Reducing the Impact of Earthquakes
Key Issues for Pacific Island Countries

1. Introduction

This paper outlines some of the key issues currently facing New Zealand in the area of earthquake risk and mitigation, and draws on the authors recent experience in the Philippines Earthquake Reconstruction Project. It identifies practical issues likely to be of interest to those responsible for earthquake mitigation in Pacific Island countries.

The issues raised and ideas put forward are very much in the nature of items for discussion.

2. The New Zealand Scene

Consideration of earthquakes has been a feature of building codes since the 1931 Hawkes Bay earthquake which killed over 250 people. Codes for buildings and other structures have developed progressively over the years with increasing sophistication reflecting the increased knowledge of seismic risk and structural and material behaviour.

Over the last four or five years interest in the subject has heightened and broadened significantly. This has been brought about by fundamental changes to the New Zealand economy, the New Zealand insurance market and the world wide insurance market.

Many Government departments are now state-owned enterprises and assets which were previously self insured by the Government must now be managed in a business-like fashion by each separate enterprise.
In addition, the Government is progressively withdrawing from earthquake insurance of commercial property. This has meant that organisations must seek insurance from private insurance companies. These companies are finding the world wide situation difficult and are being selective in taking on extra risks in New Zealand. *Premiums are now reflecting the relative seismicity of the region and the condition of the building for facility.* Many owners in high seismicity areas are having difficulty in obtaining satisfactory insurance.

A further factor is that engineering lifelines (water, gas, electricity, telecommunications etc.) are now run by separate business enterprises. This has resulted in greater attention to the performance of these facilities in earthquake.

In summary, earthquake engineering in New Zealand has shifted in emphasis from a largely building and structural dominance to include:

- engineering lifelines
- damage assessment
- planned mitigation of earthquake effects (structural, non-structural and organisational)
- business interruption effects
- disaster recovery or business continuance plans.
- social impact and preparedness
- overall impact on New Zealand's economy.

This reflects a much wider concern of the impacts of earthquakes on the community and work now being done in a number of areas by professional, Government and commercial organisations will, in time, reduce the overall impact of earthquake in New Zealand.

### 3. Philippines Earthquake of July 1991

This was a very large earthquake (magnitude 7.8) which affected a large area of Central Luzon. Buildings and facilities in the Philippines range from highly sophisticated multi-storey hotels and office buildings for multi-national clients to simple structures in rural areas.

Knowledge of the country's seismicity and the establishment of a strong motion instrument network is almost non-existent and in strong contrast with the enormous sophistication and available information on Californian earthquakes.

- The author was involved firstly as leader of a reconnaissance visit to the Philippines immediately after the earthquake. He later spent 14 months as a technical advisor on buildings and bridges for the US$400 million Earthquake Reconstruction Project which was funded through loans from the Asian Development Bank and World Bank.

Considerable technical and organisational challenges had to be faced in the implementation of this project.
Although the codes of practice used in the Philippines were found to be satisfactory, the consistency of application of the codes in design and the follow up in implementation during construction left much room for improvement. Limited financial resources and cultural limitations were at the root of these difficulties.

Assistance given to local engineers had thus to be tailored to match the experience and expectation of the engineering community.

This meant concentrating on fundamental issues, and adhering to a few simple rules without being overawed by the growing sophistication of codes of practice in other countries.

Issues focussed on included:

- proper timing and use of foundation investigations
- suitable siting of facilities to avoid hazardous locations
- employment of sound structural concepts
- detailing of structures to provide a simple and viable load
- proper consideration of non-structural elements and their possible effect on structural performance
- a focus on the critical elements in the design, construction and supervision process.

Towards the end of the author’s time in the Philippines, a workshop was held amongst Planners, Government Representatives, Engineers and Seismologists. The main objective was to establish ways of reducing the impact of earthquakes in the Philippines.

Among the recommendations made were:

- ensure that standard designs for schools, public buildings and hospitals are updated to latest seismic standards. Ensure that they are made known to all those in authority throughout the country.
- improve education and training of engineers
- improve the awareness of earthquakes and their potential for damage amongst architects
- improve discipline in recording salient features of designs
- pay attention to key points in the planning, design and construction phases as indicated in the attached summary sheet.
- conduct research into local materials and types of construction

Attached copies of overheads used put these in more direct language. They are issues which apply in varying degrees to all seismic prone countries.
4. Pacific Island Context

Earthquake engineering in USA, Japan, New Zealand, Philippines, Australia and Pacific Island Countries has many common elements in spite of varying resources and sophistication.

It is hoped that some of the issues raised will promote discussion of an appropriate approach for Pacific Island Countries, leading to a plan of action which is in tune with the engineering and social objectives of the countries affected.
<table>
<thead>
<tr>
<th>Component</th>
<th>Planning</th>
<th>Concept</th>
<th>Details</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads</td>
<td>Realignment to avoid known hazards.</td>
<td>Engineered measures for stabilisation.</td>
<td>Careful attention to drainage measures</td>
<td>Achievement of all specification requirements.</td>
</tr>
<tr>
<td>Soil boring tests to determine hazards.</td>
<td>Upgrades drainage standards.</td>
<td></td>
<td></td>
<td>Achievement of effective drainage.</td>
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<tr>
<td>Hydrological studies.</td>
<td></td>
<td>Choice of appropriate pavement types.</td>
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<tr>
<td>Bri#ges</td>
<td>Site selection to minimise exposure to earthquake (and other) risks.</td>
<td>Provision of continuous deck.</td>
<td>Ductile detailing of piles, piers and beams</td>
<td>Flexibility under contract to vary foundations to match conditions.</td>
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<tr>
<td>Soil boring tests to determine appropriate foundations.</td>
<td>Maximum redundancy in pier support system.</td>
<td></td>
<td>Provide details which will achieve continuity and integrity.</td>
<td>Close supervision of key seismic details, especially piles and piers.</td>
</tr>
<tr>
<td>Soil boring tests for two-storeys or more, and for sites with liquefaction potential.</td>
<td>Symmetrical placement of lateral resisting elements.</td>
<td></td>
<td>Detailing of CHB to take load or be separate from structure.</td>
<td>Ensure CHB is fully reinforced with dowels to columns, floor and beams.</td>
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<tr>
<td>Consideration of the positive and negative effects of Concrete Hollow Block (CHB) walls.</td>
<td></td>
<td></td>
<td></td>
<td>Ensure stirrups bent 135° not 90° to anchor in the concrete core.</td>
</tr>
<tr>
<td>Viable and continuous load path from roof down.</td>
<td></td>
<td></td>
<td>Proper anchorage of stirrups in columns and beams.</td>
<td>Ensure roof trusses property secured to concrete columns/beams.</td>
</tr>
<tr>
<td>Ensure lateral systems has sufficient stiffness to prevent CHB taking excessive load.</td>
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</table>
RECOMMENDATION HIGHLIGHTS

A. Land Use Zoning
   - Don't ignore this issue
   - Don’t expect too much too soon

B. Improve Code Compliance
   - Codes are generally OK
   - Best payback is not in code development ......

...... but in BETTER IMPLEMENTATION
C. Better Implementation

a) Design Phase

- Concepts : - Get them right FIRST
- Joint Details : - Pay close attention to them
- Non-Structural : - Beware of their effects
- Drawings : - Show more BIGGER details
- Site preparation : - Prepare full drawings and specification

b) Approval Phase

- Approval Procedures : - Tighten them up
- Approvals : - Keep full records
- Drawings : - Show authorized revisions

c) Construction Phase

- Owners/Consultants : Make effective supervision arrangements
- Contractors : Insist on signed approved drawings
- Owners/Consultants : Build teamwork to produce quality work

d) General

- Technical capability : - It exists. Make full use of it.
D. Review Existing Buildings and Bridges

- Many are in need of strengthening
- Major hospitals, schools and bridges are high priority
- Start now

E. Take Full Account of Site Investigations

- Each site is unique - recognise this
- Define the objectives of the investigations
- Be prepared to react to the results

F. Awareness Raising

- Take every opportunity
- Keep a balanced approach
- Highlight the engineer's role in mitigation

G. On-going Basic Research

- Recognise the need for it
- Support it actively
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Biographical Note

David Hopkins is a consulting civil and structural engineer in Wellington. He is Director of the Buildings Division of Kingston Morrison, a New Zealand based engineering and architectural consultancy active in New Zealand and overseas. He has worked on the design and construction of buildings and infrastructure projects in UK, New Zealand, South East Asia and the Pacific.

As an active member and past President of the NZ National Society for Earthquake Engineering (NZNSEE) he has contributed to design standards for earthquake risk buildings, storage tanks and precast concrete structures.

David was a member of the NZNSEE Reconnaissance Team to Mexico in 1985 and led a team to the Philippines in 1990. During 1991 and 1992 he acted as advisor on Buildings and Bridges for the US$400m Earthquake Reconstruction Project in the Philippines.

He has taken a close interest in earthquake insurance matters since 1986 when, as President of NZNSEE he initiated contact with the Insurance Council of New Zealand to encourage better use of seismological and engineering research data. This has led to his increasing involvement in earthquake damage and vulnerability assessments for a number of property portfolios, industrial premises and lifelines, brought about by recent changes in earthquake insurance.

In 1990 he was Director of the successful Wellington Lifelines in Earthquake Project and was keynote speaker at the 4th US Conference on Lifeline Earthquake Engineering in Los Angeles in 1991. David is a former Council Member of the Institution of Professional Engineer New Zealand (IPENZ), and is it’s representative on the New Zealand IDNDR Committee.