EDGCUMBE, NEW ZEALAND, EARTHQUAKE - MARCH 2, 1987

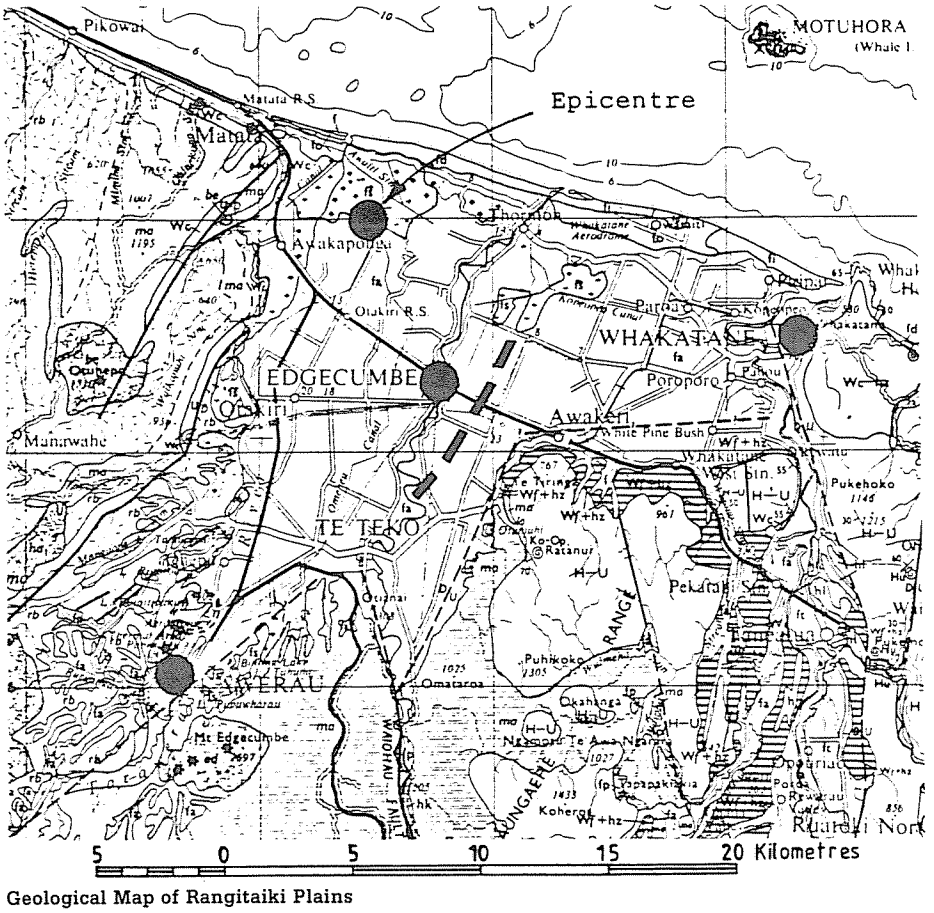
Introduction

On March 2, 1987 at 1:42 p.m. a magnitude 6.3 earthquake struck the Bay of Plenty region of the North Island of New Zealand. Propagating along a previously unmapped fault, the earthquake caused surface ruptures near the town of Edgecumbe. The adjacent towns of Kawerau, Te Teko, and Whakatane were also affected. Soil failures, liquefaction, settlement and landslides occurred throughout the region. A peak horizontal ground acceleration of 0.33 g was recorded approximately 10 km from the fault rupture, and higher accelerations were estimated in the damaged area.

This report contains contributions from T. N. Mitchell, Chief Structural Engineer, NZ Ministry of Works and Development (MWD); B. Shephard, MWD; Professor M. J. Pender, University of Canterbury; R. P. Kassawara, Electric Power Research Institute (EPRI); and D. Hopkins, President, NZ National Society for Earthquake Engineering (NZNSEE). Overlapping information has required that the submissions be rather severely edited by A. G. Brady. The late publication of this report implies that some of the preliminary information might have been superseded - the reader is expected to be duly aware.

Earthquake

The main shock, M 6.3, (Department of Scientific and Industrial Research (DSIR)) was located at latitude 37.92S, longitude 176.79E, when restricted to a maximum depth of 12 km (DSIR, on 13 March 1987), occurring at 1:42 pm local time (0142:34s GMT).



Geological Map of Rangitaiki Plains

USGS sources provide the following values: magnitudes MS 6.5, Mb 6.1; 0142:33.7 GMT; 1:42 p.m. local time; 37.92S, 176.75E, unrestricted depth 15 km.

Seismic activity in the general area during the previous week produced a foreshock on March 2 of ML 5.2 at 0135:37s. Four aftershocks with magnitudes in excess of 5.0 occurred on March 2 at 0151:08s (ML 5.5), 0207:23s (ML 5.0), 0656:32s (ML 5.2) and 0755:09s (ML 5.1).

The main shock produced a complex surface scarp about 6 km long striking SW from Edgecumbe. About 1 m of extension occurred across the scarp with the area to the north-west being downthrown by about 1.5 m and continuing to slowly subside. There are some indications of a minor strike-slip component in the faulting. Other smaller normal fault traces have been detected and additional deformation features include compressional rolls and sandblows.

The soil conditions on the plains consist of approximately 300 - 400 m of alluvial material overlying ignimbrite. The top of the profile has several meters of loose sand. Consequently there was extensive evidence of level ground liquefaction, and lateral spreading near rivers. Both these phenomena produced eruptions of sand at the ground surface.

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Soon after the earthquake, the Bay of Plenty Catchment Commission arranged for the Department of Lands and Surveys to level the main benchmarks on the plains. This has confirmed the regional subsidence. The measurements show that a maximum subsidence of 2 meters occurred just south of Edgecumbe, and subsidences of 0.4 m at Te Teko and 0.3 m on the coast at Thornton were observed. Associated with this subsidence was serious damage to some stretches of the stopbanks which provide flood protection from the three rivers that cross the plains.

Approximate population of main centers is:

Edgecumbe	1,800
Kawerau	8,300
Whakatane	12,800

There was no loss of life and only a few injuries. This can be attributed largely to the fact that the foreshock was sufficiently strong to cause a loss of electricity supply particularly at Edgecumbe. In buildings that had little or no natural lighting occupants vacated the buildings prior to the main shock seven minutes later.

Ground Deformation

Compression and tension failure of road pavements (base course and macadam seal), concrete kerbs, footpaths and driveways, railway lines and underground services are mainly confined to the Edgecumbe township area, but are numerous within that zone (Edgecumbe is approximately 7 km from epicenter).

Some wells in the area were observed to have increased flows or increased pressures whilst others had decreased flows. On one farm a well, which had water level below the ground surface before the event, had water spurting about one meter into the air just after the earthquake. This flow then subsided gradually and after three days water was barely flowing at the surface. Also springs appeared at some places on the plains.

Intensity

Modified Mercalli intensities of IX have been reported in and around Edgecumbe, with possible instances of MM X. These intensity levels are consistent with previous magnitude 5 events in the region, producing epicentral intensities of MM VII and VIII.

Building Damage

Structural damage to residential buildings was most severe in Edgecumbe where many chimneys collapsed, tile roofs were damaged and a few houses suffered foundation collapse because of lack of adequate subfloor bracing. Houses in Kawerau suffered some loss of chimneys but damage in Whakatane was slight.

Of the several thousand houses in the Bay of Plenty only a few hundred sustained some structural damage, and less than 50 suffered substantial structural damage. There were few surprises, to earthquake engineers at least, in the behavior of houses. Those constructed according to modern standards generally performed well.

Commercial buildings such as single story shops generally suffered minor damage in the form of broken display windows. Contents were lost from shelves. The most substantial damage occurred to the shopping mall in Edgecumbe where the ceiling system collapsed over a substantial portion of the complex. This single story steel frame structure on a concrete slab floor suffered large distortions to the slab on grade. Separations of up to 100 mm occurred in many places on construction joint lines in two directions at right angles. Hard drawn wire reinforcing had failed.

Distortion of the building is likely to have arisen from ground instability as a result of liquefaction, and a general ground movement towards the river.

Among the power and industrial facilities suffering damage to various extents were Matahina Dam and Power Station, Kawerau Electrical Substation, Edgecumbe Electrical Substation, Bay Milk Products Limited, The New Zealand Distillery Company Limited, Whakatane Board Mills, the Caxton Paper Mills Limited, and the Tasman Pulp & Paper Mill at Kawarau.

The Tasman Pulp and Paper Mill at Kawerau suffered damage sufficient to close the mill production for some weeks.

At the Edgecumbe Dairy Factory substantial damage occurred with buckling and overturning of storage tanks, settlement and rotation of buildings founded on raft foundations, and damage to building elements from overturned storage racks or unrestrained product stacks. Further damage was caused by the sloshing of water from a rectangular water tank.

The hospital at Whakatane contains the highest building in the area. It is a 6-story two-way reinforced concrete frame structure adjacent to a services tower which has shear walls for the primary seismic resistance.

The designer of the structure was able to perform an inspection on the Wednesday morning. There was no significant structural damage to the building but the building was evacuated because of the flooding caused by the failure of the plastic pipe connections to the water supply tanks at roof level. Some ceiling tiles were displaced and a brass plate covering the 100 mm seismic break in a corridor floor suffered shearing of its anchorages and fell to the corridor below.

Large structures were damaged and several thin-walled stainless steel tanks collapsed, often onto adjacent piping, at

the dairy products plant and the distillery in Edgecumbe. Most of the damaged tanks were filled from 50% to 100% of capacity. Mild steel tanks with thicker walls sustained no significant damage. Buildings on pile foundations performed well.

Matahina Dam

The Matahina Dam is located on the Rangataiki River approximately 20 km from the epicenter. It is 79 m high and has a clayey gravel core, weathered ignimbrite transitions and rockfill shoulders all founded on alluvial sediments but having ignimbrite abutments. No damage occurred to the powerhouse or switchyard.

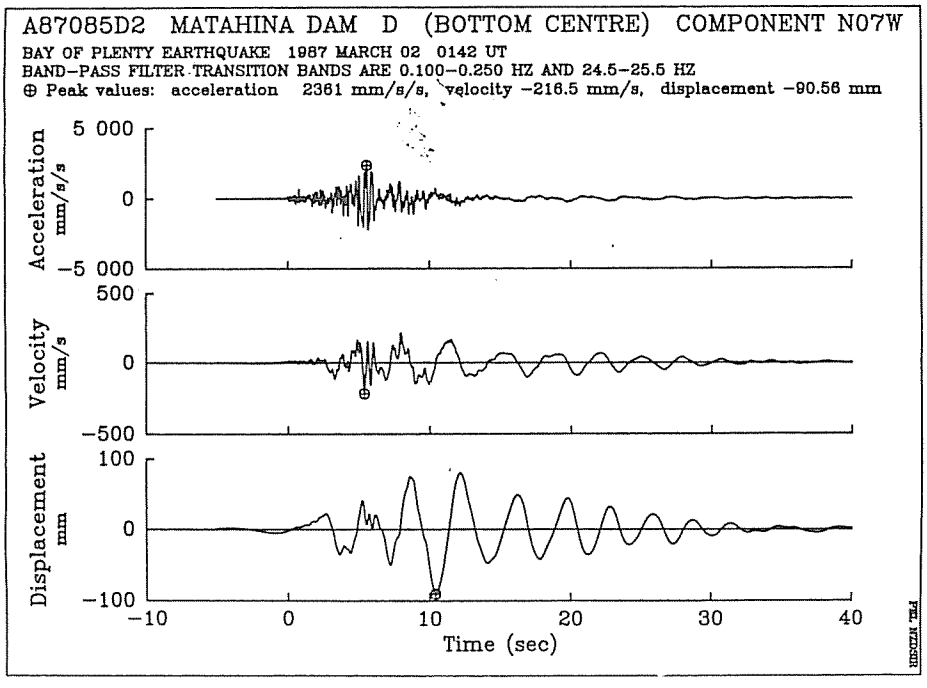
This is the most significant structure in the region. It is also the site of the strong motion instrumentation closest to the epicenter. These instruments, which are serviced by the DSIR Physics and Engineering Laboratory, gave the peak ground acceleration at the base of the dam of 0.33 g and, in the upstream-downstream direction, 0.43 g at the crest. Under these accelerations the dam performed well. There were slightly increased seepage flows through the structure and slight cracking at the crest. Surveys immediately after the event showed that a downstream displacement of about 200 mm had occurred at the crest.

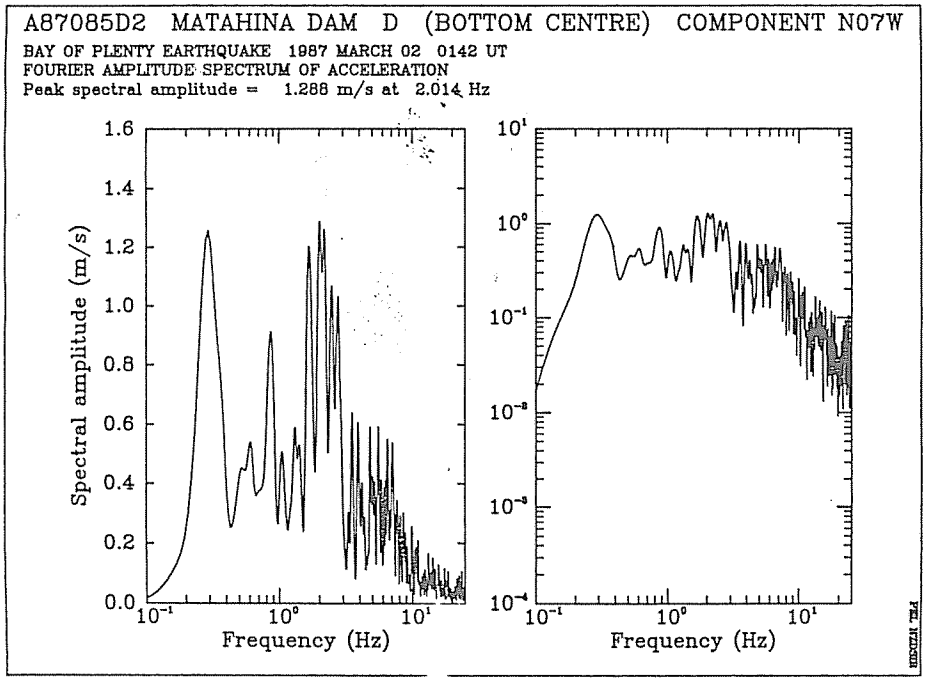
River Control Works

Stopbanks suffered slumping and cracked longitudinally and transversely and will require reinstatement if they are to withstand their design flood levels.

Roading

Roading in some locations in the area was closed for a few hours by slips. Damage was also caused by slumping of bridge approach embankments, which were also speedily repaired.



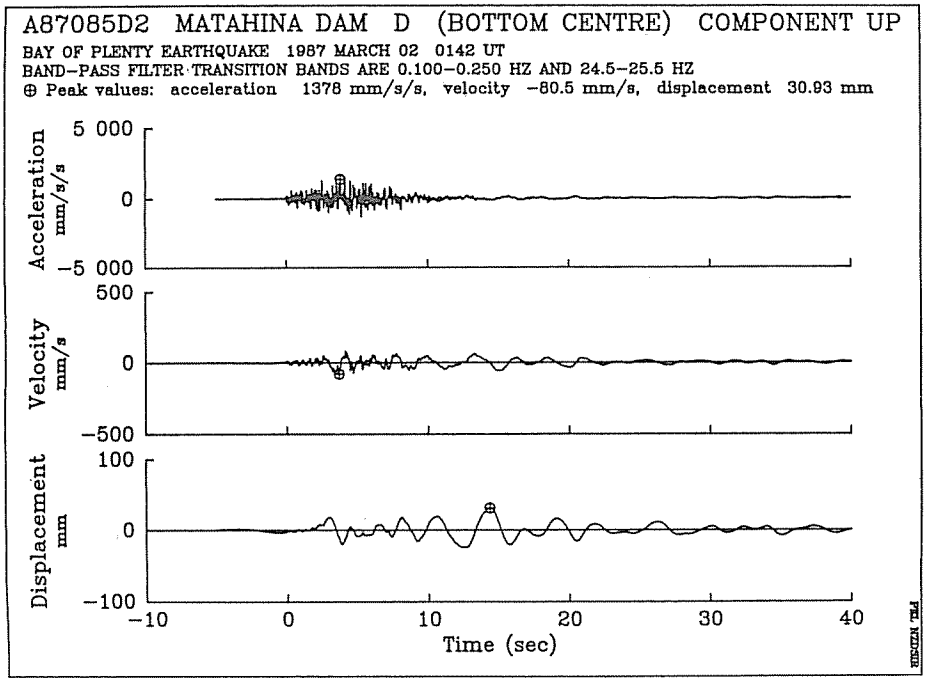


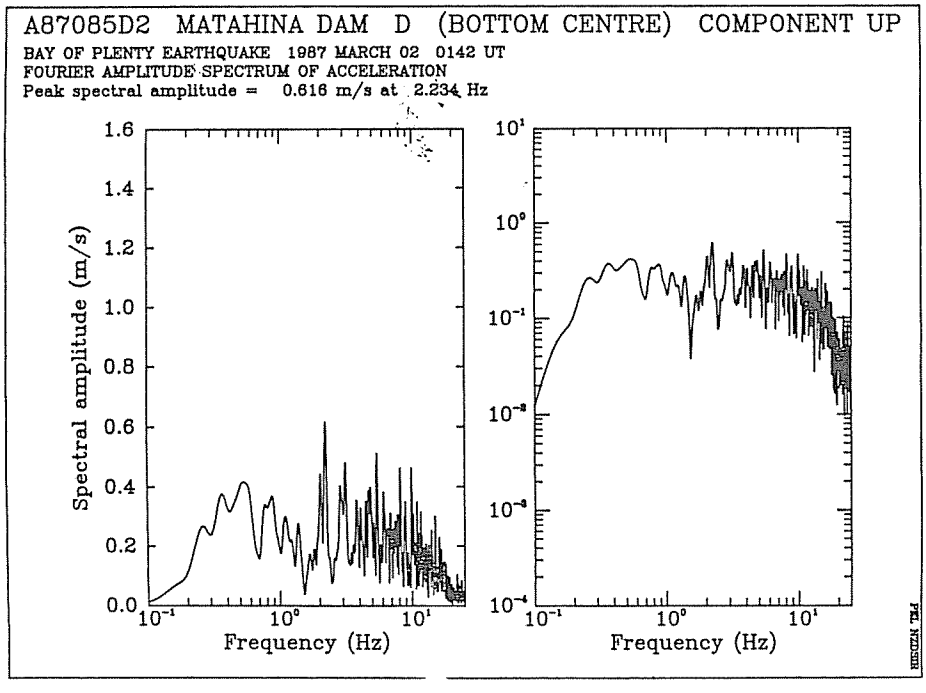
Bridges

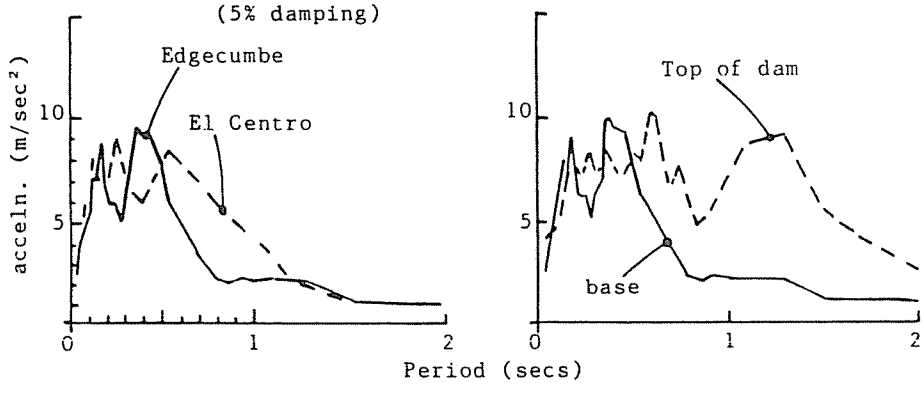
Bridges in the area suffered only minor damage. The base-isolated State Highway bridge at Te Teko, comprising single stem concrete piers on raked piles, and incorporating lead/rubber elastomeric bearings at the piers and elastomeric bearings at the abutments, suffering slight spalling of cover concrete of the pier at the plastic hinge zone and one of the abutment bearings was displaced 750 mm along the abutment pile cap. Knock-off devices at abutments were displaced.

Electricity Substations

Electricity substations in Edgecumbe and Kawerau suffered damage and loss of service. Electrical power equipment sustained damage similar to that caused by past earthquakes; that is, broken or sheared switchyard and ceramic compo-







Note: Inserts may be reproduced as desired.

nents, transformer anchorage damage and damage to poorly anchored electrical equipment.

Communication equipment at the telephone exchange was not significantly affected by direct earthquake action.

A waste water pumping station at Whakatane became unserviceable because of gross settlement as a result of liquefaction of the subsoils.

The main supply steel gasline, 114 mm diameter, 4.8 mm thickness, crossed the fault trace with a U-bend installed for other reasons. It was undamaged even though suffering an extension of 700 mm.

Underground services in Edgecumbe were seriously disrupted by the earthquake. Over 400 breaks in water and waste water lines had to be repaired before the state of emergency could be lifted in the town. These repairs required more than two weeks.

Strong Ground Motion

Ground shaking was sufficient to overturn a locomotive at Edgecumbe and metal lathes at schools at Kawerau and Whakatane.

Strong motion accelerographs recorded peak ground acceleration of up to 0.33 g at the base of the Matahina dam, 15 km from the epicenter. Processing of this strong motion data by the DSIR Physics and Engineering Laboratory has produced a response spectrum surprisingly like the 1940 El Centro spectrum.

Follow-up

Further information on this earthquake is likely to appear in subsequent literature, for example the proceedings of a conference of the Institute of Professional Engineers of New Zealand (May, 1987) and of the Pacific Conference on Earthquake Engineering (August, 1987), as well as other technical journals.