GEOTECHNICAL EARTHQUAKE ENGINEERING IN NEW ZEALAND SUMMARY OF ONGOING RESEARCH

K. J. McManus[1]

Presented at the US-Japan Workshop on Geotechnical Aspects of Recent Earthquakes, Osaka, Japan, 22-24 January 1996

INTRODUCTION

The following information is the result of a survey carried out during December 1995 of all known researchers in New Zealand. The information is as complete as possible being based on responses received by 15 January 1996. A bibliography of relevant recent publications is given together with affiliation and address information for the active researchers. Information is arranged under the same topic headings as for the main body of the proceedings.

GEOLOGIC AND SEISMOLOGIC ASPECTS OF EARTHQUAKE GROUND MOTIONS

Considerable work is being done to improve the understanding of earthquake hazard throughout New Zealand and to complete microzoning studies for urban areas, with much attention focused on the Wellington region (Van Dissen et. al., 1992). Geologic studies of the regional tectonics and faulting have given a better understanding of the seismicity of the Canterbury region, which has been incorporated into a pilot study of seismic hazard for the City of Christchurch (Berrill et. al., 1993). Site effects within the city have been studied by microtremor measurements and compared with behaviour observed during weak earthquakes (Toshinawa et. al., 1995).

Site response studies using small earthquakes and microseismic background noise have also been made by Clitheroe and Taber (1995). The frequency dependant amplification of ground motion has been determined using recordings of small earthquakes at over 90 sites throughout New Zealand (e.g., Taber and Smith, 1992, Taber, 1993). The variability of amplification at the same site for different earthquakes has been studied, and a large component has been shown to be essentially random. It would seem, therefore, that actual site response must remain to some extent uncertain (Taber, 1995, Taber and Luo, 1995).

Simple attenuation relations for peak ground accelerations in earthquakes have been developed from New Zealand strong-motion records obtained since 1966 (McVerry et. al., 1995). The strongest acceleration in the dataset is 0.58g at a source-to-site distance of 22km in the Mw 7.3 Inangahua earthquake of 1968. Accelerations recorded in New Zealand are generally much stronger than predicted by well-known western USA models. The New Zealand model provides a good match to data from the 1995 Kobe earthquake.

Strong motion recorded in the epicentral region of the M6? Arthur's Pass earthquake of June 1994 is presented in Berrill et. al. (1995).

Davis (1995) has studied the effects of weathering on site response.

GEOTECHNICAL ASPECTS OF EARTHQUAKE GROUND MOTIONS

Numerical site response studies to large magnitude events in one and two dimensions have been made to determine the total and effective stress response of soils (Marsh et. al., 1995, Marks and Larkin, 1995).

An experimental study into the behaviour of dense sands during rapid loading has shown that dilation during undrained shear leads to cavitation. The onset of cavitation leads to an abrupt change in both deviatoric stress-strain response and stress path behaviour (McManus and Davis, 1996a and b). This work is continuing.

SOIL LIQUEFACTION

Work on liquefaction has proceeded on a number of fronts. Energy-based analytical models have been proposed (Davis and Berrill, 1982; Simcock et al, 1983; Berrill and Davis, 1985; and Davis and Berrill, 1996). In the most recent work, pore-pressure increase is estimated from the density of seismic energy dissipated in the layer of interest, calculated via transfer matrices for a hysteretic soil starting with the ground surface spectrum. As well as being a convenient engineering procedure, this analysis brings out the important role played by resonance of internal layers.

The other main area of research in liquefaction has been in documenting liquefaction sites (Fairless and Berrill 1984; Berrill, Bienvenu, et. al., 1988; Berrill, Mulqueen,et. al., 1994; Berrill, Ooi, et. al., 1987; Berrill, Adlam, et. al, 1987; Christensen and Berrill, 1994; Berrill and Christensen, 1995).

An interest in the behaviour of the piezocone grew out of the site studies. Of particular interest is the effect of layering on

[1] *University of Canterbury, Christchurch (Member)*

cone resistance (Vreugdenhil et al, 1994) where soil density, and hence liquefaction resistance may be seriously underestimated in thin layers. Other work on the CPTU test itself and testing technique is described in references: (Berrill, Canou, et. al., 1992, and Berrill, Christensen, et. al., 1995).

An empirical procedure for predicting liquefaction potential from CPTU results has been developed by Dou and Berrill (1993) which employs all three piezocone measurements (qc, Rf and u) rather than simply cone resistance as in most empirical methods. The procedure has been calibrated on a small local data set. Calibration against a larger set of world wide data is required.

A laboratory project to assess the liquefaction potential of pumice sands is in progress (Pender, 1996).

PILE SUPPORTED STRUCTURES

A detailed overview of aseismic pile foundation design and analysis has been prepared by Pender (1993, Pender and Wood, 1994). Field studies on the response of pile groups in cohesive soil to lateral loads have been made by Pender (1994) and analytical methods developed. Nonlinear methods of evaluating the response of single piles have also been developed (Wood and Pender, 1994).

The behaviour of drilled shafts (bored piles) under earthquake induced loads is subject to ongoing experimental study (McManus and Turner, 1994, McManus and Chambers, 1995). Earthquake induced cyclic axial loads have been found to cause significant reduction in capacity. The effect of combined axial and lateral loads is presently being studied as is the effect of simultaneous shaking of the soil.

LIFELINES

Lifeline research is has been focussed on regional studies of major, at risk, urban centres (Centre for Advanced Engineering, 1991).

WALLS AND RETAINING STRUCTURES

No current research has been reported.

REMEDIATION

No current research has been reported.

OTHER ISSUES (LANDFILLS, FAULT RUPTURES, ETC.)

Methods are being developed for computing the seismic displacements of small to medium size embankments on soft soil (Larkin, 1996). Numerical methods are being developed for computing the response of shallow foundations in a nonlinear soil medium (Larkin, 1996). The effect of lateral spreading is being studied by Berrill et. al. (1995). Analytical solutions for strip footings have been presented by Ghahramani and Berrill (1995a and b).

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