The new earthquake loading code AS 1170.4

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Introduction

This paper reflects a little on the history of earthquake design codes in Australia and also what the future may hold. Unfortunately the production of Codes of Practice these days takes a long time, as the work is carried out on a volunteer basis by a number of co-opted members. With the financial restraints within all organisations there is a real need for change in this area to perhaps paying a group to prepare a draft or other methods to reduce the time taken. Standards Australia has already recognised this and changes are likely to occur in drafting codes.

Australia can no longer afford to ignore the world outside and as part of the international business community, we must be prepared to work in the international scene. There will be a major shift in codes in the next 20 years as we move towards common world codes.

This paper reviews the background to the current Code AS 2121, and the work of the current Code Sub-Committee in establishing the new Earthquake Loading Code AS 1170.4, which is to be published early in 1993 for Australia.

In 1979, Australia's first Earthquake Code AS 2121 was published. It was as a result of the earthquake at Meckering in Western Australia on 14 October 1968. After the Meckering earthquake, a number of engineers decided Australia needed an Earthquake Code. The Standards Association of Australia (as it was then) produced Australia's first earthquake code under the chairmanship of Mr C T J Bubb, then Director of Engineering, Department of Housing and Construction. AS 2121 was adapted for Australian conditions from the 1977 SEAOC Code (Seismology Committee, Structural Engineers Association of California), `Recommended Lateral Force Requirements and Commentary' and the International Conference of Building Officials, California, USA `Uniform Building Code' 1976. It was both a loading and material design code in working stress.

AS 2121 was adopted by the then Department of Housing and Construction in March 1980. The Department required that all its projects should be designed for earthquake loads, as appropriate. AS 2121 was also incorporated into the Building Act in 1982 in South Australia. Unfortunately, the requirements of the Code were varied. Buildings under 12 m high were not required to be designed for seismic loads except where they had a post-disaster function. This meant that earthquake engineering design was mostly only done for larger multi-storey buildings, or buildings such as hospitals with specific post-disaster requirements. Western Australia introduced earthquake design requirements for buildings in the Meckering area.

The effects of AS 2121

AS 2121 has not been an entirely successful code. It has largely been used in only two States, South Australia and Western Australia, the latter in a limited way, and in selected areas for Commonwealth Government projects. It has been ignored by all other States for political and other reasons. The 1977 SEAOC Code has four zones of earthquake forces, Zones 0 - 4, which increase in severity of earthquake loading up to a maximum Zone 4. In Australia, only Zones 1 and 2 were used but an additional Zone A

with lesser forces than Zones 1 and 2 was introduced, to take account of non-ductile construction i.e. unreinforced masonry structures. Much of Australia was in Zone 0 (zero) and therefore had no specific design requirements.

Adelaide is the only capital city in Australia in Zone 1 with specific design requirements but other towns and cities such as Apollo Bay in Victoria, Bowral and Wollongong in New South Wales were in seismic Zone 1. Because of lack of commitment, or perhaps indecision by building regulators, AS 2121 was not called up in the various building acts for each State. As a result, buildings in these areas were not required to be designed for earthquakes loads. Unfortunately, AS 2121 has been on the whole, a non-code, ignored largely by the design community and building regulators and brought back into focus only as a result of the Newcastle Earthquake in 1989.

The new earthquake code AS1170.4 is the next step along the earthquake design path for buildings in Australia, and we hope it will not suffer the same fate as AS 2121.

Standards Australia in 1988 decided to revise AS 2121. A Code sub-committee was assembled during that year consisting of representatives of Government Departments, both State and Federal, seismologists and engineers and other interested parties and the sub-committee was drawn from a wide range of participating interests including:

Australian Uniform Building Regulation Consultative Committee
Australian Construction Services, Department of Administrative Services
Bureau of Mineral Resources, Geology and Geophysics
Cement and Concrete Association of Australia
Department of Housing and Construction (SA)
Department of Mines and Energy (SA)
Department of Resource Industries (QLD)
Division of Building, Construction and Engineering, CSIRO
Institution of Engineers Australia
Insurance Council of Australia
Phillip Institute of Technology (VIC)
Public Works Department (NSW)
Steel Reinforcement Institute of Australia
University of Adelaide (SA)
University of Queensland (QLD)

The Sub-Committee is part of the SAA Committee BD6, which is responsible for all the loading codes for structures.

The new Earthquake Code is to be a Loading Code as part of the AS 1170 series. The design of specific materials will be part of the material codes. The new Code will be titled `AS 1170.04 - Minimum Design Loads on Structures, Part 4 - Earthquake Loads'.

The Code Committee members are:
Dr Lam Pham - Division of Building, CSIRO, Melbourne
Prof Graham Hutchison - Department of Civil & Agricultural Engineering, University of Melbourne
Mr Kevin McCue - Australian Geological Survey Organisation, Canberra
Mr Gary Gibson - Seismology Research Centre, Royal Melborne Institute of Technology, Bundoora, Melbourne
Mr Bill Boyce - Cameron McNamara (Qld), Brisbane
Mr Gerhard Horoschun - Australian Construction Services (ACT), Canberra
Mr Bob Potter - Technical Manager, Cement and Concrete Association of Australia, Sydney
Dr Mike Griffith - Department of Civil Engineering, University of Adelaide
Mr Rob McPharlan - Kinhill, Melbourne

Dr Steve Lawrence - Division of Building, CSIRO, West Ryde, Sydney
Dr Jim Loake - Public Works Department, Sydney
Mr Norm Gilchrist - Australian Uniform Building Regulations Co-ordinating Council (AUBRCC), Perth
Mr George Capentanaksis - AUBRCC, Adelaide
Mr Jim Wilson - SACON, Adelaide
Mr Norm Griffiths - Australian Insurance Council, Melbourne
Mr David Love - Department of Mines and Energy, Adelaide
Mr John Woodside - Connell Wagner (SA) Pty Ltd (Chairman), Adelaide
Mr Eddy Go - Standards Australia (Secretary), Sydney

The Sub-Committee first met in December 1989 about two weeks before the Newcastle earthquake of 28 December 1988.

The effects of the Newcastle earthquake on the Code committee

There is little doubt that the Newcastle earthquake has changed the attitude of professional designers and those involved in the building industry's to earthquake damage in Australia. As a result of the Newcastle earthquake, there are many more people interested in earthquake design and research. Standards Australia has been under considerable pressure to have the Code published. It is unfortunate that nearly three years has passed since the Sub-Committee first met, and no new Code has yet been published. The reasons for this delay are set out below.

The Newcastle earthquake has also prompted considerable discussion and research. It confirmed that many of the lessons learnt from overseas earthquakes such as the failure of un-reinforced masonry, the amplification of forces in softer soils and the impact of such a disaster on a community, occurred in Newcastle.

In many ways Australia is a lucky country when it comes to earthquakes. Most earthquakes occur in uninhabited areas far from our major population centres. The 1954 Adelaide earthquake occurred when Adelaide was a city of approximately 300 000 people, and the main centre of the earthquake was some distance to the south of the city in what was then farming land. If the same earthquake occurred today, significantly greater damage would result because the whole area is occupied by housing.

The 1968 Meckering earthquake occurred on a public holiday when most people were not indoors. The 1989 Newcastle earthquake also occurred over the Christmas/New Year period, when many people were away from Newcastle and the schools and public buildings were not in use. If it had occurred on a normal working day at the same time, the death toll would have been significantly higher, possibly in the hundreds. As population and population density increase, the extent of damage which can be caused by earthquakes in Australia also increases.

Status of the new loading code

Public review of the new Code was held in 1991 with comments closing in July 1991. A considerable amount of comment was received, indicating scrutiny by the design community. The Code Committee met to consider the comments and to review and incorporate them as appropriate. As part of the Closer Economic Relations Agreement, Standards Australia and Standards New Zealand moved closer to each other. After meetings in Auckland in November 1991 and Wellington in February 1992, Standards Australia approved the finalising of the Australian Code on the basis that the Australian Code would adopt appropriate elements of the New Zealand Code. It was recognised that the new Australian earthquake loading code would have a finite life because New Zealand and Australia were moving towards common loading codes including an earthquake code.

Postal ballot for acceptance of the new Code was held in 1992. Publication is excepted in early 1993. After publication, the Code must be incorporated into the Building Code of Australia and gazetted by each State before it becomes a legal requirement for design. Materials codes such as the Concrete Code AS 3600 and Steel Code AS 4900, will have to be amended to bring them into line with the new Loading Code.

History of the loading code

At the first meeting of the Sub-Committee, one of the crucial decisions made was whether to write a specific code for Australian conditions or to take the previous path of adapting an overseas code. After considerable discussion the decision was made for the latter alternative, as Australia carries out only limited research in earthquake engineering at Adelaide and Melbourne Universities, and geological and seismologic research institutions and organisations such as the Australian Geological Survey Organisation.

The Sub-committee based the new Code on the `Tentative Provision for Development of Seismic Regulations for Buildings, ATC-3-06' (second edition), prepared by the Applied Technology Council of the USA. Material was also drawn from the National Earthquake Hazard Reduction Program (NEHRP) document `Recommended Provisions for the Development of Seismic Regulations for New Buildings' 1988, of the USA.

Standards Australia specified that the new earthquake Code was to be a loading code, not a combined loading and design code (like AS 2121), and that it had to be written in limit-state format to suit other loading and materials codes.

The Code Sub-Committee did not use the previous zones of AS 2121 which had large jumps between zone values. Zones with much closer contours were used to avoid the problem of designers arguing that their project was on one side or the other of a boundary with significant force differences. Contours are also used in New Zealand.

AUBRCC advised the Code Sub-Committee that the Building Code of Australia would not accept the code as a loading code for the Building Code of Australia without domestic housing being included, which was done on a limited basis.

A review of the aftermath of Newcastle

One of the more obvious deficiencies seen at Newcastle was the failure of un-reinforced masonry. This matter needs to be addressed by the Masonry Code Committee and other bodies of the Masonry Industry, and must be properly considered by architects, building designers and engineers.

The Sub-committee was concerned about whether the new Code would be seen as an over-reaction to Newcastle. Some suggested it doesn't go far enough and others that it is too onerous for Australian conditions given the relative low level of seismicity. The Sub-Committee has tried to achieve the best solution without either reducing the force levels of buildings to be designed to a meaningless level or imposing a cost on the community that cannot be justified. As most of Australia's building is domestic housing and one or two storey buildings, the new Code has been structured so that these building generally do not need complicated design, but are tied together to prevent collapse and allow people to escape. The new Code does not prevent damage to buildings, a fact which is often forgotten.

Unfortunately the vunerability of existing buildings has not been addressed by this Code, and Standard Australia are now setting up another committee to review this matter.

Conclusions

The new Code represents a major step. It is neither a non-Code like AS 2121, nor does it attempt to impose a strict earthquake design regime on all of Australia. It is an attempt to provide a good basis for future design and a safer Australia.

We must ensure that the new Code is called up by the Building Code of Australia so that a reasonable level of safety is incorporated in our new buildings commensurate with our current understanding of the risk.