AEES NEWSLETTER

March 2014

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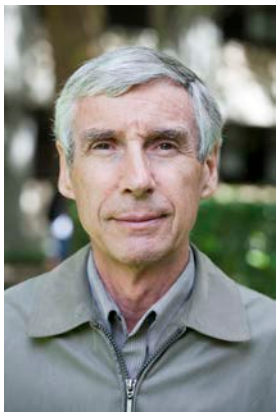
President's Report

Improving Robustness of Buildings



In January, Bill Boyce wrote that "A couple of years ago we had a discussion on this forum stressing the need to provide robustness in structures to give them a better chance of resisting earthquakes - effective load paths, design for ductility and careful detailing to accommodate the disaster scenario. It is not always difficult nor expensive to improve robustness provided a reasonable structural system is chosen in the first place. Improved robustness, in my opinion, is more valuable than larger design forces. An interesting article by Richard Robinson, "Near enough not safe enough", appeared in Civil Engineers Australia, Jan 2014, pp30-32. The article discusses risk analysis and the legal response to failure caused by a low frequency, high severity event (such as an earthquake!!). The article notes that 'the overall situation is perhaps best summarised by Chief Justice Gibbs of the High Court of Australia: "Where it is possible to guard against a foreseeable risk, which, though perhaps not great, nevertheless cannot be called remote or fanciful, by adopting a means, which involves little difficulty or expense, the failure to adopt such means will in general be negligent." That is, it does not matter how low the risk estimate is, if more can be done for very little effort, then the failure to do so will be negligent, in the event of an incident.' The article reinforces (no pun intended) the importance of improved robustness by careful detailing."

This prompted Richard Weller of Cardno to write: "AS/NZS 1170.0 is about to be revised. If you have any suggestions for modification of the Robustness clauses, can you please send them to me for tabling with the committee. We would be most interested, particularly in the light of the safety in design issue. AS1170.4 is also to be revised, so comment on that can be provided through Standards Australia to be sent through to the appropriate committee."

Bill Boyce then wrote: "I suppose, Richard, what I am contemplating is a change in mind-set on the part of structural engineers. We seem to be too driven, and limited, by Standards & Codes (and I am not denying their usefulness) so that deep understanding of structural behaviour is not seen as vital – provided we satisfy the rules in the Standards we believe we have done all that is necessary. Section 6 of AS1170.0 limits itself to load paths and tying together. Perhaps the essence of C6.1 of the Commentary, modified to suit a Standard format, could replace 6.1 of the Standard. C6.1 embraces detailing as well as load paths."

I encourage all members to participate in this discussion, and have asked Vice President Peter McBean and Secretary Helen Goldsworthy to work with Bill Boyce to pursue his suggestion regarding modifying C6.1 of the commentary to replace Section 6.1 of the Standard and provide that to Richard Weller.

Meanwhile, Colin Gurley suggested that AEES should put Peter McBean up for the BD2 committee for AS3600 (Australian Standard for Concrete Structures), stating that this is where the real action is. Peter is willing to go for that, with the following comments: "To introduce myself again to those who don't know me, I am a consulting engineer based in Adelaide with some 30 years of experience in the design of earthquake resistant structures all of all shapes and sizes. I spent a

number of weeks in Christchurch with the Australian USAR team closely observing how various structures failed, and I am currently the Engineering Design Director for the new $1.85b Royal Adelaide Hospital which may prove to be the most seismically resistant building yet built in Australia. That experience has I believe given me a good feel for what is likely to work, and what won't. I am firmly of the opinion that well configured structures, with sensible load paths, and good detailing consistent with the anticipated ductility demand have an excellent chance of surviving moderate to large earthquakes in the Australian context. Unfortunately, I see many structures being constructed both here in Adelaide, and around the country, which have convoluted load paths and poor detailing practices which would most probably be found wanting if tested. The inevitable consequential loss of life and property would be economically and politically unpalatable to all. Much of that poor practice is simply ignorance and apathy by my fellow designers, which is an education and registration matter, and some of it mistakenly perpetrated in the name of reducing construction cost." Richard says that we may not need to wait for a vacancy on the BD2 committee to arise to get Peter on it.

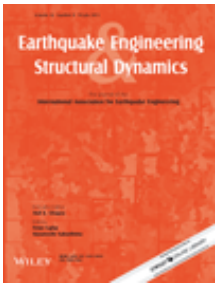
Paul Somerville
AEES President

AEES news goes digital

This is the final edition of the AEES newsletter in the traditional print-style format. Future editions will be distributed as an e-Newsletter through the AEES mailing list and will continue to be accessible through the AEES website.

Articles will be posted to the AEES website as they become available. If you are interested in contributing articles, please email webmaster@aees.org.au

Earthquake Engineering & Structural Dynamics



Edited By: Anil K. Chopra, Peter Fajfar, Masayoshi Nakashima

EARLY VIEW ARTICLES ARE NOW AVAILABLE ON WILEY ONLINE LIBRARY

This is the journal of the International Association for Earthquake Engineering to which AEES is affiliated.

North Island NZ earthquake 2014-1-20

A magnitude Mw6.1 earthquake struck the lower half of New Zealand's North Island, knocking out power in the town of Eketahuna, and causing property damage from Wellington to Manawatu.

The earthquake at 3.52pm (15:52 UTC) local time occurred about 110km NNE of Wellington at a focal depth of 30 kilometres.

The quake was widely felt in Wellington.

Kevin McCue soon afterwards emailed PhD candidate and seismologist Dee Ninis in Wellington NZ to ask if she had felt the earthquake, to compare the MM intensity at a similar distance from Perth during the 1979 Cadoux WA magnitude Ms6.1 earthquake.

At Perth the intensity in WA was about MM5 (from the isoseismal map, soon on the GA website).

Kevin: **How would you rate the MM intensity in Wellington generally, and where were you?**

Dee: **I'm not sure about MMI in Wellington generally, but certainly where I was it was about a MMI 5. It felt like being on a tram in Melbourne :-)**

We were outside and everyone felt it but we weren't really alarmed - we just went along for the ride.

The two events were different; normal mechanism in NZ, thrust mechanism at Cadoux. The geology could hardly be more contrasting, relatively young tectonic basement compared with ancient Shield. Yet the intensity is similar!

Bulletin of Earthquake Engineering

Volume 12, Issue 1, February 2014

Special Issue: In memory of Nicholas Neocles Ambraseys (1929-2012) & A new generation of ground-motion models for Europe and the Middle East

ISSN: 1570-761X (Print) 1573-1456 (Online)

http://link.springer.com/journal/10518/12/1?wt_mc=alerts.TOCjournals

AS1170.4 upgrade

It seems the process leading to a new upgrade of the earthquake loading code has started (see president's column). Karine Naud is Standards Australia's project manager for the new BD-006 committee.

A project proposal was submitted to Standards Australia by John Wilson on behalf of BD-006-11 to revise AS 1170.4.

This proposal was accepted and a meeting was held on 11 February 2014 in Sydney to kick-off the project (in conjunction with the kick-off of revision of AS/NZS 1170.0).

While trying to determine the scope of revision for part 4 (referred to as project 101816), it was decided to wait until more information was available so the project has been put on hold.

It is well to review what happened after the damaging earthquake in Newcastle and follow-up Coronial enquiry and we should expect the same after the next one. This process of code development is a dynamic one and we learn after every new large earthquake. The Coroner's first recommendation was adopted but the second one seems to have been forgotten.

The Canberra Times Thursday 19 July 1990 **Page** 4

Revise earthquake code in wake of deaths: coroner

NEWCASTLE: Coroner Kevin Waller has recommended changes to the Australian Earthquake Code for Newcastle in the wake of the December earthquake that claimed 13 lives.

Presenting his findings at the end of a 12-day coronial inquiry into the deaths, Mr Waller said *an upwards revision of the code* was one of two matters "crying out" for definite action.

His second formal recommendation was that *engineering and architectural courses be reviewed to include the study of earthquakes and their effect upon structural engineering design*.

Mr Waller said the inquest had constituted an historic occasion, being the first in Australia concerning death resulting from earthquake activity.

He made a further formal recommendation that local council engineers be available to advise on the structural integrity of buildings at disaster sites. He said the State Rescue and Emergency Services Board should confer with the Department of Local Government with a view to formalising a procedure for this.

Future Conferences

March 19, 2014 at 1pm – London UK

Half-day symposium at the Royal Geographical Society, 1 Kensington Gore, London, SW7 2AR

Nicholas Ambraseys Memorial Symposium

Chair: Prof. David Potts – Imperial College London

This is a joint symposium of Imperial College, SECED and the British Geotechnical Association, kindly supported by Fugro . Please note that there is no charge to attend, but registration is required. Please register your attendance by 30th January 2014 to Sue Feller at s.feller@imperial.ac.uk.

March 21-23, 2014 – Auckland NZ

New Zealand Society for Earthquake Engineering 2014 Conference

http://confer.co.nz/nzsee2014/

May 28-30, 2014 Brisbane, Queensland

RISK 2014 - Brisbane Convention & Exhibition Centre

RES, a technical society of Engineers Australia, provides national leadership and actively contributes to the effective management of risk in the workplace and community. This conference compliments our other activities that include technical meetings, symposia and liaising with interested organisations.

http://www.engineersaustralia.org.au/risk-2014-conference

July 7-10, 2014 – The Australian Earth Sciences Convention. Newcastle NSW. http://www.aesc2014.gsa.org.au/registration/

November 2014

The AEES Annual Conference will be held in Victoria**.**

June 2015 – Prague, Czech Republic

The 26th General Assembly of the International Union of Geodesy and Geophysics

www.iugg2015prague.com

Earthquake Drives NZ Building Activity

Thursday, December 12, 2013 by: Property Wire

Experts say the recent earthquake experienced in New Zealand (NZ) is spurring growth in the country's homebuilding sector, particularly in the area of Canterbury. Statistics New Zealand reports that residential building activity increased 20% in that area, while overall activity grew by 9% when seasonally adjusted. Data show that building permits are at their highest in five years, but they also appear to be nearing their peak. New house trends are improving, but they still remain below the peak seen in 2003. For more on this continue reading the following article from Property Wire.

Residential building activity grew strongly in New Zealand in the September 2013 quarter, particularly in Canterbury, according to the latest data from Statistics New Zealand. In current prices, residential building activity grew by a seasonally adjusted 9%. Within this, Canterbury region grew by 20% and the increase across the rest of the country was 6.2%

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Looking back to 1973: Planning for the next earthquake

The Canberra Times (ACT) Saturday 24 March 1973, Page 2

From PATRICK CONNELLY, in Perth

The earthquake felt throughout NSW two weeks ago did little harm but another more serious one in Western Australia only 4½ years ago caused severe damage to at least one country town. In this article Patrick Connelly discusses the development of a national code on earthquakes and its particular relevance to WA, Australia's most seismically active State.

THE political speech writer who was prompted by the minerals boom several years ago to call Western Australia "the State on the move" could well have coined the slogan years before - but for a vastly different reason.

WA has been, for decades, the most seismically active of all the States. Six major quakes have been recorded here since 1941 and even during a relatively dormant period such as now subterranean spasms happen more frequently than is good for peace of mind.

The biggest quake to hit WA came on October 14, 1968. It recorded 6.9 on the Richter scale and was the strongest ever registered in Australia. (The NSW tremor two weeks ago was measured at 5.5 in Canberra.) It shook the southern half of the State, levelling much of Meckering, a small town 84 miles east of Perth, sending people screaming in panic from their homes in the metropolitan area.

Yet, though the quake shook WA politicians out of their apathy (especially in the Legislative Assembly, where a big decorative moulding cracked and then dangled dangerously from the ceiling), the effect was only temporary. Neither the previous Liberal Government nor its Labor successor have done anything to establish a warning system or to ensure that another big quake will have minimal effect on people and property.

Other Australian centres that are shaken - as Canberra and Sydney were recently - will have to look beyond Perth for advice on mitigation of earthquake damage. Canberra and Sydney, however, have undergone their tremors at an opportune time. The national code on earthquakes is expected to be completed and ready for publication in a couple of months' time, possibly sooner.

The code is likely to incorporate a recommendation that Australian safety provisions be based on those of California rather than of New Zealand, on which they are now based (Ed. ??).

Earthquakes in New Zealand tended to begin deep in the earth, a spokesman for the National Earthquake Committee said in Perth last week. In California, Japan, WA (and possibly in Sydney and Canberra) the quakes are relatively close to the earth's crust. He believes that the Meckering quake came from about five miles underground.

Dr G. B. Hill, a member of the committee, said in Perth that the report and recommendations of a sub- committee that had been working on the code, were completed and ready for typing.

This sub-committee, established by the Australian Standards Association, dealt with safety in buildings. The over-all report would be completed when a "seismicity" sub-committee, which determined active zones and the degree of their activity for all Australia, presented maps to the earthquake committee.

Dr Hill, a consulting engineer, is a member of the building safety sub-committee. He is also chairman of the WA Premier's advisory committee on earthquakes and it is in this capacity that he has been critical of governmental tardiness.

He said, "The State Government is disturbingly slow in implementing precautions. It should get moving on ensuring that earthquake safety provisions are included in uniform building regulations so that damage to buildings and people is kept down during quakes.

"The building regulations specify that steel, concrete, timber, etc must meet certain standards. Surely the constructions themselves must be made with a view to the facts of life in this earthquake-prone State".

This is all that remained of St Peter's Church at Meckering after the earthquake in 1968

Safety measures had to be carried out more urgently in and around Perth than elsewhere in the State. This was because so many buildings in the metropolitan area were on sedimentary soil and were thus in more danger from quakes than those built on solid foundations elsewhere. Perth would suffer much more from a quake centred on Meckering than would other settlements equidistant from that town.

Dr Hill made similar comments four months ago after a fatalistic annual report by the WA Mines Department. The report said that damage to Perth would occur only if a major quake happened within 100 miles, that a damaging quake could occur any where in the south-west seismic zone (that has its western border only 25 miles to the east) and added, "Earthquakes are something that have to be tolerated. There is not much hope at present of predicting them and none of running away".

Dr Hill said then that the Premier, Mr Tonkin, had not replied to submissions sent to him by the advisory committee. Six months earlier, last May, another member of the advisory committee, Mr Ray Gordon, said that the Government had ignored recommendations despite advice that there would he another earthquake and that it would be more severe than any previous ones.

"In 1968, no-one was killed - probably because it was a public holiday", he said. "If it had gone on for six more seconds the Narrows Bridge might have been severely damaged or even collapsed". (The Narrows Bridge carries a major road across the Swan River).

Possibly the most important recommendation by the advisory committee was that bore-water levels be monitored. It is known that the water table rises suddenly when a quake is imminent; in the case of the Meckering quake, the water rose noticeably 1½ hours before the tremor. The cost of monitoring the level at several points in Perth has been estimated at a total of no more than $1,000. Yet it has not been done.

While the tremors continue to be registerd from as far away as Marble Bar, 1,000 miles to the north and as near as the Darling Ranges, 20 miles to the east, the experts disagree as to whether the big one will come at all.

Mr Gordon says it will strike "within our lifetime", but the former officer in charge at the geophysical laboratory in the Darling Range, Mr I. B. Everingham, has said that another Meckering-type quake will not recur for many years.

Perhaps business is the most reliable guide. The WA Fire and Accident Underwriters Association included a $100 excess clause in the revised policy introduced in January last year. Policy holders will have to pay the first $100 of any loss caused by earthquake.

Seismic Assessment of Existing Masonry Buildings

By Professor Sergio Lagomarsino, University of Genoa (Italy)

Seminar Series Auckland, Wellington, Christchurch

Apologies, for by the time you read this the seminars have been concluded, however you might be able to find out more details as this is an important topic for Australia.

The Professor presented recent European research into modelling strategies, target performances and acceptance criteria for the seismic assessment of masonry buildings. The displacement-based approach is adopted both for the global and the local seismic behaviour.

About the presenter:

Sergio has been a Professor of Structural Engineering at the University of Genoa since 2000. He is the author of more than 250 papers on numerical modelling of masonry structures, seismic risk analysis, preservation of monumental buildings and historical centres. He has coordinated many research projects, in particular the European FP7 project PERPETUATE (www.perpetuate.eu). He has served on the drafting panel of the new Italian seismic code, for the chapters "Design of masonry buildings" and "Assessment and retrofit of existing masonry buildings" and the drafting panel, formed by the Ministry of Cultural Heritage and the Civil Protection Department, which prepared the "Guidelines for the safety and conservation of monumental buildings in seismic areas". He has developed, together with co-workers, the program TREMURI for the static and dynamic nonlinear analysis of masonry buildings and has developed the survey form for seismic damage assessment of ancient churches, used by the Italian Civil Protection Department.

About the project on "**Vulnerability analysis of unreinforced churches in New Zealand**":

Professor Lagomarsino is currently part of a group of national and international researchers working on a 2- year project on "Vulnerability analysis of unreinforced masonry churches in New Zealand" funded by the Earthquake Commission (Earthquake Commission Biennial Grants Programme 2014, reference 14/660).

The aim of the project is to analyse and quantify the seismic vulnerability of New Zealand churches. The vulnerability index (*VI*) methodology developed by Lagomarsino et al. (2003) for European churches and other monumental buildings will be used. The technique entails a macro-seismic approach based on the use of vulnerability curves to correlate the post-seismic damage grade of the building to the shaking intensity experienced, using a discrete probabilistic distribution. The methodology has been applied in Europe with successful results, especially for churches. We will use damage data for 48 URM churches in the Canterbury region following the February 2011 earthquake, as well as structural data for other URM churches all over the country. The vulnerability analysis of churches in several New Zealand cities will assist decision-makers to determine appropriate retrofitting strategies for this building type, and will consequently mitigate damage in future earthquakes. In addition, the project outputs will assist decision-makers in the process of identifying and ranking the seismic vulnerability of URM churches and the prioritising of seismic retrofitting interventions. Successful application of this methodology to URM churches in several New Zealand cities will enable subsequent use of the methodology nationwide, plus potential application to other types of historical architectural monuments.

These presentations are part of a 2-year project funded by the Earthquake Commission Biennial Grants Programme 2014 titled "Vulnerability analysis of unreinforced masonry churches" (reference 14/660) and an abstract of one of the talks is presented below.

Seismic vulnerability of ancient masonry structures: post- earthquake actions and preventive mitigation strategies

Abstract

The last earthquakes in Italy have highlighted the high vulnerability of ancient masonry structures, including ordinary and heritage buildings. In order to mitigate their seismic risk effective actions are needed including: effective damage assessment and provisional interventions during the emergency and post-event; assessment procedures and retrofitting interventions pre-event.

After a brief classification of European ancient masonry structures and the description of their seismic behaviour, some examples of observed damage for different types of construction (residential buildings, churches, towers, fortresses) will be presented. The damage interpretation, by subdivision of the structure into macroelements and related collapse mechanisms, can support the definition of damage survey procedures and the execution of provisional interventions. Some examples from the last earthquake in Italy will be shown.

Assessment procedures for existing masonry buildings are needed for ensuring safety and planning preventive interventions, pre-event. Reliable nonlinear models are necessary for an accurate evaluation of single buildings, through a displacement-based approach (static pushover or incremental dynamic analysis). Simplified analytical models can be effectively used on a regional scale, for seismic risk analysis. They are based on few geometric and mechanical variables and are able to represent in a consistent way the influence of each relevant parameter, as well as the dynamic interaction with seismic hazard (in terms of spectral ordinates). Observational vulnerability models, although less accurate, are very valuable being implicitly validated.

An innovative method for developing fragility functions from both observational and mechanical vulnerability models will be presented.

Welcome to 2014 - Adelaide shaken by earth tremor

6th January 2014 at 8:25am

Adelaide shaken by earth tremor which sounded like 'jet taking off'.

Adelaide was shaken by an earth tremor just hours after separate small quakes were recorded east of Hawker in the Flinders Ranges and offshore Port Noarlunga. Its magnitude was assessed as less than 3, just a microearthquake, yet it aroused intense public interest and media focus.

Callers to ABC local radio reported a boom and loud rumble that lasted a couple of seconds, shaking windows. The tremor was felt in suburbs across the city, including Belair, Kensington Park, Wayville and in the hills.

Geoscience Australia says the magnitude 2.6 quake was centred at Aberfoyle Park and struck just before 8:30am ACDT (yellow triangle marked GA). DMITRE SA said the location was under Belair about 9 km closer to the city (Yellow triangle marked DMI. Senior GA seismologist Jonathan Bathgate says the quake shook Adelaide's south eastern suburbs but was not connected with the earlier magnitude-3 tremor in the Flinders.

"The reports that we have had is people feeling a very short and sharp jolt and a loud accompanying bang to go with that and a little bit of shaking," he said. He says while small tremors are common across Australia, a quake centred so close to a city is rare. "We don't get so many that are in the suburbs that are felt so strongly," he said.

A look at the epicentre map shows that this earthquake was near the epicentre of the 1954 Adelaide earthquake and on the surface expression of the Eden-Burnside Fault, indicated by the yellow arrows. At face value the focal depth of 10km assessed by DMITRE would indicate that the focus was not on the Eden-Burnside Fault but perhaps on a sub-parallel fault further west, dipping east, perhaps the Para Fault.

60 Years Ago - The Adelaide Earthquake SA

28 February 1954 at 18:10 UTC

This was the most damaging earthquake in Australia's modern history for 35 years until Newcastle NSW was struck by a similar sized earthquake on 28 December 1989. There were three injuries in Adelaide but no deaths unlike Newcastle, more by good fortune rather than astute planning or robust building design. No buildings in either city were designed or constructed with earthquakes in mind, despite several earlier warnings.

The damage bill in Newcastle was 10 times the cost of the Adelaide earthquake yet both cities have areas with poor foundation materials, from an earthquake viewpoint, and both have a similar building portfolio dominated by URM buildings, badly behaved in an earthquake, both had similar populations (nearly 800,000 in Adelaide in 1954 while the greater Newcastle area had nearly 500,000 in 1990).

Both Adelaide and Newcastle have a history of felt earthquakes dating back to their establishment in the early 19th century so it is surprising that neither governments nor the architecture/engineering/building profession thought to engineer their structures to resist earthquakes until forced to do so in 1993 (only the Commonwealth Government buildings were modified using earthquake engineering principles from 1979 onwards, a response to the 1968 Meckering earthquake.

100 Years Ago - An Earthquake near Newcastle NSW

11 August 1914 at 14:40 UTC

The Maitland Daily Mercury, Friday 14 August 1914, page 3

The earthquake shock experienced here on Wednesday morning at a very early hour was felt by many persons living in different parts of the municipality, and it was of a most startling nature. Few seemed to realise until it was over what it actually was. The walls of some houses shook violently, and several persons rose from their beds hurriedly and rushed outside their dwellings in the endeavour to ascertain the cause of the unusual occurrence. Descriptions of the earth tremor vary; with some the uncanny sensation caused by it was similar, namely that their residences were being broken into with violence, while others thought their houses were going to fall. The most remarkable feature of the phenomenon is that it does not seem to have been felt anywhere else, or if it was, the newspapers have let it pass unnoticed, their managers probably thinking that an earthquake shock is a small matter in comparison with the present gigantic conflict of nations.

Newcastle Morning Herald & Miners' Advocate Friday 14 August 1914, page 7

A sharp earthquake shock, lasting about two seconds, was experienced at Muswellbrook at twenty minutes to 1 o'clock on Wednesday morning. Roofs of houses were violently shaken.

The newspaper made no mention that the earthquake was felt in Newcastle itself.

Weekly Times Saturday 22 August 1914, page 24

At Muswellbrook, on August 12, a sharp earthquake shock was felt at 12.40 a.m. Houses were violently shaken, windows rattled, and in some of the dwellings pieces of ceiling fell. People who were out of bed at the time stated that the vibration was intense, and the sensation unique. Many householders rushed out of doors and dogs barked loudly.

20 years ago - The Northridge earthquake, California

http://www.latimes.com/local/la-me-northridge-earthquake-internet-20140116,0,3862183.story#ixzz2qhglIQ3R

Earthquake risks have evolved since Northridge. Cellphone and Wi-Fi communications have proliferated since the 1994 disaster and raise new seismic safety concerns.

http://www.latimes.com/local/la-me-northridge-earthquake-internet-20140116,0,3862183.story#ixzz2qhgaVk6Q

In the 20 years since the Northridge earthquake, the state's freeway bridges have been strengthened. A new generation of hospitals, schools and university buildings designed to better withstand a massive quake has risen.

But for all those strides, changes in society and technology have left California vulnerable in other ways. The 1994 Northridge disaster occurred in an era before Wi-Fi computer access and at a time when cellphones were still something of a rarity. Seismic safety experts say that if a huge quake strikes the state now, both services would be interrupted — possibly for days.

The proliferation of personal technology offers some huge opportunities on the quake safety front, most notably a fledgling early warning system that one day could send alerts of a coming quake to phones, computers and tablets up to a minute before the shaking begins. But it's what happens to those networks after the shaking that is generating increased attention from earthquake researchers and public safety officials.

When Los Angeles Mayor Eric Garcetti announced an extensive new earthquake safety effort Tuesday, he said one focus would be strengthening the telecommunication network. "We created a society that requires the Internet to function," said U.S. Geological Survey seismologist Lucy Jones, who is heading L.A.'s new effort. "The Internet is adding this whole new level of complexity to our society."

Like water and gas lines, most Southern California Internet lines run across the San Andreas Fault, and officials fear the Big One could cut off service. In the case of a huge earthquake, fiber optic telecommunication lines could

be severed by the violent dislocation of the fault. Cellphone towers in areas that experience heavy shaking could collapse or be damaged, experts say. Even if the towers are not damaged, a surge in phone usage after a major quake is sure to bring interruptions.

The relatively modest magnitude 5.5 Chino Hills quake in 2008 caused major problems with cellphone and land-line communications. Some cellphone companies reported up to an 800% increase in calls, far more than they had expected in a true disaster. Even phones in some police agencies near the epicenter were knocked off line. The same thing happened after the 2011 Washington, D.C.-area quake. Several companies said that many customers struggled to make phone calls but could still send and receive text messages.

While police officers and other first responders have personal cellphones, they also use radio equipment that is much less likely to be compromised during a big quake. Sgt. Daniel Gomez, who works in the Tactical Technology Section of the Los Angeles Police Department, said the computers in police cruisers use cellular technology but have data connections similar to text messaging that are more reliable than phone service.

The LAPD and other agencies, he added, also have backup communications plans so that even if a big quake takes out radio towers they "at no point would be totally out of commission."

Adam Rose, a USC professor and coordinator for economics for the Center for Risk and Economic Analysis of Terrorism Events, said many big companies have taken steps to protect themselves, like moving servers to locations less likely to be damaged by earthquakes. "We're more vulnerable but we also have more coping mechanisms," Rose said.

Seismic experts say it's important to put the communications risk in context. They said damage to unstable buildings — which would bring loss of life — and the possible cutoff of the water supply are much more serious concerns. But they argue the seismic risks to telecommunications need more study because so many basic functions are now controlled by computers.

"It used to be that grocery stores in Southern California had big warehouses in the Inland Empire where food was stockpiled," Jones told quake experts in a December speech in San Francisco. She said the development of the Internet helped create a more efficiency-minded "just-in-time economy" where far less food is stored on the L.A. side of the San Andreas fault.

Though the 6.7 Northridge earthquake killed about 60 people and caused billions of dollars in damage, experts warn that the region is overdue for a much larger temblor. A 7.8 or larger earthquake along the southern end of the San Andreas fault that has long been predicted would be exponentially more powerful and destructive over a much larger area.

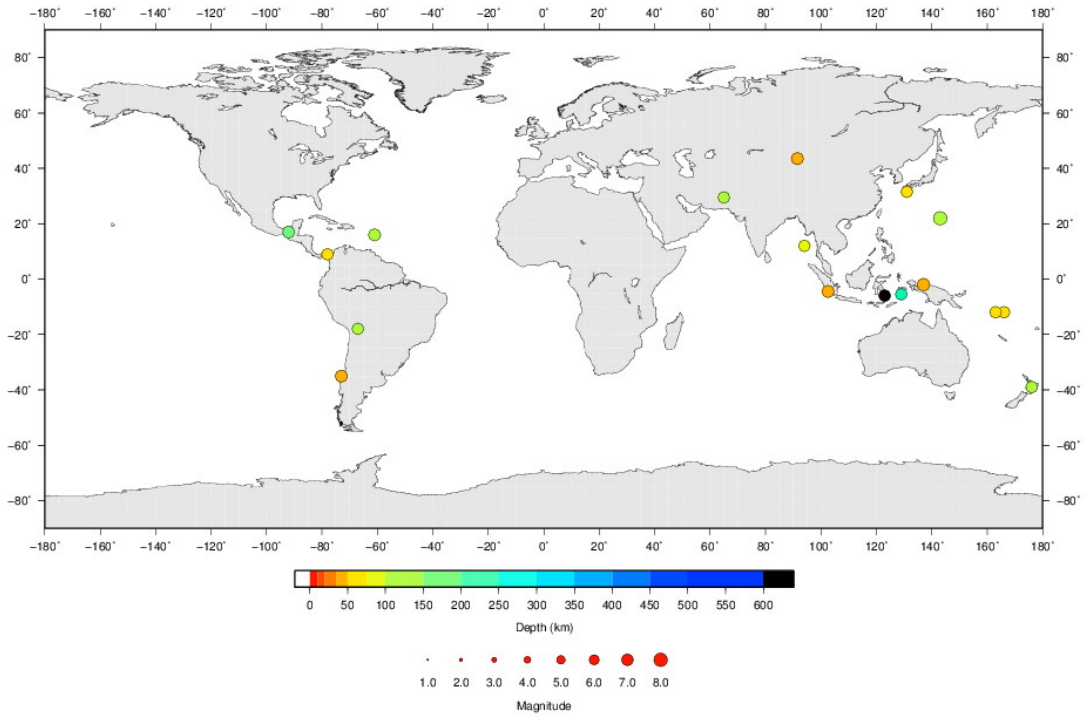
If such a quake significantly affects telecommunications, Southern California is going to have to adjust to getting information more slowly than it does now, said Karen North, a social media professor at USC's Annenberg School. "The first thing that's going to happen is that if a big quake happens, pretty much everybody is going to go to their digital devices to find out what's happening and to communicate with other people about it," she said.

hector.becerra@latimes.com

100 years ago - The earthquakes of 1914 worldwide

The ISC lists a single great earthquake in the Volcan Islands and 16 other earthquakes of magnitude 7 or more (map attached). Most of the earthquakes occurred where we would expect them today, on the Circum-Pacific belt from New Zealand, New Guinea and around to Chile, and the Alpide-Himalayan belt through Indonesia, Sumatra and Iran. China and the Carribean Plate sourced the two others. In other words every major earthquake occurred in what would be rated high-hazard zones today.

Volcanic eruptions occurred at Kagoshima, Japan, both Sicily and Italy, with Etna, Stromboli and Vesuvius all active and related seismicity led to many casualties.



The GA earthquake database accessible on the internet at www.ga.gov.au has zero events listed for Australia, however a quick search of Australian newspapers using TROVE confirms that earthquakes were reported in most states other than the then newly constituted ACT. Earthquakes occurred in all the usual zones in South and Western Australia, NSW, Victoria but not Tasmania. The surprise was a report that people were killed on Norfolk Island, not renowned for its high seismicity:

The Sydney Morning Herald, Monday 20 July 1914, page 9, reports:
EARTHQUAKE.
NORFOLK ISLAND, Sunday.
Au earthquake occurred at Oba during the week, and as a result three natives were killed.

This earthquake actually occurred in the New Hebrides where ~100 landslips are reported to have been triggered (Northern Star, Saturday 25 July 1914, p 7). Researchers need to be vigilant.

New South Wales

It is surprising that an earthquake in the vicinity of Newcastle has gone unnoticed until now but here are two reports about a local event causing slight damage in the process.

The *Maitland Daily Mercury*, Friday 14 August 1914, page 3

THE EARTHQUAKE. The earthquake shock experienced here on Wednesday morning at a very early hour was felt by many persons living in different parts of the municipality, and it was of a most startling nature. Few seemed to realise until it was over what it actually was. The walls of some houses shook violently, and several persons rose from their beds hurriedly and rushed outside their dwellings in the endeavour to ascertain the cause of the unusual occurrence. Descriptions of the earth tremor vary; with some the uncanny sensation caused by it was similar, namely that their residences were being broken into with violence, while others thought their houses were going to fall. The most remarkable feature of the phenomenon is that it does not seem to have been felt anywhere else, or if it was, the newspapers have let it pass unnoticed, their managers probably thinking that an earthquake shock is a small matter in comparison with the present gigantic conflict of nations.

The *Maitland Daily Mercury*, Wednesday 12 August 1914, page 4 had earlier reported that the earthquake was felt at Musewellbrook so the comment in the above extract that it wasn't felt elsewhere is hard to fathom.

EARTHQUAKE SHOCK. MUSWELLBROOK, Wednesday.

A startling shock of earthquake occurred here at 1.30 this morning. The roofs were violently shaken, windows rattled with considerable force, and in some houses portions of plastered ceilings fell. Residents in all parts of the town were disturbed by the intensity of the unusual vibration, and dogs barked loudly. Persons who were up at the time say the trembling sensation was violent but lasted no more than two seconds.

This earthquake is not in modern databases though its magnitude must have been greater than 4.0, Maitland and Muswellbrook are 80 km apart, yet it wasn't reported felt in Newcastle or Singleton.

Queensland

The Bathurst Times, Thursday 12 February 1914, page 3 reports:

EARTHQUAKE SHOCK. SYDNEY, Wednesday.

St. George, 94 miles from Mungundi, reports a distinct earthquake tremor early this morning. The observer was unable to say in which direction the tremor was going.

South Australia

Katherine Dix (2013) lists seven earthquakes in the state in 1914, the two larger earthquakes accorded magnitudes about 4, the first on 28 May just east of Adelaide near the Eden-Burnside Fault was strongly felt in the city, the second on 6 August near Caltowie east of Port Pirie in the mid-north was widely felt. An eighth has come to light via TROVE, a small earthquake near the coast of Kangaroo Island at 7.35pm on 4th October.

Western Australia

The only report of a local earthquake discovered was the following from *The West Australian* Wednesday 25 November 1914, page 6 in the middle of a discussion about the recent NZ earthquake:

…it is interesting to note that Wahroonga and Meedo stations, in the North-west, report rumblings and shaking of the earth, accompanied by loud booming noise, on Sunday morning at 6.30, travelling from west to east.

Victoria

The Ballarat Courier of Thursday 9 April 1914, page 6 notes:

CASTERTON. EARTHQUAKE SHOCK. A shock of earthquake was distinctly felt here on Sunday afternoon about 3.30. Windows rattled, and some alarm was caused.

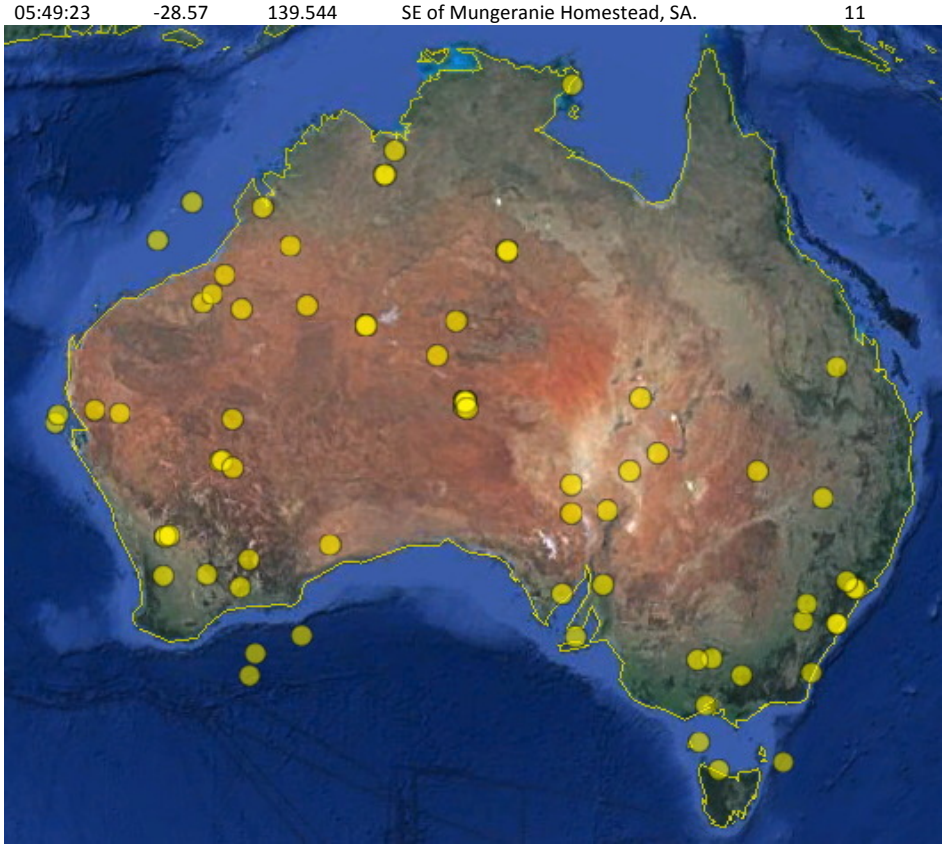
In August Warragul and Bunyip in Gippsland were shaken to the core, people rushing from their dwellings in alarm, but without damage (*Stratford and Briagalong Express*, Friday 21 August 1914, page 2). One story indicated that this earthquake was felt at Flinders Island.

Australian Earthquakes 2013

The year was an interesting one for statistics; the largest was magnitude ML5.7 which is well above the average annual event of magnitude 5.3 but there were only 2 earthquakes of magnitude 4 or more compared with the 20 expected and 72 of magnitude 3 or more campared with 200 expected. Plotted are earthquakes of ML ≥ 3.

Table Earthquakes in the Australian region, ML ≥ 3.5 or greater, located by Geoscience Australia. Focal depths are mainly notional, set by the analyst, hence 0, 5 or 10km. The range of measured magnitudes is ±0.2.

UTC Date	UTC Time	Latitude	Longitude	Approximate location	Depth (km)	ML
2013-01-18	15:35:44	-18.486	118.563	SW of Broome, WA.	5	3.7
2013-02-13	16:49:40	-12.796	136.589	Near Gove, NT.	10	3.6
2013-03-11	10:32:34	-19.862	133.89	SW of Tennant Creek, NT.	13	3.7
2013-03-15	04:40:02	-22.755	127.693	W of Lake Mackay, WA.	10	3.6
2013-06-05	13:17:52	-20.263	121.548	Great Sandy Desert, WA.	0	3.6
2013-06-09	05:38:43	-25.924	131.966	Near Mulga Park, NT.	0	3.6
2013-06-09	14:22:15	-26.11	131.994	Near Ernabella, SA.	0	**5.7**
2013-06-12	13:30:39	-22.752	127.743	Lake Mackay, WA.	0	3.6
2013-07-15	04:19:14	-39.746	144.432	Offshore King Island, Bass Strait, TAS.	10	3.5
2013-07-18	11:39:11	-19.821	133.885	Tennant Creek, NT.	10	4.2
2013-09-13	11:58:52	-20.993	120.93	Pilbara, WA.	2	3.7
2013-09-30	21:14:03	-31.898	121.498	Near Norseman, WA.	12	3.7
2013-10-07	20:15:41	-34.172	150.762	Appin, NSW.	0	3.5
2013-10-30	22:25:38	-27.786	120.746	Near Leinster, WA.	0	3.7
2013-11-03	02:51:57	-36.369	149.935	Cobargo, NSW.	2	3.5
2013-11-30	05:49:23	-28.57	139.544	SE of Mungeranie Homestead, SA.	11	3.7



Plotted epicentres 2013, ML ≥ 3 from Geoscience Australia