Australian
Earthquake
Engineering
Society

AEES Newsletter

No 2/91

The Society

David Rossiter

Membership has now topped 50 with members in all States, the ACT and two overseas, one each from Japan and Papua New Guinea.

Contents

Presidents column

Charles Bubb

It is necessary to postpone our considerations of the recent past and instead look to the immediate future. In particular I want to tell you of recent developments which will soon affect the practice of earthquake engineering in Australia and almost immediately the drafting of Standards and Codes.

The Australian and New Zealand Governments have agreed to a Memorandum of Understanding between Standards Australia and the Standards Association of New Zealand and that all standards of the two countries be harmonised by 1995.

A new committee of Standards Australia, the Structures Standards Advisory Committee, has recommended that the Loadings Codes be harmonised over the next two years or so. Under current thinking, the Earthquake Code is regarded as part of the Loadings Code and therefore Standards Australia has placed the preparation of the new Australian Earthquake Code on hold.

As Colin Gurley said at the Newcastle Conference, we ought always remember that earthquake engineering is not a subset of structural engineering, rather the opposite is true. Therefore we should be most concerned that in the praiseworthy pursuit of harmonisation we do not overlook the profound differences between Australian and New Zealand earthquakes.

Briefly, Australian earthquakes are intraplate not interplate in origin, shallow (0-15 km) rather than deep and of lesser magnitude and duration than New Zealand earthquakes. These are not small differences. They must be reflected in the actual practice of earthquake engineering or that practice will be too far removed from reality to be worthy of the name engineering.

To ensure that these matters are not overlooked, the AEES has arranged to be represented at the forthcoming discussions in New Zealand in November arranged in conjunction with the Pacific Conference on Earthquake Engineering. AEES will be represented by our Secretary, Kevin McCue, who will be attending the conference as a BMR delegate and speaker. As you know, Kevin is a senior research scientist in, and head of, the Bureau's Earthquake Seismology program. He is an Engineering seismologist with extensive practical experience in seismology in Australia and Papua New Guinea. He is exceptionally well qualified to discuss with New Zealand earthquake engineers and seismologists the similarities and the differences which concern us and the special characteristics of Australian earthquakes.

We should support harmonisation but to treat things as if they were the same when in fact they are different is to produce not harmony but discord.

Conferenceville (Kevin McCue)

On 24 and 25 October last, a conference organised by the Newcastle City Council and CERA, Q'ld on the theme *What we*

have learnt from the Newcastle earthquake was held in Newcastle. Coordinated by Jack Rynn, the Conference attracted a wide audience and covered topics from structural and geotechnical engineering to insurance and legal liability. Dr Klaus Jacob from Lamont-Doherty Geological Observatory, New York, presented the aprés-dinner address titled *Seismic Hazard in the New York City Metropolitan Area.* where the level of earthquake hazard is similar to that of Eastern Australian cities.

He outlined the probabilistic analysis used to derive hazard estimates for New York, similar if not identical to that used in Australia except that they had available recent recordings of strong ground motion in Canada and the Eastern US to determine attenuation laws and spectra (for the 500 and 3000 year events). He revealed that new regulations would prohibit unreinforced masonry construction and the problem posed by those already built would be dealt with at some later date.

The legislators recognise the problems of site amplification and liquefaction but have not yet prepared a map of soil classification in the Greater New York City area. BMR's Dr Malcolm Somerville presented results of a recent microzonation study of Newcastle (see article p5). Frequency dependent amplification was clearly observed although the actual amount of amplification could not be determined from the microtremor measurements but was likely to be in the range of 2 to 4 during the earthquake in Newcastle. Dr George Walker, CSIRO, cited ground motion amplification factors of 3 to 4 in San Francisco with ground accelerations on soft alluvium of 0.25 to 0.3 g during the Loma Prieta earthquake of October 1989 and commented that the ground motion in Newcastle was likely to have had a similar pattern (but of course of much shorter duration- Ed.).

Another important finding was presented by Bob Carr from D J Douglas & Partners. He debunked the press stories concerning the possibility that ground movement in Newcastle as a result of the earthquake could continue for many years. He pointed out that many parts of Newcastle normally suffered ground movement from mine subsidence, clay reactivity and slope instability and that the ongoing cracking of many buildings in Newcastle was attributable to the very wet February in 1990 and following eight month-long dry spell. Nothing to do with the earthquake. His New Zealand and North American colleagues confirmed that `there is no definite experience of damage appearing more than a few days after the earthquake'.

Professor Rob Melchers pointed out that the vast majority of buildings (in Newcastle) did not collapse despite the fact that none had been designed against earthquake forces. He claimed that with only some exceptions, the conventional wisdom in earthquake engineering to prevent collapse of buildings while not necessarily limiting damage, was attained in Newcastle. Most of the damage could, he reiterated, be attributed to the poor quality of many houses and buildings caused by poor initial construction, and long-term structural deterioration. Hari Gohil, speaking for his coauthors Craig Abbs and Jim Loke from the Public Works Department, agreed with this analysis of the cause of damage and went on to detail ways they had developed to improve the earthquake resistance of Government buildings, more than 700 of the total stock of 1000 buildings required repair at an estimated cost of $62m.

Melchers cites Arch Johnson, Memphis University, in claiming that the likelihood of earthquake occurrence in intraplate regions such as Australia is about 1/600th that in plate margin regions such as New Zealand and the west coast of North America, not including the difference in area. These numbers are very misleading. I have recently plotted the frequency of Australian (depth < 15 km) and New Zealand shallow earthquakes (depth < 50 km) against magnitude over approximately the last 100 years in the magnitude ranges 5 to 7 and 6 to 8 respectively, the higher value is the largest earthquake observed in each country. The lines of best fit with a b-value of 1.0 almost overlap. For a given magnitude, the observed average frequency in New Zealand was less than a factor of 2 higher than that in Australia, not including the difference in area. Take

the post-1960 period; there have been seven shallow earthquakes in New Zealand over magnitude 6 (Gisborne & Cook Strait 1966, Inangahua 1968, Fjordland, 1976, Cook Strait 1977, Bay of Plenty 1984 and Edgecumbe 1987) and seven in Australia (Meckering WA 1968, L McKay WA 1970, Cadoux WA 1979 and Tennant Creek NT (3) 1988).

Bill Boyce gave a clear outline of the techniques used to plot response spectra and discussed the sources of uncertainties in determining earthquake hazard. He went on to recommend a blueprint for seismic risk analysis that is virtually identical to that used by Standards subcommittee BD/6/4/1 for adoption in the draft code. It was based on a hazard map by Gaull, Michael-Leiba and Rynn which the subcommittee subsequently smoothed.

There was inevitable debate about the exact focus of the Newcastle earthquake, whether at Boolaroo (the BMR/PIT location) or offshore (the ANU location). Each organisation has been consistent in co-locating the mainshock and the following days aftershock indicating that the difference is a modelling one. Significantly, the BMR/PIT computation of the aftershock focus was very accurate using data from the BMR/PIT portable network of ten analogue and triaxial digital recorders installed around Newcastle whereas the ANU used just the single component stations of their southeast Australian network installed between the Snowy mountains and Katoomba, 150 to 400 km from the epicentre. The BMR solution is the 'better' solution.

Another point of argument was whether liquefaction had occurred although all speakers acknowledged that none of the classic features such as sand boils or large settlement were observed. In the few seconds of strong shaking in Newcastle, liquefaction would be all but impossible.

Newcastle has, the Lord Mayor assured us, recovered from the earthquake but the Insurance Industry has not yet modified policies to accomodate the lessons learnt. These are likely to include an optional earthquake insurance premium with premiums adjusted according to the perceived risk.

There is not space to review every paper presented, but the Society is investigating ways of ensuring that these and other relevant conference proceedings, books and journals are available on loan to members to peruse at their leisure.

Editorial

Kevin McCue

Debate is a necessary component of change in science as much as in any other field. At many international scientific conferences the debate can sometimes become quite vitriolic but when that debate has died or is squashed then science suffers. Take the fixist stance in geology during the early half of this century which stifled the debate and deferred the advent of Plate Tectonics for nearly half a century or that famous 17th century battle between first Kepler and later Galileo with the Church over whether the Earth or Sun occupied the centre of the solar system. More recently a very public debate in Australia between the proponents of Darwinian evolutionary theory and the old Testament account of the development of life on earth raised more heat than light but at least aired what were articles of faith to some and of science to others. Whether the biblical account should be taught in schools in a science or religious education course is not this writers immediate concern, but that a public debate take place is not only natural but essential.

Often there is not sufficient data or information to resolve a problem to everyone's satisfaction and such is the case with earthquake hazard assessment. Both deterministic and probabilistic methods can be used, zones or contours plotted, ground velocity or acceleration adopted as the pertinent zoning parameter. Because different researchers make different decisions on the location of source boundaries, on which attenuation laws to use, and on whether to employ Poisson, maximum likelihood or extreme value methods should not cause policy makers (Standards setters) to throw out the results. It is their reponsibility to ensure the results are subject to peer review by a professionally competent committee.

The Australian seismological data set, now approaching a 100 year sample, cannot be neglected. The advances made in modelling by both engineering and seismology professions parallel the collection of data and information. To blithely dismiss the seismological assessment on the grounds that the seismologists cannot agree on every detail is akin to throwing out the baby with the bathwater.

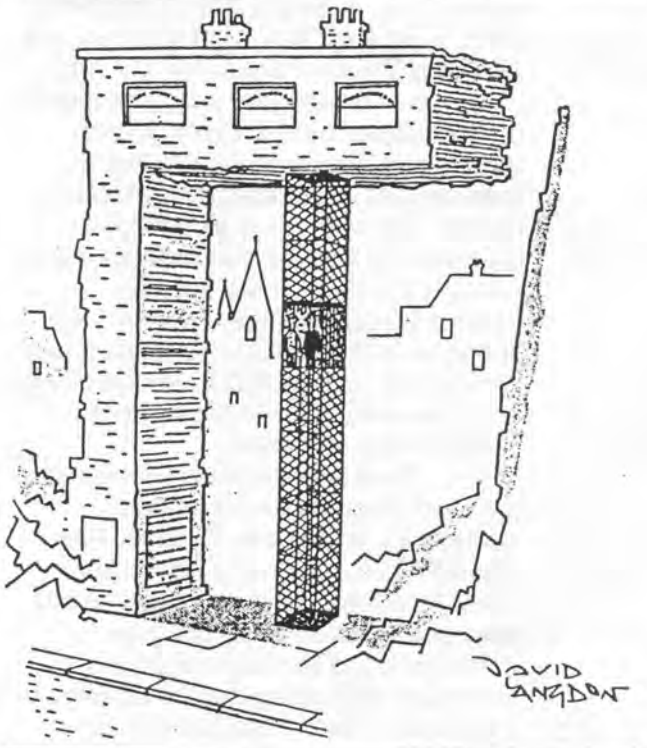
The clash of opposing views is an essential preliminary to consensus, it should not take place behind closed doors and the result of applying it should be better zoning, safer and more economical construction and more relevant insurance cover.
We welcome correspondence on any issue raised in these newsletters or of relevance to our Society.

News items

• Public comment on the draft Australian Standard DR 91094 S: part 4 of Design Loads closed in June. Since then the goalposts have moved dramatically as discussed in the Presidents column. Two meetings will be held in Auckland on 19 November prior to the Earthquake Engineering Conference; between SAA and NZSA to decide a timetable and action, and between the code drafting bodies to discuss a technical agenda. .

• A video of the effects of the October 1989 Loma Prieta earthquake is available on loan to members at IEAust, Canberra.

• The following extract from the New Zealand Herald (~100 years ago) was republished in the Australian Geologist No. 80 and bears copying: *`Practically, there is no danger at all from earthquakes in New Zealand, and it is quite safe to say that much greater damage has been done by earthquakes in Great Britain or France during the present century than in New Zealand'.*
`During a prolonged sitting of the Colonial Parliament, a tedious orator was boring the house into the small hours when a somewhat sharp shock occurred, accompanied by the ususal rattling noise. The astonished legislator stopped in his torrent of talk, gazed vacantly around him for a moment, and then fled precipitately from the chamber. The wag of the house immediately proposed a vote of thanks to the earthquake, and the weary members adjourned amid loud cheers'.



Who said unreinforced masonry has no ductility?

The first Queensland accelerogram

R Cuthbertson, Q'ld Dept Resource Industries

An earthquake which was located near Georgetown in north Queensland has provided the first recorded acceleration data from an earthquake in that State. The earthquake which had a magnitude of 4.5 occurred at 12:11 am (AEST) on 7 August, 1991. Residents of the townships of Georgetown and Forsayth were awoken and while there were isolated reports of minor damage the maximum intensity was assigned as MMIV.

The acceleration data (see figure) were obtained from one of the digital recorders in a network of six instruments near Cairns. This recorder is equipped with both a three-component, velocity transducer (top three traces) and a three-component accelerometer (bottom three traces). The acceleration traces show a much lower signal to noise ratio than the velocity traces but usable accelerations

can be obtained for the latter part of the record.

For those interested, the acceleration was 0.0005 (±0.0001) g, obtained at a distance of 206km from a magnitude 4.5 earthquake. Although this value is exceedingly small it is hoped that the collection of more of this sort of data will eventually allow for the determination of attenuation relations based on local data. Seismic risk determinations in Queensland are currently based on attenuation relationships obtained using data from interstate or overseas.

The seismograph network near Cairns is monitoring seismicity in the area of the proposed Tully-Millstream Hydroelectric Scheme. The network is operated by the Queensland Electricity Commission with data being analysed by the Department of Resource Industries.

Alluvial site response in Newcastle

Dr Malcolm Somerville, BMR

Microtremor recordings obtained by ASC in July 1991 at rock and alluvial and/or fill sites in Newcastle show that significant dynamic amplification can occur at frequencies in the same band as structural resonances. Amplified response was observed at frequencies ranging from 1.5 Hz to 10 hz, at sites with alluvial depth ranging from 40m to 5m. These observations can be interpreted straightforwardly in terms of fundamental-mode (quarter-wavelength) resonance of the alluvium overlying a substratum of much greater rigidity. At some sites, however, the quarter-wavelength resonance is not identifiable, due to a steep interface between the alluvium and substratum, or perhaps the lack of a pronounced rigidity contrast.

The microtremor method is an inexpensive way to obtain information of fundamental importance to seismic design and analysis of structures founded in low-rigidity strata. But the degree of amplification observed for microtremor excitation can not be expected to replicate that in the case of earthquake excitation.

The microtremor observations provide independent evidence to illuminate the controversy that has arisen about interpreting the geographic distribution of damage in the Newcastle region.

The IEAust Newcastle Earthquake Study states (p.xiii): "The Newcastle observations show a high degree of correlation between areas of significant damage and areas in which the foundation material consists of alluvial soil strata and/or fill." The existence of a causative relationship between alluvial cover and high seismic intensity was inferred from the results of approximate wave propagation calculations: a more comprehensive study has subsequently been published (H.G. Poulos, Aust. Civil Eng. Trans., CE33(3),181-188, July 1991). Poulos states (p.181): "It has been demonstrated that the extent of damage can be related to the computed spectral acceleration, and that, in turn, the spectral acceleration is related to the depth of soil and the number of storeys in the structure at the site."

Site resonance frequencies in these computations are consistent with the microtremor observations.

A different interpretation of the geographic distribution of damage has been advanced by the UK-based EEFIT (A.M. Chandler, J.W. Pappin and A.W. Coburn, Bull. N.Z. nat. soc. Eq. Eng., 24(2), 116-138, June 1991). They argue that structural factors were the primary determinant and assert (p.116) that "contrary to reports published by the Institution of Engineers, Australia amongst others, the areas of deep alluvial soil and fill do not correlate strongly with the more heavily damaged districts determined from post-earthquake assessments. Hence, suggestions that this sort of site soil amplification effect played a major part in the distribution and extent of heavy damage in this earthquake are somewhat misleading for the future development of planning and design regulations."This is problematical on several counts: (1) the correlation observed by IEAust, quoted above, refers to alluvial soil strata and/or fill, unqualified by "deep"; (2) there is more than just a suggestion that alluvial amplification played a major part in the distribution and extent of heavy damage; and (3) no sound reason is given for contradicting the IEAust recommendation (p.xiv) that "specific provision should be

made for the amplification effects associated with alluvial soils and filled areas".

Recent earthquakes

The following table summarising recent Australian earthquakes during 1991 was supplied by the Australian Seismological Centre, BMR. The Centre publishes a more detailed monthly list for subscribers and contributors.

Jun - Sep 1991 Earthquakes

Date	ML	Place
28 Sep	4.0	St George Q'ld
24 Sep	4.3	St George Q'ld
23 Sep	4.0	Marble Bar WA
21 Sep	3.1	Broome WA
5 Sep	3.0	Carnarvon WA
2 Sep	3.3	Peterborough SA
2 Sep	3.7	Peterborough SA
27 Aug	2.9	Vacy NSW
18 Aug	3.9	Kununurra WA
17 Aug	3.7	Kapunda SA
6 Aug	4.4	Georgetown Qld
4 Aug	4.3	Tennant Ck NT
17 Jul	3.2	Eyre Peninsula SA
17 Jul	3.3	Singleton NSW
8 Jul	5.0	Tennant Ck NT
2 Jul	3.4	Carnarvon WA
23 Jun	2.7	Dartmouth Dam Vic
19 Jun	5.1	Tennant Ck NT
14 Jun	3.6	Norseman WA

Current Earthquake Engineering Research at the Department of Civil Engineering, University of Adelaide

Dr. Michael Griffith

The Civil Engineering Dept. has built a small earthquake simulator (2.2m x 1.4m) which has a dead load capacity of 66kN and a maximum horizontal base acceleration input limit of about 1g ($9.8 m/sec^2$). The simulator is driven by a 250 kN Instron Hydraulic Actuator and a Concurrent Computer (Model 6655) which can input real earthquake ground motion records to the Instron as well as performing high-speed data collection and processing.

Currently, two earthquake related projects are underway. The first of these uses the earthquake simulator and consists of earthquake tests of two separate 1/5-scale models of a 3 storey reinforced concrete building. One model was detailed in accordance with the requirements of AS 3600 for Sydney and Melbourne. The second model was detailed with the additional seismic requirements for Adelaide. Each model is 2.4 m tall, 1.2 m x 1.2 m in plan, and weighs 36 kN.

The second project involves the development of a simplified method of seismic design for unreinforced masonry (URM) buildings. The first phase of this project is nearly complete and involves measuring the dynamic characteristics of a wide range of existing URM buildings in Adelaide. This data will then be used in the final phases of the project to develop a simple method for estimating the magnitude and distribution of seismic forces for the design of URM buildings.

China

Mr Peter Gregson (BMR) and Gary Gibson (PIT) were in China from 20 Oct to 3 Nov to install two Australian Kelunji accelerographs and exchange earthquake databases under a Memorandum of Understanding signed by respective Government delegates in Beijing last year. This MOU encourages the exchange of data, information and scientists to jointly study the problems posed by intraplate earthquakes. A report of their trip will be included in the next newsletter but it is true that only 90 minutes after installing a Kelunji near Tangshan, they recorded a magnitude 2 earthquake at a distance of about 4 km. Gary Gibson has to be one of the tinniest seismologists....

Dam monitoring in Victoria

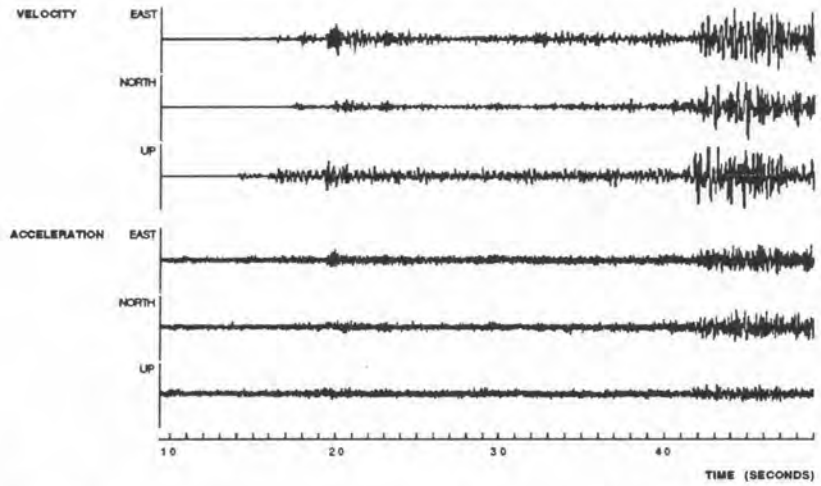
Vaughan Wesson, SRC

The Seismology Research Centre at PIT has been contracted to design, build and install a real-time earthquake warning scheme at Thomson Dam, Victoria by Melbourne Water. It is envisaged that an earthquake will trigger a Kelunji which will actuate by phone a beeper carried by SRC scientists. The seismologists will immediatley interrogate the dam seismographs by telephone to assess the location and magnitude of the earthquake and advise MW officials accordingly.

Courses & Conferences

• First International short course on dynamics of structures and structure-foundation soil systems. 11-15 November 1991. University of Missouri-Rolla. Professor S Prakash, Professor of Civil

The first accelerogram recorded in Queensland, compliments of Russell Cuthbertson, Department of Resource Industries (see text for details)



Engineering, Fax (314) 341-4729.
• Pacific Conference on Earthquake Engineering, Auckland NZ, 20-23 November, 1991. NZ National Society for Earthquake Engineering, PO Box 17-268, Wellington, NZ.
• The 11th Australian Geological Congress, 20-24 January 1992, Ballarat, Vic. The Secretariat, 11th AGC, Bloomsbury Conference Services, 232 Bridge Rd., Vic 3121. Fax: 61 03 427 0715
• International symposium on the effects of surface geology on seismic motion. 25-27 March 1992, Odawara Japan. Dr M Reichle, Dept of Conservation, Division of Mines & Geology, 630 Bercut Dr., Sacramento, Ca., 95814, USA
• The 10th World Conference on Earthquake Engineering, July 19-25, 1992, Madrid, Spain. Steering Committee, c/o Tilesa, Londres 39-1°B, 28028 Madrid, Spain (flyer available from Hon Secretary).
• 7th Int. Seminar Earthquake Prognostics, Sept 22-26, 1992; Asian Disaster Preparedness Centre, Bangkok, Thailand.
• The 10th European Earthquake Engineering Conference: 28 August to 2 Sept 1994, Vienna, Austria

Earthquake publications

• A new book on the earthquake history of Newcastle has recently been published. Local historian Cynthia Hunter has delved into old newspapers and rare reports to compile the most complete account yet published of earthquakes felt in the Hunter region since European settlement. The book should be of great interest to town planners, engineers, architects and hazard researchers alike as well as the general public. It is a well written, and fascinating account of the early development of Australia and so of interest to the general reader. The book *EARTHQUAKE TREMORS FELT IN THE HUNTER VALLEY SINCE WHITE SETTLEMENT* can be purchased for $18.50 ($1.50 postage) from Hunter House Publications, PO Box 536, Raymond Terrace 2324.
• The IEAust Newcastle Earthquake Study is still available at EA Books, PO Box 588, Crows Nest NSW 2065 at the reduced price of $30.
• There are a number of BMR Bulletins and reports describing earthquake activity in Australia which can be purchased from BMR. The Isoseismal Atlas, parts 1 & 2, (Bulletins 214 & 222) contain maps and descriptions of 149 felt and damaging earthquakes. A third edition with another 80 odd maps is almost ready for publication. The Australian Seismological Centre also publishes an annual report featuring the year's seismicity with summary, glossary and descriptions of the larger earthquakes. Reprints of papers on the Newcastle and other important earthquakes may still be available from the authors. A monthly summary of Australian and worldwide activity is distributed at cost to subscribers.