

A HISTORY OF ANTI-SEISMIC MEASURES IN NEW ZEALAND

G. A. Eiby*

ABSTRACT

The existence of a seismic problem in New Zealand was recognised in 1848. Limited governmental action and pioneering structural investigations followed. There were no major disasters between 1855 and 1929, and interest in earthquakes declined. Nevertheless, several papers by New Zealanders were published in the early 1920s, and the schools of engineering and architecture drew the attention of students to seismic problems. Modern building regulations have their origin in the report of a committee set up after the Hawke's Bay Earthquake in 1931, but some local authorities have still to adopt anti-seismic measures. The Hawkes Bay earthquake also stimulated observatory seismology. The earliest Civil Defence legislation was intended to deal with riots, and later with the effects of air attack, and the organisation has only recently become concerned with natural disaster. Relief measures were traditionally considered a matter for local bodies or for the police and armed forces, and these bodies are still involved. Unique insurance measures were introduced during the Second World War. Since then there has been continuous advance in engineering and seismological research, improvements in building regulations, insurance provisions, and the organisation of civil defence.

INTRODUCTION

There seems little present likelihood that anyone will undertake the laborious search through political and technical records that should precede any authoritative account of the measures that New Zealanders have taken to minimise the losses and inconveniences that arise from earthquakes. The justification for this outline is the hope that it will elicit corrections and further information on specific points, accompanied by the necessary documentation.

EARLY RECOGNITION OF THE PROBLEM

Although earlier shocks had caused public alarm, the magnitude 7 earthquake near Wanganui on 1843 July 8 gave the first indication that traditional methods of construction would have to be changed if buildings of European type were to be erected in New Zealand. Most houses in the young settlement lost their chimneys, and in some cases suffered more serious damage. Part of the Rev. Taylor's brick church at Putiki collapsed upon the pulpit and split the floor, and there were serious landslides and changes in the level of the low land at the river-mouth.

For practical purposes, administrative authority then lay in the hands of the New Zealand Company and its officials, and the settlers appealed to them for help. The policy of the Company being to hush up natural disaster, help was not forthcoming. Indeed, there were hints in its reports that an inferior type of settler had put up an inferior type of building, and that any troubles they faced were no more than their just deserts. The Company's success in concealing the facts was so great that

most accounts of destructive earthquakes in New Zealand still take the Marlborough earthquakes of 1848 as their starting-point.

The earthquake on 1848 October 16, also about magnitude 7, was centred in the lower part of the Wairau Valley, which was then very sparsely settled, but the damage to Wellington was severe, and was augmented by the effect of two large aftershocks upon the already weakened buildings, one of which collapsed and caused three deaths. On this occasion the buildings destroyed included the headquarters of the Company, and concealment was out of the question.

Lieutenant-Governor E. J. Eyre's despatches to Auckland are suggestive of panic, and certainly contain exaggerations, but he nevertheless took practical steps to meet the emergency. First he sent the Colonial Chest aboard the H.M.S. "Fly" for safe keeping, and placed a ban upon other vessels leaving port, lest the settlers should "feel themselves deserted". He also took the patients from the ruined Colonial Hospital into his own residence, and ordered "a day of public and solemn fast, prayer, and humiliation". Under pressure from a meeting of businessmen he also required anyone wishing to leave to give 48 hours notice "to prevent persons taking advantage of the occurrence of the earthquake to abscond without paying or making provision for their debts", appointed a Board of Damage to assess the loss and to direct the removal of dangerous buildings and rubble, and made the men of the 65th regiment available to help with the clearing and to guard unprotected stores. An attempt on the part of some settlers to leave on the barque "Subraon" ended when she ran ashore at Seatoun.

* Seismological Observatory, D.S.I.R., Wellington.

On the whole, action to deal with a situation that must have been altogether

unfamiliar seems to have been prompt and sensible. The Wellingtonians were soon at work repairing their homes and businesses, and in sufficiently good heart to return relief money subscribed by a sympathetic Auckland. This was apparently premature, as they were to ask the Colonial Office for help some months later. Dislike of Governor Grey, who was thought to be behind the Auckland offer, probably played a part in their decision to decline it. An interesting consequence was that the difficulty of communication at the time of the disaster was a major factor in Grey's decision to set up Provincial Governments.

The South-West Wairarapa earthquake of 1855 was the greatest New Zealand shock in historical times, and it was again the city of Wellington that was most seriously affected. Many citizens who had rebuilt in 1848 had done so with some awareness that their buildings might have to withstand further shocks, and with the growth of the colony the general standards of construction had improved, but there was little knowledge of principle to guide them. Wooden houses had performed well in 1848, but some like Justice Chapman queried whether it was better to have the city destroyed occasionally by earthquake or more frequently by fire. The luckless Baron Alzdorf, who, having suffered damage to his hotel in 1848, placed his faith in strong brick was killed by the collapse of his chimney in 1855.

The report of the commission set up to survey the damage (substantially the work of C. R. Carter, a contractor deeply involved in the politics of the day, now perhaps best known for his bequest of the Carter Observatory) anticipates in some respects Mallet's book on the Neapolitan earthquake of 1857, which is generally considered to mark the beginning of modern seismology. There are warnings against the less satisfactory building practises of the day, tests of the breaking strength of local timbers, and a theoretical discussion leading to the conclusion that of the known types of architecture the one most adapted to survival in a country subject to earthquakes was the pyramid. This suggestion seems to have had little influence on New Zealand architecture, but it did at least present the view that counter-measures were possible. By the time the report appeared, one civil engineer had already returned to Britain, remarking that in a country where only light huts could ever be safely erected, there was no future for members of his profession.

On the whole, the view that fire was more to be feared than earthquake seems to have prevailed in the building by-laws of the next half-century, which coincided with something of a lull in seismic activity. Christchurch twice experienced trouble with the cathedral spire in the 1880s. When a system of mounting the cross on gimbals proved a failure, the upper part of the spire was reconstructed in wood, and suffered only minor damage in the Cheviot earthquake of 1901. The geologist Alexander McKay, who wrote the major account of this shock, is justifiably censorious of those who exaggerated the state of "stricken Cheviot", but there are few signs that the damage on

this occasion led to counter measures in other parts of the country. The attempt of a departmental head to use this shock as an argument to dissuade R. J. Seddon from putting up the five storey Public Trust building in Wellington was unsuccessful, but does seem to have resulted in some special attention to the steel frame at the core of the building.

FOUNDATIONS OF A SCIENCE

The foundation of earthquake engineering were laid at the end of last century, by pioneering Japanese seismologists who had come under the influence of Professor John Milne at the University of Tokyo. Milne's work had as its inspiration the ideas of Mallet and a seismological committee set up by the British Association for the Advancement of Science. On his way back to Britain from Japan Milne briefly visited New Zealand. The result was a humorous book about his experiences written under a pseudonym. It shows him to be aware of the events of 1855, but he does not seem to have made professional contacts.

Before the 1920s, when isolated papers by New Zealanders began to appear in the Bulletin of the Seismological Society of America, there were few signs of local interest in the problems of seismic engineering. The belated upsurge came when the lessons of the San Francisco earthquake in 1906 were brought to memory by the Santa Barbara shock in 1925. At this time most New Zealanders who thought about earthquakes at all held the view expressed by the seismologist Dr. C. E. Adams in the official Year Book for 1921 - that they were of scientific rather than practical importance - but New Zealand engineers nevertheless were quick to see the possible relevance of the work in California. Earthquake problems became part of the courses at the Engineering School at Canterbury College, and a series of technical lectures given in Auckland in 1926 by C. R. Ford became one of the earliest treatments of the subject in book form.

NAPIER AND MURCHISON

The Murchison earthquake of 1929 June 16 was the first New Zealand shock to constitute a disaster in modern times. It involved the loss of 17 lives, and required a substantial evacuation of refugees to Nelson. Important geological investigations were made, and the effect upon public opinion was to hasten improvements in instrumental seismology. Civil Defence problems were handled by the police, and relief by committees sponsored by local bodies, particularly in Nelson, to which evacuees had been sent. The only report of engineering significance known to the author was prepared by a committee of the Institute of Architects. Although not without value at the time it did little more than underline the more obvious lessons.

The earthquake studies of the twenties were not entirely theoretical, but there were still deep differences of opinion on basic principles. Some supposedly earthquake-resistant buildings of this period, particularly those designed by advocates of extreme flexibility, have not performed well,

and at least one has since been braced to provide additional stiffening.

The Hawke's Bay disaster in 1931 had more far reaching consequences. Once again, the civil defence problems were in the hands of the police, with important and indispensable help from the armed forces, particularly the navy. For the first time the government moved to impose formal legal requirements aimed at improving public safety in the event of an earthquake.

Its first step was to set up a Building Regulations Committee under the chairmanship of Professor J. E. L. Cull of Canterbury University College. On it were representatives of structural and design engineers, architects, and builders. With the help of the Public Works Department it began by collecting plans and photographs of damaged buildings for further study, and it heard and appraised a multitude of suggestions from other bodies and from individuals.

The direct result was a recommendation that Parliament should meet in emergency session and at once compel municipalities to pass by-laws ensuring that all new buildings were designed to withstand a minimum horizontal acceleration one tenth of that due to gravity. Some local bodies combined this with a restriction upon height. The committee hoped that further deliberations would lead to less arbitrary design principles, but realised that the rebuilding of Napier could not wait until their discussions were complete. Two important further points were made. The first was that requirements should be uniform throughout the country, and the second that local bodies should be compelled to adopt and to police the regulations. This is a requirement that successive Governments have been reluctant to enact, and even now some parts of the country do not have the protection of an adequate code.

The first Model Building By-Law appeared in 1935, and was revised in 1938. It was the work of the New Zealand Standards Institution, which was set up in 1932, and had found that some local bodies were without building by-laws of any kind, and that others were badly out of date. The campaign to make these bodies aware of their responsibilities was interrupted by the outbreak of war.

WAR, INSURANCE, AND CIVIL DEFENCE

The war brought development in the field of earthquake engineering almost to a standstill, but there were important changes in civil defence, and the inauguration of the Earthquake and War-Damage Fund arose directly from war-time problems, complicated by the occurrence of a shock near Masterton in 1942 which again damaged the Capital.

Civil defence has had a curious history that has left citizens a little suspicious of its aims. The earliest civil defence measure was G. W. Forbes's Public Safety Conservation Bill of 1932, which sought sweeping powers to handle disorders among the unemployed, making it clear that in the case of "fire, upheaval, earthquake, or anything of that kind" the police were to be left in charge. The police had indeed performed well in both the Murchison and

Hawke's Bay events, subsequent relief and reconstruction being handled by local bodies and committees of citizens established under local body auspices. In fact, the resources and assistance of the Army and Navy played a vital part in every major earthquake from 1848 to 1942, and it would be impossible to over-emphasise the value of the Naval detachments that landed in Napier in 1931. With the change in military emphasis from manpower to machinery and the abandonment of compulsory military training and the maintenance of reservists, the need for some alternative source of massive and disciplined help would grow.

Social reforms followed a change of government, and the threat of riot and civil commotion became an unhappy memory, but the possibility of war was becoming real. The Internal Affairs Department studied the precautions against air-raids that were being taken in Britain, and issued householders with a booklet as part of an Emergency Precautions Scheme. Now that the real threat was war, the booklet spoke of "epidemics, earthquakes and other natural disasters", but its implications were clear enough to most citizens who bothered to read it. Few of them responded to the unenthusiastic initiatives of local bodies, who were expected to form voluntary organisations - and to bear the cost.

Once war became a reality, public attitudes quickly changed. The organisation sprang to life, and at its peak 150,000 people assisted in providing air-raid shelters. When the 1942 earthquakes near Masterton caused extensive damage there and in Wellington, the E.P.S. Organisation was called upon to help, but the burden of organising the clearing up fell mostly upon the depleted council staffs, who gratefully accepted the help of the then fully-mobilised army units. This was the only real test of the scheme in a natural disaster. It was at best a qualified success, and when the war ended the organisation withered away, and in all but a few centres died completely.

The principal gain of the war years was the establishment of the Earthquake and War Damage Fund. In 1941, Parliament authorised the imposition of a compulsory levy of 25 cents on every \$100 of all fire insurance premiums. This was initially to reimburse the owners of property damaged by enemy action, but it was further provided that any money remaining after the war should be transferred to an Earthquake Fund. In 1944 the premium was reduced to five cents, and the Act amended to provide further monetary support from the Consolidated Fund.

The need for an earthquake insurance scheme had become apparent in the Hawke's Bay earthquake of 1931, when the insurance companies paid out only £250,000 for losses they assessed at ten times that figure. By 1942 it was obvious. The Wellington City Engineer estimated that the damage from the Masterton earthquake had cost £900,000, and that £80,000 of this affected private houses. There were some 20,000 chimneys in need of repair, but because of the usual £50 franchise even those householders who were insured would receive little or nothing.

The Earthquake and War Damage scheme

now provides that anyone insured against fire is also insured against earthquake. At present the Fund stands at \$150 million, from which claims for minor damage are regularly met. After the Inangahua earthquake in 1968 the payments totalled \$2.5 million, but the scheme has still to meet the test of a major disaster. In addition to earthquake risks, the results of storms and several other types of "extraordinary" disaster have also to be covered by the fund.

Parliamentary interest in civil defence revived under the new threat of nuclear attack. In 1953 a Local Authorities Emergency Powers Act was introduced, which made references to "earthquake, fire, flood, and other natural phenomena", but it was not until 1959 when A. H. Nordmeyer announced that a Ministry of Civil Defence was being set up to "operate not only in the event of war, but also in the event of earthquake or other natural disaster" that there were any signs that considerations other than military ones lay behind Departmental thinking.

In 1960, there was a change of government, and the new Minister, F.L.A. Götz, returned to the earlier concept of the Ministry's purpose. He explained to a rather unconvinced Municipal Association that its main problem was to deal with "toxic gases, nuclear fallout, poisons, epidemics, and plagues" adding as an afterthought "and the occasional earthquake". To a suggestion from the press that they should find a place in the new organisation, he replied that their methods of informing the public were now too out of date. When his Civil Defence Bill was introduced in 1962 the Christchurch Star accordingly dismissed it as "a document drawn up by civil servants for civil servants. In an emergency it would dispense with government by the people's representatives. The country is not in a mood to be governed by a committee of civil servants".

In fact, the "Ministry" remained a paper creation within the Department of Internal Affairs, although signs of some public concern about earthquake risk were beginning to appear in the press. In 1963 the Ombudsman was persuaded to intervene by a plea that his rights to examine departmental action must surely extend to departmental inaction. He reported that the minister had withheld staff and funds, and that the departmental head had accepted this position without exercising his clear duty to complain. The result was a major reorganisation and the appointment of a full-time director in 1966. Further, there were to be subsidies for local bodies, who had previously been expected to find most of the cost of the practical measures needed.

The organisation and staffing of Civil Defence, both at the national and local level, has since improved continuously, but evidences of lingering suspicions of its military past persist, including periodical suggestions that the name should be changed, and that retired army officers should be less in evidence. However, it cannot be denied that these men have many qualifications for their task, and public apathy is a much more serious obstacle to continued improvement.

THE POST-WAR YEARS

It is beyond the scope of this paper to review the enormous development in New Zealand geophysical studies, and it is not for a seismologist to offer detailed comment upon technical developments in the engineering field, but it is necessary to provide a sufficient outline for their interplay to be traced.

The Third World Conference on Earthquake Engineering, held in New Zealand in 1965, and the subsequent formation of the National Society for Earthquake Engineering within the framework of the Institution of Engineers marks the full maturity of an engineering interest in seismological problems that had been growing steadily since the subject was first introduced into university courses. In 1940 S. Irwin Crookes published his Structural Design of Earthquake-Resistant Buildings and by the end of the war engineers of the Railways Department and Ministry of Works were leading an agitation for improved building codes.

War-time legislation had given local bodies some powers to deal with hazardous structures, but a new Local Bodies Act and a test case in which the court had held that inability to resist earthquakes constituted only a potential and not an actual hazard had effectually destroyed them. Few local bodies were greatly concerned, but some, notably the Wellington City Council, continued to press successive governments for the restoration and strengthening of these powers.

In 1961 the Model Building Code came up for revision, leading to an unfortunate controversy that resulted in seismic zoning becoming part of the code. Not only was this contrary to the weight of seismological evidence, but it was to divert energy that would have been better applied to the development of microzoning techniques and the carrying out of surveys of foundation characteristics.

Once consequence of New Zealand's moderate level of seismicity and its scattered population is that Napier is the only city of even moderate size to have been at the centre of a serious earthquake. Typical domestic houses performed well, and showed up the need to introduce anti-seismic measures for more substantial structures. There has been less appreciation of the vulnerability of gas, electrical, and water supplies, and of sewerage reticulation; and fire problems are not usually set in a seismic context. While the long-standing practice of sending a man on a jigger to inspect railway tracks whenever earthquakes are felt is in itself commendable, it is a somewhat primitive response to the more general problem of ensuring that communications remain open.

At the present time, research in seismology and into the problems of designing and constructing earthquake resistant buildings is vigorous and healthy, but there are still administrative barriers preventing the full application of existing knowledge. Even more serious than any defect of the Model By-Law is the fact that local bodies are not compelled to adopt it.

In 1970 there were still more than 50 who had either taken no action in the matter, or had declined to act. Powers to require the strengthening or removal of aging buildings are still limited, and are not always used. New building developments continue to take place on old river-beds, beach sands, or inadequately consolidated fill, and the excavations on many urban sub-divisions are imprudently steep. It is too soon therefore to bring the history of anti-seismic precautions to a tidy end.

SOURCES AND ACKNOWLEDGEMENTS

The preparation of this outline would have been much more difficult without the help of two unpublished theses presented for the M.A. degree of the University of Canterbury. Both of them contained valuable bibliographies, particularly Rawlinson, who lists most of the more recent primary sources. Copies of the theses are held in the University library. They are:

Rawlinson, M. R. 1971: Organisation for Disaster. The Development of Civil Defence in New Zealand, 1959-1970.
Bligh, P. McL. 1972: Human Adjustment to the Earthquake Hazard in New Zealand.

Older material will be found in:

Eiby, G. A. 1968, 1973: A Descriptive Catalogue of New Zealand Earthquakes.

Part I (before 1845) N.Z. Jl. Geol. Geophys. 11: 16-40.

Part II (1846 - 54) N.Z. Jl. Geol. Geophys. 16: 857-907.