through IPENZ and similar industry groups) would probably be useful to let people know what they should be doing at a minimum to ensure the safety of staff and to cover off any DoL requirements in these unusual times.

Individual vs. Societal Risks

An aspect of risk theory that it is probably worth talking about as it is bound to come to the fore is the difference between individual risk and societal risk. Individual risk is the risk to an individual taking part in an activity. Societal risk is the risk to the broader population of that activity taking place. There are some risks that can be unacceptable from an individual risk perspective, but acceptable from a societal risk perspective and vice versa. There are also quite different risk acceptability criteria that apply to each.

To give an example, mountaineering has a very high risk to the individual doing the mountain climbing, but for society is a very low risk because so few people take part. Contrast that to pandemic influenza, which is a relatively low risk to any one individual, but a very high risk to society

just because of the proportion of people exposed. You can see conflicts of individual vs societal risks coming through in our situation when people want to enter dangerous buildings to retrieve important documents/belongings. The rationale they are using is that they will only be in the building for a very short period of time and so the life-safety risks, while real, are relatively small compared to the economic risks of not retrieving the items. Looking at this problem from society's viewpoint however gives quite a different perspective. You let one person in and you would need to let several people in. So if/when an aftershock occurs it would most likely not be one but many people in dangerous buildings at the time and therefore the risk starts looking less appetizing.

This issue also starts coming to the fore when evaluating the risk to individual buildings vs. the whole of the city's building stock, and also when considering the adequacy of the code from the perspective of one city/community vs. to the nation as a whole. To just illustrate this last point, we set our design earthquake at the 10% chance of occurring in 50 years – for that region. However if you looked at the risk for NZ as a whole, we have many different regions subject to earthquake risk, and therefore the chances of a design level earthquake occurring *somewhere* in New Zealand over the next 50 years is going to be much larger than 10% (but then the risk is tempered by the odds that the earthquake could be centred well away from a populated area...).

So that is a description of the problem – the way to resolve it is to make sure that you think very carefully about the perspective from which you are assessing and evaluating risks, and where there are multiple perspectives that are relevant, make sure that the risk is assessed and evaluated for each of these perspectives before judging if it is acceptable/tolerable/unacceptable. You may also find that teasing the issues out in this way also opens up new ideas for how you might manage/reduce the risk.

Balance in Code focus

An issue particularly brought to the fore by the recent earthquakes is that while we have codes etc relating to a building's structural design; there are no comparable geotechnical codes. Similarly, while the building codes focus on structural performance, a lot of the damage, downtime and lives lost during the Canterbury earthquakes were due to poor performance of non-structural elements of buildings. As David Elms points out, these gaps potentially create an imbalance in our design focus as well as limiting our ability to influence the risk profile for New Zealand communities.

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