MODELS FOR SEISMIC HAZARD ASSESSMENT IN AUSTRALIA

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SUMMARY

The United Nations International Decade for Natural Disaster Reduction has drawn to a close but the need for risk mitigation continues at an ever increasing pace as the population increases and the building stock ages. The problem is acute for areas where earthquakes are frequent but some of the worst disasters have occurred in areas where earthquakes are infrequent and no engineering design or construction precautions have been used. Intraplate areas like Australia have suffered large earthquakes in the last 100 years, all of them distant from major population centres but the historical record is extremely short.

Various models have been proposed for earthquake occurrence rates in parts or all of the continent and here these are appraised and a new unified map of hazard prepared at the 10% in 50 year level of probability. An explanantion is given on how this map can be used in the new Loading Code in conjunction with a table of dynamic amplification factors and a design response spectrum we have recently compiled for Australia

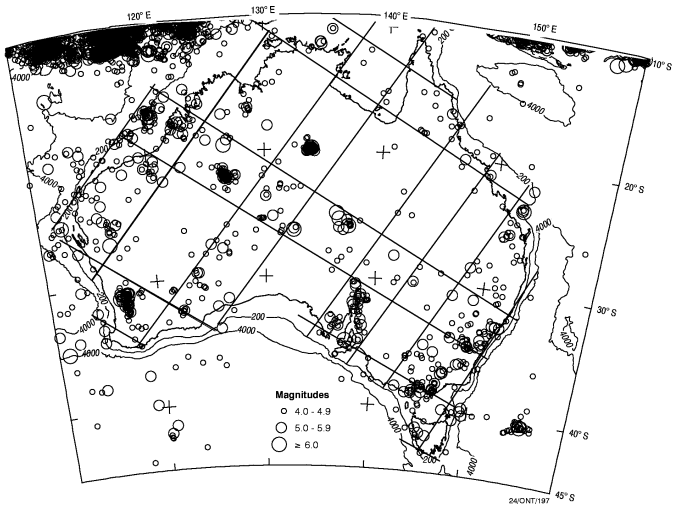

Figure 1:

The cross-shaped pattern typical of brittle failure under compression or shear might have been expected as a result of simple Coulomb failure under north-south compression of the continent given the Australian continents tectonic setting. Direct GPS measurements confirm that Australia is moving north relative to Antarctica and Eurasia under external tectonic forces.

The final product of this latest revision of the hazard will be a new earthquake hazard map of Australia, based on the weighted assessment of expert opinions of various proposed models. The risk will be depicted as contours of peak ground velocity or acceleration, with a given percentage probability of being exceeded in a certain number

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of years. These maps are the entry level requirement for risk analysis, the next level is the structural response to this vibration.

Response spectra suitable for intra-plate regions differ in shape from the ones adopted in the existing loading code from accelerograph records from inter-plate regions. We carefully selected 13 strong motion records and response spectra recorded on rock at close range to thrust type earthquakes with magnitudes ~6 away from plate boundaries. We normalised the records to a pgv of 50 mm/s and computed the 5% damped elastic spectra which we plotted on tripartite log paper. These lent themselves to modelling using a trapezoidal scheme, as illustrated in Fig.2. We have adopted published frequency dependent factors to scale the spectra for different soil foundations. The proposed set of response spectra can be scaled to magnitude or any given peak ground motion parameter, whether it be a referenced peak ground displacement, velocity, or acceleration.

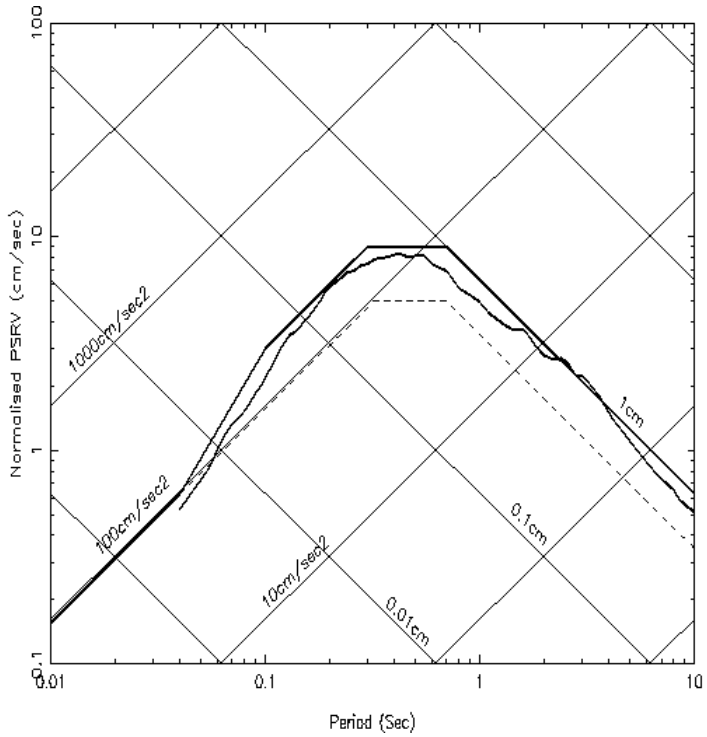

Figure 2:

The resultant hazard maps and spectra will form the core of the new jointloading code and can also be used for non code design and all-risk analyses.

The United Nations recognised that natural disasters are a major threat to human life and development, and declared the 1990-2000 period as the International Decade for Natural Disaster Reduction. In that context the Australian Geological Survey Organisation (AGSO) in Canberra is coordinating a study to revise the current earthquake hazard map of Australia, both as part of the Global Seismic Hazard Assessment Program (GSHAP) under the International Lithosphere Program and the joint Australian/New Zealand earthquake Loading Code.

The earthquake database of Australia compiled by AGSO over the last 40 years has been supplemented with pre-instrumental historic and paleoseismological data. The distribution of epicentres in the Australian region shows that intra-plate earthquakes are far less frequent in Australia than are earthquakes in the inter-plate regions of our near north such as Papua New Guinea and Indonesia, but they can potentially affect every major population center in Australia.

We have superimposed these earthquake epicentres on AGSO's continent-wide geophysical images of the magnetic and gravitational fields and on the elevation and crustal element maps. There appears to be little correlation between the patterns of epicentres and the topography, geophysics (ie crust and upper mantle fine structure) and crustal element boundaries.

Besides, earthquakes occur outside many of the zones defined statistically during studies of past earthquakes. Two models, the *past-earthquake* and *uniform hazard* models have been commonly used to assess earthquake hazard in Australia, resulting in, on the one hand a complex map subject to potential change every time a new unexpected earthquake occurs, and on the other, a map of unified values which is oversimplified and overgeneralised.

Here, we describe a third model, a physically based one which we call the *Coulomb* model (Fig.1). It was derived from the observed pattern of epicentres, recent volcanoes, paleo-faults and continent-scale lineaments and referenced to plate boundary stresses.

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