PROJECTS TO BE FUNDED BY THE EARTHQUAKE COMMISSION RESEARCH PROGRAMME 1995/96

EQC PUBLIC GOOD RESEARCH FUNDING

The EQC funding of public good research, with project topics related to its sphere of activities, was put on a systematic basis from early 1991. Project funding is on a biennial basis. Supported projects for 1991/92 are given in the September 1991 Bulletin of NZNSEE, while 1993/94 projects are given in the June 1993 issue.

For each funding round the availability of EQC funds was advertised several months before their allocation. At each round the applications for research project support had budgets which totalled several times the available funds. Within EQC budget constraints, the most worthy and appropriate projects have been funded.

The major input to the selection of research proposals for funding has been made by a panel of six experts. These were chosen to cover research fields related to EQC activities, and for their knowledge of the progress and needs of these research fields in New Zealand.

174 The psychological consequences of earthquakes on children and others and the most efficacious processes for addressing this trauma (Part 1)
Special Education Service - Mr Peter Stanley

The Special Education Service is a leader in the management of traumatic incidents for children. This service has highly developed expertise in assisting large groups of young people make positive responses to fires, sudden death and other personally debilitating situations. Earthquakes are a special case. The proposed research would review the relevant literature and give rise to a manual for helping agents on the best ways to organise and deliver the most appropriate psychological aid to affected populations.

ES 175 Liquefaction Forces on Landing Road Bridge
University of Canterbury - Professor J B Berrill

The objective is to understand the behaviour of the Landing Road Bridge, Whakatane, the 1987 Edgecumbe Earthquake, when its foundations were subjected to lateral spreading loads, with the principal aim of obtaining further information about the loads applied to piled foundations and buried pipes by liquefied soil. This project continues general studies of liquefaction dating from 1980, and directly extends projects funded by EQC in 1989 and 1993.

ES 177 Attenuation of weak ground motion.
Victoria University of Wellington - Dr John Taber

Historically, there have been separate networks in New Zealand to record weak and strong ground motions. The strong motion recordings were used for engineering purposes while the weak motions were used for earthquake locations and seismotectonic studies. Now the dynamic ranges of the two networks overlap and therefore data from the National Seismic Network (NSN) can be used for engineering purposes.

The purpose of this project is to use selected events from the NSN archives to help constrain an attenuation model for NZ. Seismograms from NSN archives will first be converted to ground acceleration so they can be processed the same way as the strong motion records. Peak ground acceleration, RMS ground acceleration, and spectral accelerations will then be determined from the ground motions. The attenuation of these parameters with distance will be determined, taking into consideration hypocentral depth and tectonic region.

GE 183 Design of Permanent Slopes
Tonkin & Taylor Ltd - Mr Peter Millar

The Building Act requires a factor of safety of 1.5 be achieved for permanent slopes in developments. Councils' interpretation vary on the applications of The Act but many require the conservative approach of the above factor under full saturation of slops regardless of soil conditions, geometry and geohydrology. Tonkin & Taylor has been promoting a review of this requirement for sites where it is demonstrable that a lesser design condition exists. On selected sites full saturation may then be considered an extra event permitting a reduced factor of safety to be applied.

This approach has now been largely accepted by Auckland and Waitakere City Councils and the Geomechanics Society is also debating the issues.

A position paper with direct approach using a questionnaire to Councils and Consultants throughout New Zealand is proposed to promote a consensus of interested groups. The Hong Kong system will also be considered as a basis in which the quality of technical data, economic risk (risk to structures) and risk to life

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ES - Engineering Seismology

GE - Geomechanical Engineering

S&G - Seismology and Geology

SE - Structural Engineering

will be considered. The results will be used to promote revisions to the Building Act on the required factors for stability for permanent slopes.

GE 184 Axial behaviour of bored pile foundations
University of Canterbury - Mr Kevin J McManus

Two recent experimental studies of model bored piles subjected to cyclic axial loading have shown that substantial reductions in capacity may occur at moderate levels of cyclic load leading to pull-out of the foundation in some cases. Based on these model results, analysis of a typical New Zealand bridge structure founded on pairs of bored piles has showed that degradation in pile capacity is likely to occur during the design earthquake resulting in loss of equilibrium, a crude rocking motion, and large permanent settlement.

The aim of the proposed research is to determine whether or not the same loss of capacity observed for the models is repeated for full-size bored pile foundations. Unfortunately, it is impossible to use model results directly to predict full-size behaviour because of intractable problems with model scaling laws in geomechanics.

S&G 193 Probability & consequences of the next Alpine Fault earthquake
Geotech Consulting Ltd - Mr Mark Yetton

The Alpine Fault is the largest active fault in New Zealand. The central section has the potential to generate earthquakes of magnitude 8 or greater affecting all the central South Island. Limited paleoseismic work in the 1970s suggested a recurrence interval of around 500 years with the last event 550 years ago. This work has subsequently been challenged but no attempt has been made to improve upon it. It is proposed to undertake a research project jointly funded by the numerous affected local authorities and EQC to determine the probability and consequences of the next Alpine Fault earthquake.

S&G 194 Synthesis of strong motion records using fault-slip distributions from historical NZ earthquakes
Institute of Geological & Nuclear Sciences - Dr Terry Webb

Existing techniques to invert for the time and space distribution of fault slip will be improved, using source time functions obtained by deconvolving empirical Green's function events from existing data recorded during aftershock surveys. These inversion techniques will be applied to strong motion data from larger New Zealand earthquakes. This will produce the distribution of slip, in space and time, over 2D fault planes for these events. Typical slip distributions which result will be applied to small earthquakes recorded along the Wellington Fault. These small events will be scaled using constant stress-drop scaling, and added according to the derived slip distribution, to synthesise strong motion records at local rock sites for a large earthquake on the Wellington Fault.

S&G 195 A seismological and engineering study of the 1934 Pahiatua earthquake
Institute of Geological & Nuclear Sciences Ltd - Mrs Gaye Downes

The M_S 7.6 Pahiatua earthquake of March 5, 1934, ranks as one of New Zealand's largest historical earthquakes. Yet it is one of the least documented and understood. Previously calculated epicentres have been over 100 km apart, and the two published isoseismal maps for the earthquake bear little resemblance to each other at higher intensities. The uncertainties associated with the earthquake will be reduced by determining felt intensities using Seismological Observatory records, contemporary newspapers, personal papers and other archival material, and reinterpreting seismograms from New Zealand stations. Building damage in the highest intensity areas will also be determined in more detail, by searching local body records and interviewing witnesses.

S&G 196 Implications of earthquake-induced landsliding for MM intensity and seismic hazard assessments in NZ
Institute of Geological & Nuclear Sciences Ltd - Mr Graham T Hancox

Damage caused by landslides during earthquakes is usually second only to that of strong shaking, and landslides have often been used in New Zealand in assigning MM intensities for historical earthquakes. However, landslide effects are poorly defined in the (1991 revised NZ) MM scale, largely because they vary with different geological conditions, material strength, slope angle, groundwater, and earthquake size and location, and there is little published data in NZ correlating earthquake-induced landslides with MM intensities.

A systematic study of earthquake-induced landsliding and ground damage during historical earthquakes in New Zealand is proposed. This will review existing relevant information on earthquake-induced landsliding in NZ and appropriate overseas data; determine the locations, failure types and sizes, and extent of areas affected by landslides during selected historical earthquakes in NZ; establish preliminary relationships to earthquake magnitudes, epicentral distance, MM intensity, geology and topography; critically evaluate MM intensities assigned in NZ on the basis of earthquake-induced landslides in relation to structurally-determined intensities; and develop appropriate diagnostic criteria for using landsliding and ground damage observations in the New Zealand MM intensity scale.

Such a study will indicate the threshold shaking levels required for earthquake-induced landsliding of varying severity and impact in different regions, and provide a factual basis for improving the environmental criteria (landsliding, ground damage) in the New Zealand MM scale. This will allow better use of such criteria in assigning felt intensities during past and future earthquakes, and provide better data for earthquake hazard assessments and insurance underwriting in New Zealand.

S&G 197 Seismotectonics of the Arthur's Pass earthquake of 18 June 1994
Institute of Geological & Nuclear Sciences Ltd - Dr Martin Reyners

The M_L 6.6 Arthur's Pass earthquake of 18 June 1994 was the largest shock to occur in the Southern Alps for 65 years. Immediately after the event, 16 portable digital seismographs were installed around the aftershock zone, and over 10,000 aftershocks were recorded. These data and those from the New Zealand seismograph network will be used to derive a seismic velocity model for the region, relocate the earthquake sequence, determine the location and nature of the fault(s) involved, derive focal mechanisms and construct a tectonic model for the earthquake. Changes in failure stress on nearby large faults caused by the earthquake will also be determined. The study will provide information which is central to understanding the deformation and distribution of shaking produced by the earthquake.

S&G 199 Earthquake hazard from cross-faulting in North Canterbury: Broader implications from the Avoca River earthquake of 18 June 1994
University of Canterbury - Dr Jarg R Pettinga

The Avoca River earthquake of 18 June 1994 (M6.5) was followed by an aftershock sequence delineating a broad, north-northwest trending shear zone linking the major northeast striking Kelly and Harper Faults. No know fault lies along this zone and it is not yet known if surface rupture has occurred until snow melt. Recent international seismological studies demonstrate the importance of cross-linked relay systems and of blind faults (not expressed at the surface). Paleoseismic and structural data from the Canterbury research programme has already demonstrated the relevance of complex penecontemporaneous activity on linked orthogonal structures to the regional tectonic style. It is proposed that mapping of the ephemeral surface expression of seismic activity should be documented soon and also of bedrock structure to identify any primary or secondary expression of the shear zone. The study will expand to investigate other suspected sites of cross-linked structures to build on work already in progress.

S&G 203 Effect of earthquakes on sedimentation in Wellington Harbour - Assessment of potential geohazard areas
Victoria University of Wellington - Dr James Goff

Ten wood or shell fragments extracted from cores of harbour sediments are to be radiocarbon dated. Dates will be used to determine the chronology of earthquake signatures identified in cores of harbour sediments. Earthquake signatures are characterised by abrupt tectural changes which mark instantaneous changes in relative sea level on wave-graded coasts. Samples for dating will be extracted from the vicinity of these textural changes to determine earthquake historicity. We anticipate identifying both the 1855 and circa 1460 events. Net sedimentation rates will be calculated based upon radiocarbon dates and other data (industrial pollutants, pollen, diatoms, radioisotopes caesium-137 and lead-210).

S&G 206 Uplift history of Pencarrow Head from stratigraphy and palynology of lake sediment
Research School of Earth Sciences - Dr Michael Hannah

The project is to core Lake Kohangapiripiri near Pencarrow Head, Wellington, to investigate uplift and earthquake history of the site. The study will include:

- Lithologic description of strata beneath the lake floor, measuring their position with respect to sea level, to a depth of about 7 m.
- C14 dating and palynological analysis for chronology and vegetation history around the lake.

  The description and palynology will be carried out for a BSc Honours thesis under the supervision of Drs M Hannah, J Goff and P J Barrett.
- Record of sea level change over the last 1,000 years from lithologic description of cores.
- Record of vegetational change from description of pollen samples.
- Age of the strata from C14 dating.
- Relating uplift events at this site with those found in Wellington Harbour to the west and Turakirae Head to the east.

SE 210 Rational earthquake resistance rating of sheathed walls
Building Research Association of NZ - Mr Andrew King

During the inspection of building collapses following the January 17 Northridge (LA) earthquake, it became apparent that the commonly used gypsum sheet lining materials approved for use as seismic bracing elements within New Zealand houses may not possess the resistance to dynamic loading which they have been assigned. A pilot test programme of walls which replicated those found deficient at Northridge was undertaken at BRANZ in July. this study confirmed that the level of ductility assigned to such walls was grossly overstated, particularly when these walls are dominated by shear actions (ie, long squat wall configurations). This followed an extensive review programme targeted at ascertaining the interaction of framed walls of various stiffnesses and geometry (reported in BRANZ study report SR54). These studies point to a very significant deficiency in the method by which earthquake resistance ratings of framed wall systems are currently assigned in New Zealand.

This proposal is to re-evaluate the current method of determination of lateral load resistance used in New Zealand. This method, known as the BRANZ P21 Test and Evaluation Procedure, appears to significantly over-estimate the ductility, and thus resistance, of degrading sheet materials. The program proposed both physical testing of typical systems in the laboratory to identify key geometric and physical parameters which influences lateral load resistance and also to use a recently developed time-history analysis suite, PhylMas (Pinched Hysteric Loop Matching and Analysis System), to ascertain the engineering properties from which an accurate performance evaluation assessment can be determined.

SE 216 Behaviour of reinforced concrete beam-column knee joints under seismic conditions
University of Auckland - Mr Les M Megget

Reinforced Concrete knee joints often fail in the joint before full member strength is reached, especially under opening bending moments. As little research has been completed on the cyclic behaviour of knee joints this project would test a series of joints under reversing moments with differing amounts of joint shear reinforcing and anchorage details of the beam and column reinforcing.

SE 221 Precast concrete floor unit support and diaphragm action
University of Canterbury - Professor R Park

In New Zealand the use of precast concrete flooring systems in buildings has become commonplace, leaving cast in place concrete floor construction generally uncommon. While design and construction aspects of precast floors for gravity loading have generally been carefully considered, aspects of precast floor support (seating) and diaphragm action in building structures designed for seismic loading are not comprehensively covered by New Zealand or overseas building standards. A Study Group of the New Zealand Concrete Society, the New Zealand National Society for Earthquake Engineering and the Centre for Advanced Engineering of the University of Canterbury published in 1991 a manual entitled "Guidelines for the Use of Structural Precast Concrete in Buildings" which identified support conditions and diaphragm action of precast concrete floor systems as problem areas in building design and construction in seismic regions. These problem areas were again emphasised by the observed collapse in the 1994 Northridge earthquake in Los Angeles of a floor constructed of precast concrete hollow core units with a cast in place concrete topping slab which failed through lack of adequate support.

The aim of the proposed research project is to obtain additional information on the performance of various possible methods for supporting precast concrete floors in buildings designed for earthquake resistance, and for achieving satisfactory diaphragm action. A major aspect of the latter problem will be to determine criteria which will ensure adequate bond and shear transfer between the precast floor elements and the cast in place concrete topping concrete.

SE 222 Seismic assessment and retrofit of existing reinforced concrete building structures
University of Canterbury - Professor R Park

Typical early reinforced concrete building structures, designed according to building codes prior to about 1970, have reinforcing details which are adequate for gravity and wind loads but may not be adequate for earthquake loads. Earthquake design codes before about 1970 did not specify capacity design nor detailing procedures which ensure adequate strength and ductility in the event of a major earthquake.

A typical reinforced concrete building which was designed in Christchurch in the late 1950s has been assessed and several full scale replicas of the columns and the beam-column joints of the building have been tested under simulated seismic loading in the Structures Laboratory to establish their performance in a major earthquake. Retrofitting methods have been devised and tested (EQC Projects 91/15, 91/18 and 93/102).

The aim of the proposed research is to conduct inelastic dynamic analyses of further typical existing reinforced concrete building structures which were designed to early building codes, and to conduct further seismic load tests on subassemblages containing a range of poor reinforcement details typical of many early structures to obtain additional information for seismic assessment procedures. The investigation of methods for retrofitting such buildings will also be continued.

SE 225 Theoretical seismic vulnerability functions for NZ concrete shear wall and frame buildings
Works Consultancy Services Ltd - Mr R A Davey

Seismic Risk assessment of buildings for the insurance industry requires a knowledge of the losses that can be expected when the building stock being assessed is subjected to a range of EQC intensities (ie, seismic vulnerability). Currently there is very little published data from previous earthquakes that can be used to estimate the expected seismic vulnerability of New Zealand's commercial building stock.

To supplement the published data, it is proposed to carry out theoretical studies of typical New Zealand shear wall and frame buildings to determine their expected vulnerabilities.

The vulnerabilities would be estimated by analysing typical buildings and then assessing the expected damage that can be expected to the various structural and non-structural components of the building due to the building's inelastic response.

Using this methodology, published data from previous earthquakes and tests relating to the various components of a building can be used to estimate the vulnerability of the building as a whole.