A DECADE OF PROGRESS SINCE THE EDGECUMBE EARTHQUAKE - BUILDINGS

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SUMMARY

Notwithstanding the mixed fortunes of the construction industry over the last decade, there has been progress in the development of improvements in methods of providing seismic resistance in buildings.

The last 10 years has seen developments in the assessment of existing buildings, confirmation of the seismic performance of structural precast concrete, development of new analysis techniques and the greater use of base isolation in specialised situations.

INTRODUCTION

The last 10 years has seen major swings in the fortunes of the building industry. From the building boom of the late 1980s, to the depression in the aftermath of the stockmarket crash and more recently the construction of major projects and some revival in the Auckland commercial sector.

This sequence of events has to a large extent determined the emphasis and direction of progress in the seismic design of buildings over this period.

REGULATORY CHANGES

The last 10 years has seen the passing of the NZ Building Act (1991)[1], the introduction of the NZ Building Code[2], the publishing of NZS 4203:1992[3] and the updating and in some cases rewriting of the materials standards.

Each of these has affected the way in which buildings are designed to resist earthquakes.

Change is showing no signs of slowing down. For example, work has already begun on the formulation of a joint Australian/NZ loadings standard which may bear little resemblance to either the current NZ or Australian standards, especially as far as the seismic provisions are considered. Some may not consider this as progress.

TECHNICAL ADVANCES

The last decade appears to have been one of consolidation rather than one of dramatic change in terms of the way buildings are designed and detailed for earthquakes.

On the analysis side the most notable development has been the work carried out by Priestley[4] and others on the displacement approach to design. This method still requires further development before it can be considered practical for the design office. However, it offers the potential benefit of greater understanding of the seismic performance of buildings where the force based methods of analysis are really a contrivance and do not adequately predict the damage potential of earthquakes.

The research work by Fenwick[5] into the effects of growing plastic hinge lengths is of significant interest to designers of framed buildings with precast floor systems.

It is the author's opinion, however, that finesse in the detailing of buildings will only bear fruit if the fundamentals of good earthquake engineering are observed.

So many buildings under construction today rely on dubious analysis techniques and voluminous standards to *prove* good performance. The proven features of symmetry and reliable load paths still often receive scant attention.

The known weaknesses of our commonly used analysis techniques, especially for multi-storey buildings have still not been addressed. Perhaps this is a task for the next decade.

STRUCTURAL PRECAST CONCRETE

The boom years of the 1980s produced a significant increase in the use of structural precast concrete mainly due to the advantages of quality and speed of construction.

The speed with which the technology was required to develop, in order to meet the immediate requirements of developers and contractors, necessarily resulted in designers extending the experience of cast-in-place concrete to the precast situation.

With so many buildings being produced using precast technology there became growing concern that some of the design solutions being employed should be subjected to further research, and in particular full scale testing, to verify their performance during seismic shaking.

A study group, jointly funded by the National Society for Earthquake Engineering, the NZ Concrete Society and the Centre for Advanced Engineering of the University of Canterbury (CAE) was formed.

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This group's investigation concentrated on areas of concern including:

1. Jointing of precast columns and beams
2. Beam column joints
3. Continuity and support of precast floor slab systems
4. Diaphragms
5. Precast wall systems, and
6. Jointing techniques

The results from this group's deliberations were produced in a CAE publication "Guidelines for the Use of Structural Precast Concrete Buildings"[6]. This document sets out recommendations for the use of precast, gives the summary of overseas experience and provides recommendations for further research. It also identifies the main design issues relating to providing adequate seismic performance. More importantly, however, the investigations of the study group confirmed that the details already employed, should generally provide adequate seismic performance.

This was an important piece of work in establishing the likely seismic performance of a significant proportion of the buildings constructed over the last 10 years.

EXISTING BUILDINGS

Existing buildings have received a significant degree of attention over the last decade and more particularly over the last four years with the publication of drafts for comment for both unreinforced masonry structures and pre-1975 "modern" structures[7], [8].

The introduction of the Building Act in 1991 and the publication of NZS 4203:1992 provided the impetus for the NZ National Society for Earthquake Engineering study group's update of the 1985 Red Book "Recommendations and Guidelines for Classifying, Internal Securing and Strengthening"[9].

There was a perceived need to update this document to make it compatible with NZS 4203:1992 both in terms of the loading required and the limit state format. Other features of the update are the inclusion of the attribute scoring scheme which is tied directly into one of the available loading deviation methods. The attribute scheme which is an extension of that presented in the 1985 Red Book has the primary aim of focusing the user's attention on the fundamental features of the building which are likely to affect its seismic performance. The intention is to divert the focus away from "strengthening" (ie providing more strength), in the first instance, to first addressing the problems of building form and layout. Feedback from users of the draft indicate that they like the approach and that the aims are largely being met.

Foreshadowing a likely revision of section 66 of the Building Act, the Building Industry Authority commissioned the NZNSEE to produce a document setting down the requirements for structural engineers to follow when evaluating and improving the seismic performance of pre-1975 buildings. A draft document[8] has been produced and circulated for comment. Features of this document include:

- Presentation of performance criteria in terms of NZS 4203:1992.

- Presentation of a rapid evaluation scheme which is intended to focus the attention of the user on the salient aspects of the building likely to influence it's performance during earthquake shaking.

- New displacement-based procedures.

When this document is combined with the recommendations for URM a definitive text for dealing with earthquake risk buildings will be available to designers.

SPECIALISED SYSTEMS

The use of specialised forms of earthquake resistance such as base isolation have escalated over the last few years. In Wellington, three buildings have been or are being constructed to site on lead rubber bearings, the new National Museum building (yet to be opened), Wellington Newspapers Ltd Printing Press building[10] and Hutt Valley Health's new operating and emergency building.

Base isolation has also been used as a retrofit measure. The most notable example is the NZ Parliament buildings refurbishment project[11].

Practical systems involving damping devices are also under development.

The new Police Headquarters building in Wellington which incorporates base isolation and lead extrusion dampers is such an example.

Such systems offer the benefit of predictable performance and damage limitation and, with reducing costs, should become the norm for critical and important structures.

BUILDING CONTENTS

Experience in past earthquakes, including the Edgecumbe earthquake, has identified the potential hazard of unrestrained building contents.

The work of Charleson[12] and other members of the Standard's committee leading to the production of NZS 4104:1994[13] should prove invaluable in the mitigation of seismic hazard within buildings.

CONCLUSION

The author has concluded that the last decade has been one of progress as far as the seismic design of buildings is concerned. The mixed fortunes of the building industry over the period have necessarily meant that the impetus for developments for new buildings has not been present in recent years. However, methods for assessing and retrofitting existing buildings have received emphasis and in the area the emphasis on the fundamentals of earthquake resistance bodes well for the future.

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