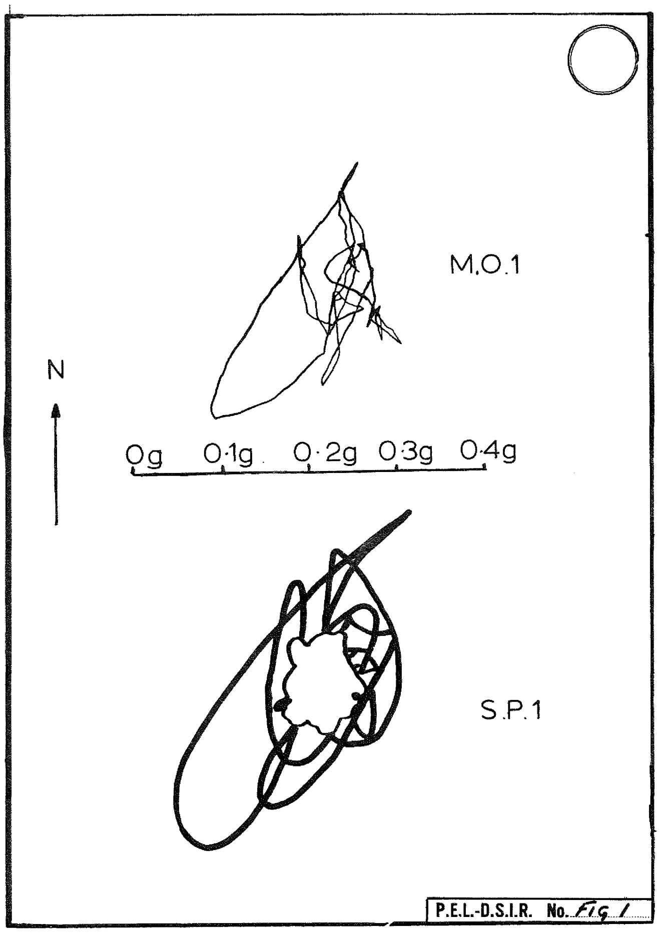
ENGINEERING SEISMOLOGY

W. R. Stephenson*

Instrumental effects

The aftershock that occurred at 12:45 GMT on June 5 gave the first direct comparison of a 3-component time base accelerograph (MO1) with the simpler scratch-plate horizontal accelerograph (SP 1) developed at Physics and Engineering Laboratory. Figure 1 shows both the SP1 record, and its equivalent derived from the MO1 at Westport Post Office. The scratch-plate type of instrument



gives a good idea of the number and direction of impulses, but only an approximate idea of their magnitude.

The largest five aftershocks recorded on the MO 1 proved to have their peak energy concentrated near 7 c/s which is nearer to structural and instrumental resonances than the 4-5 c/s thought typical before.

We can say that accelerations of the order of 0.3g to 0.5g occurred at close in areas such as Murchison, Reefton, and Westport. In any event, present thinking indicates that microzoning effects could dominate, and that peak accelerations at a point are no more than an indication of the order of forces in an area.

The SP1 record made at the Greymouth Post Office shows a pronounced east-west elongation, not characteristic of the earthquake in other localities. The elongation could be attributed to local ground effects.

Structural and ground effects

At Inangahua, an attempt was made to deduce ground motion from natural objects. For example, stones that have been thrown from depressions have been taken to indicate a vertical acceleration of greater than 1 g. Permanent displacements of objects can be taken to imply the directions of accelerations. Care must be taken in doing this sort of work, as structural effects can easily dominate. The direction of attack must be shown by many structures before it becomes admissable evidence. On this basis nothing was found at Inangahua.

+ Physics and Engineering Laboratory, Department of Scientific and Industrial Research.
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The most significant damage at Inangahua was that occurring to the Inangahua road-rail bridge, the Buller rail bridge, and domestic dwellings.

The Inangahua bridge (Fig. 2) and the Buller bridge (Figs. 3 and 4) were attacked in two distinct ways.

Each pier, with some of the mass of the spans, acted in cantilever fashion, with the excitation applied at the top. In this situation, the maximum bending moment occurs near the root, and, indeed, the piers on both bridges were fractured near the ground. Such a damaged cantilever can still withstand considerable vertical loading.

Both the bridges also suffered damage due to longitudinal compressive forces, which sheared bolts holding the spans to piers and abutments, closed expansion joints in the rails, and buckled various straps. These longitudinal forces were apparently caused by soil flowing behind the abutments and forcing them towards the river, during times when the abutments were vibrated in that direction. This compressive force was a blessing in disguise, because the inertial forces developed were insufficient to detach the spans from the piers, and allow the spans to fall into the river. The compressive forces gave the structure enough coherence to remain on the piers, and the total damage was smaller than it may have been. The action of spans detaching from piers was seen on the Showa bridge, Niigata, Japan after the earthquake of June 16, 1964.

Domestic dwellings suffered, as usual, from certain weaknesses in structural design. The New Zealand wood-frame dwelling would be highly resistant to earthquakes if it had continuous foundations externally, and a light reinforced chimney. Conventional piles have low resistance to a force applied horizontally at their tops, while the chimney is far stiffer than the building frame and, in undergoing displacement relative to the frame, causes damage. The present inadequacy of tie wires and tile battens was also demonstrated, and many examples of failure of each were seen. Even when the roof did not shed the tiles, the chimney crashed through, but corrugated iron roofs deflected the chimneys to the ground outside.

Conclusion

Because there were no major engineering works, or multistorey buildings in the area, the main lessons for engineering seismology were indirect. The low casualties and relatively low damage may lead to the severity of this earthquake being under-rated.