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Paper No. 1264. (quote when citing this article)
Eleventh World Conference on Earthquake Engineering
ISBN: 0 08 042822 3

Earthquake Risk Reduction for a Major New Zealand Corporation

David C Hopkins and Winston D C Clark

Buildings Division, Kingston Morrison Limited
Architects Engineers Planners Scientists
PO Box 10-238 Wellington New Zealand

ABSTRACT

A large corporation occupies over 200 premises throughout New Zealand. These are of various sizes, ages and designs. Some are owned and others are leased. In conjunction with a major refurbishment programme the corporation implemented comprehensive seismic evaluation and risk reduction measures. These included:

- initial appraisal of selected premises,
- a review of all properties for structural integrity,
- broad estimation of the costs of risk reduction measures,
- prioritisation of recommended actions,
- strengthening of several unreinforced masonry buildings,
- development of a comprehensive and detailed Generic Specification covering the securing of ceilings, partitions, glazing, office equipment, computers, furniture and building services,
- implementation of securing measures in over 200 premises.

The diversity of the work together with the tight timeframe and strict budget constraints provided significant challenges both technically and in project management. This paper describes the work and points to some of the lessons for others undertaking similar work.

KEYWORDS

Earthquake; Risk; Buildings; Strengthening; Non-Structural Elements; New Zealand; MPL; Insurance; Securing; Appraisal; Project Management; Implementation.

1. INTRODUCTION

This paper describes earthquake risk mitigation measures carried out by a major nationwide corporation with premises of various sizes throughout New Zealand (refer Figure 1). The measures were taken as part of a company wide risk reduction programme which was designed to provide a safer environment for their employees and to reduce exposure to business interruption due to all types of hazard.

Particular driving forces in the New Zealand context have been recent legislative changes putting more responsibility on employers for the health and safety of building occupants and the withdrawal of the Government-backed Earthquake Commission from coverage of commercial losses. They now cover only residential claims and this has resulted in commercial organisations paying far more attention to their earthquake risks.

The earthquake risk reduction programme of this corporation was implemented simultaneously with a major refurbishment programme for all premises designed to enhance and unify its image.

Kingston Morrison were engaged initially to carry out a preliminary assessment of some typical properties in relation to non-structural aspects. This was extended to cover all premises and to encompass a brief appraisal of each building's structural condition. Recommended measures were costed and prioritised and the major items have now been dealt with, as described below. The limited time and budget for implementation of these measures brought a number of challenges which are the focus of this paper.

2. INITIAL APPRAISAL

The programme started with an appraisal of selected premises in Wellington in order to gauge the nature and extent of work likely to be needed. These inspections were used to identify generic issues which were likely to occur in many if not all premises.

A comprehensive list of these issues was drawn up and typical mitigation measures identified. These were then costed. Prioritisation was based on an analysis of the cost benefit of the measures in reducing the risk. A score between 1 and 10 was assigned to each of : a) Importance of the item; b) Risk of failure; c) Effect of failure on operations; and d) Disruption likely to result. These factors were combined to determine a priority index as a measure of order of implementation.

Two factors were allowed to override the priority index - life safety and regulatory compliance. Where a significant threat to life existed or regulatory requirements were not currently met, measures required were accorded top priority.

An extract from the table of items and measures is reproduced as Table 1 and shows a typical range of items and calculation of priority index and cost effectiveness, CE. This table was used to produce a rough estimate of the cost of implementation in all premises, even though only a small fraction of the total had been inspected.

3. NATIONWIDE SURVEY

The large assessed cost of implementation raised the question of the wisdom of carrying out this work without inspecting all premises and, in particular, making a brief assessment of the structural condition of the properties. If considerable structural strengthening was required, this would alter the perspective. The corporation had three options: a) Dispose of the property and obtain alternative premises; b) Carry out strengthening work first; c) Proceed with the securing of non-structural items as identified.

A very brief assessment was carried out of all but the most remote and insignificant premises, largely focused on overall structural integrity, but also designed to record information on the likely non-structural issues. Key features affecting seismic performance of the buildings were recorded and summarised in tabular form. Type of construction, age, condition, structural concepts and, in a few cases, details were assessed in grading each building:

- Good - expected to perform well and maintain integrity
- Average - expected to perform satisfactorily, with an acceptably low chance of major damage or collapse
- Poor - expected to perform poorly, with an unacceptably high chance of major damage or collapse

An extract from the table presented is shown in Table 2.

4. STRENGTHENING OF BUILDINGS

Following the nationwide survey, an assessment was made of the cost of strengthening each of the 20 buildings designated as "poor". This was done initially on the basis of the broad inspection, but later refined to reflect a more detailed inspection and a specific report on recommended strengthening measures.

The client made a decision whether or not to proceed, and if so , the estimated costs became a not-to-be-exceeded budget . Work on these properties was commissioned on a property by property basis and, as far as possible, timed to suit the overall refurbishment programme.

Typical measures used for strengthening these mainly 2 and 3-storey unreinforced masonry buildings included tying of floors to walls, introduction of alternative means of vertical support and incorporation of steel bracing elements or concrete sprayed shear walls.

5. IMPLEMENTATION OF STRENGTHENING TO NON- STRUCTURAL ELEMENTS

5.1 Generic Specification

A major component of the implementation of the programme of improving the performance of non-structural items was the development of a Generic Specification. This drew on the experience of the consultants and covered all aspects identified in the initial and subsequent inspections. These included:

- Bracing of suspended ceiling systems and securing of tiles, light fittings
- Separation of sprinkler systems from ceiling systems
- Securing of shelves, filing cabinets, safes, cash trolleys and computer network hardware
- Securing of critical personal computers
- Separation of general glazing systems from adjacent structural elements
- Separation of automatic teller machines from shopfront glazing
- Separation of shopfront glazing from surrounding structure
- Bracing of internal partitions, and their separation from suspended ceilings
- Restraint of lift machinery, HVAC equipment and standby power generators
- Securing of loose items such as fridges, stoves, vending machines, especially when these were close to an egress way.

Emphasis was on practical solutions using readily available materials. Solutions had to be capable of adaptation to a wide variety of circumstances in locations throughout the country. A minimum of supervision of the implementation was assumed because of the high cost. Background reasons for the measures were included. The whole format of the document was designed so that each section could be extracted and reassembled to form a specification for a particular premises or group of premises.

In deriving suitable details, some reference was made to a recent New Zealand Standard, NZS 4104:1994, Seismic Restraint of Building Contents. This code was produced in response to growing concerns about the safety and damage losses due to failure to properly secure building contents. It was produced by a committee comprising representatives from consultants, chambers of commerce, retail and wholesale merchants, local government organisations, emergency management, and workplace safety. The second author was a member of the committee.

5.2 Application to Premises Nationwide

The application of the Generic Specification to premises nationwide proved a challenging exercise both technically and management-wise. Firstly, it was important that technical criteria were consistently met and that the aesthetic quality of solutions was unobtrusive and consistent throughout the country. Secondly, a fixed budget amount was available covering both the implementation and fees for design, project management and inspections.

The programme for all 200 plus properties was implemented in a space of four months which included time of preparation of contract documents, calling tenders and physical construction. Such a timetable put considerable demands on consultant and corporation staff, especially since the budget for the whole programme was set on the basis of the initial inspections only. A pilot programme of implementation was initially envisaged to better establish likely costings, and to identify any teething problems and reaction from occupants.

Competitive tendering was achieved by splitting the country into six zones and performing the work in two series of contracts. Each contract comprised around 10 premises. Typical contract lengths were 3 to 10 days which called for detailed programming. As work proceeded, contract progress, quality and costings had to be monitored and reported on. Special seminars were held firstly for consultant representatives and then for contractors to emphasise the importance of quality and consistency.

Special efforts were taken to ensure that the projections of cost did not exceed the allocated budget. This required close monitoring of the scope at each premises and the agreed costings so that adverse trends could be picked up early. Measures were broadly prioritised to enable quick decisions to be made to adjust the scope of work.

A significant issue to emerge was the wide variety of situations for securing some loose items such as safes, cash trolleys etc. This frequently led to apparent inconsistencies due to the differing approaches of the six contractors.

Overall, the programme was successfully accomplished within the specified time, and to the satisfaction of the corporation as owners/managers of the properties. Earthquake performance of the non-structural elements is expected to be considerably improved.

6. ONGOING PROGRAMME

The nationwide securing programme and the strengthening of selected buildings has addressed most of the major issues identified for action. In the initial appraisal, items were categorised into A, B or C depending on priority. Category C items remain to be done, being either expensive or of low cost effectiveness. They are relatively minor and the corporation intends to include a few in its budget each year and review the relative urgency of each on the basis of more detailed investigation.

One major issue unresolved is the possible reglazing of a 17 storey head office building, a particularly costly item. The risk perceived is that the glass is not adequately separated from the concrete moment-frame structure. There are plans to look more closely at the capability of the glass to absorb structural movement and compare it with calculated interstorey drifts of the building. It is hoped to gain a better appreciation of the risk of failure and thus cost effectiveness. Past experience suggests that unless window separation details are particularly intolerant of movement, implementation of this measure is unlikely to be cost effective.

Other items include the influence of an access ramp to a carpark on the overall performance of an 8 storey building, and the influence of non-separated blockwork on a 17 storey building. These were earmarked for urgent action on the basis of the original inspections. However, recent closer investigations showed that the adverse influence had been accounted for in the design details, meaning that no further action was necessary.

7. MAXIMUM PROBABLE LOSS ASSESSMENT FOR INSURANCE

Over the last three years in New Zealand, there have been dramatic changes in the earthquake insurance market. Not only has the Earthquake Commission withdrawn from covering commercial properties, but the insurers and re-insurers are less willing to take on earthquake insurance as a result of recent natural catastrophes worldwide. On top of this, New Zealand market has seen the divestment of what were previously self-insured government-held assets to private enterprise or to autonomous local or national government corporations. The effect of this has been to swell the market for commercial earthquake insurance even further.

In this overall climate it is not surprising that earthquake insurance is becoming more expensive, particularly for properties which are not expected to perform well. Considerable interest has been taken in risk assessment in the past few years and the client corporation is no exception. Faced with rising premiums and a more critical appraisal of their building portfolio by brokers they have found it beneficial to have professional assessments made of the Maximum Probable Loss (MPL) of their portfolio. This includes buildings owned by them, fit-out work of all premises and contents.

The client corporation was provided with an authoritative assessment of likely loss and a comment on the benefits of the strengthening and securing measures undertaken. These included reduction in physical loss, increased safety and reduced business interruption.

8. CONCLUSIONS AND LESSONS LEARNT

The range of different issues dealt with in this project provide some useful pointers to others contemplating similar measures. These include:

- There is value in viewing the problems globally to start with and addressing issues in increasing detail as more about them is learned and priorities become clearer.
- Worthwhile cost-effective measures were identified and implemented, reducing business interruption exposure, increasing life safety, and raising awareness of earthquake risk among all staff.
- Implementation of measures requires practical application of general principles. Solutions must be adaptable, simple and acceptable to users.
- The aesthetics of proposed solutions require especially careful consideration, in design and in construction phases.
- Consistency of application was paramount in this case - and would be in any case where corporate identity over a wide area is needed.
- Work must be carefully programmed and communication with affected parties must be top notch to minimise negative feedback and unnecessary disruption.
- For work of this nature, pilot programmes are a worthwhile method of identifying teething problems and dealing with them before the main implementation programme.

Acknowledgement

The permission of the Client to publish this paper is gratefully acknowledged. The implementation of the work was a team effort between the client's project managers and Kingston Morrison. Particular thanks are due to Andrew Duncan, John Baldwin and Con Saltos who developed an understanding of the seismic requirements and helped us understand the practical imperatives of this corporate operation.

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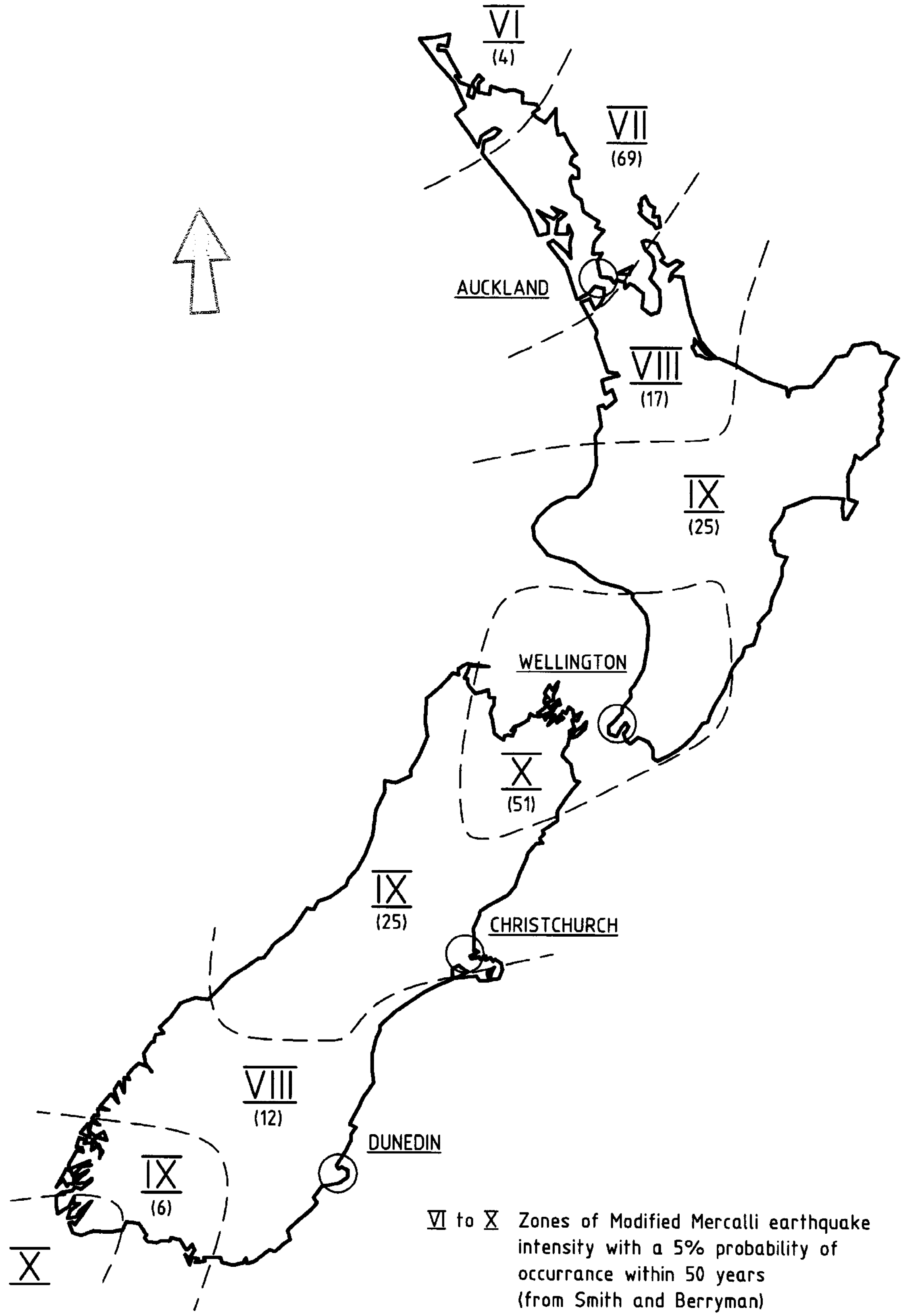
Table 1

Item	Description	Level	Effect	Consequences of Failure	Risk Factors				PI	Estimated Cost	CE
					I	R	E	D			
1.04	Ceiling tiles & light fittings in circulation/public areas	All	2,3,4	Hazardous to personnel, obstruct egress route	2	8	2	8		12,000	
1.05	Filing cabinets, shelves, wardrobes, drawer units	All	1,2,3	Damage to equipment if fall, hazardous to personnel, obstruction to egress	8	7	5	8		6,000	
1.07	Uplighting fittings unrestrained	3&4	2,3	Loss of lighting, hazard to personnel	2	9	2	8		1,000	
1.08	Glazing on critical floors	5 floors	2,3,4	Loss of weatherproofing, hazardous to personnel & public	8	8	5	10	320	130,000	0
1.09	Glazing on non-critical floors	10 floors	3,4	Hazardous to personnel & public	2	8	2	10	32	260,000	0
1.10	Partitions, full height glass	Most	3	Hazardous to personnel	5	8	2	6	48	45,000	0
1.11	LAN system control	6	1	Loss of computing capability	10	10	10	10	1,000	1,000	100
1.12	LAN system & cabinets unrestrained	All	1	Loss of network	10	10	10	8	800	2,250	36

Table 2

Building	Location	Est. Constr. Date	No. of Storeys	Structure	Seismic Performance	Comments
Bldg 1	Dannevirke	pre 1935	2	Unreinforced masonry	Poor	More recent extension at the rear. Horizontal eccentricity.
Bldg 2	Marton	pre 1935	2	Unreinforced masonry	Poor	Significant damage.
Bldg 3	Bulls	1935-65	1	Timber	Average	Timber framed building, should perform reasonably well.
Bldg 4	Feilding	1965-76	1	Concrete or masonry shear wall	Average	
Bldg 5	Palmerston North	1935-65	3	Concrete shear wall	Average	
Bldg 6	Palmerston North	1965-76	3	Concrete shear wall	Average	
Bldg 7	Linton Army Camp	1965-76	1	Timber	Good	
Bldg 8	Carterton	pre 1935	1	Concrete	Average	
Bldg 9	Foxton	1935-65	1	Masonry & concrete	Average	No seismic gap on one side.
Bldg 10	Levin	1965-76	2	RC frame/RC shear wall	Average	No seismic gap to adjacent building.
Bldg 11	Wellington	post 1976	7	RC frame	Good	Carpark ramp causes eccentricity at 1st floor. Performance good if ramp is separated from the frame.
Bldg 12	Wellington	post 1976	1	RC concrete, masonry shear wall	Good	Some horizontal eccentricity, potential damage from falling masonry from adjacent building.



VI to X Zones of Modified Mercalli earthquake intensity with a 5% probability of occurrance within 50 years (from Smith and Berryman)

(4) Number of Corporate premises within zone

FIGURE 1

DISTRIBUTION OF CORPORATE PREMISES THROUGH NEW ZEALAND