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From Case History to Practice
In honour of Prof. Kenji Ishihara

A COMPARISON OF GROUND MOTIONS AND FIRST-HAND EXPERIENCE OF THE 2011 M_W6.3 CHRISTCHURCH, NEW ZEALAND AND 2011 M_W9.0 TOHOKU, JAPAN EARTHQUAKES

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EXTENDED ABSTRACT

This poster provides a comparison between the strong ground motions observed in the 22 February 2011 M_w6.3 Christchurch earthquake with those observed in Tokyo during the 11 March 2011 M_w9.0 Tohoku earthquake. The destuction resulting from both of these events has been well documented, although tsunami was the principal cause of damage in the latter event, and less attention has been devoted to the impact of earthquake-induced ground motions. Despite Tokyo being located over 100km from the nearest part of the causative rupture, the ground motions observed from the Tohoku earthquake were significant enough to cause structural damage and also significant liquefaction to loose reclaimed soils in Tokyo Bay. The author was fortunate enough (from the perspective of an earthquake engineer) to experience first-hand both of these events. Following the Tohoku event, the athor conducted various ground motion analyses and reconniassance of the Urayasu region in Tokyo Bay affected by liquefaction in collaboration with Prof. Kenji Ishihara. This conference is therefore a fitting opportunity in which to discuss some of authors insights obtained as a result of this first hand knowledge.

Figure 1 illustrates the ground motions recorded in the Christchurch CBD in the 22 February 2011 and 4 September 2010 earthquakes, with that recorded in Tokyo Bay in the 11 March 2011 Tohoku earthquake. It is evident that these three ground motions vary widely in their amplitude and duration. The CBGS ground motion from the 22 February 2011 event has a very large amplitude (nearly 0.6g) and short duration (approx. 10s of intense shaking), as a result of the causal M_w6.3 rupture at short distance (R_{rup}=4km). The CBGS ground motion from the 4 September 2010 earthquake has a longer duration (approx. 30s of intense shaking), but reduced acceleration amplitude, as a result of the causal M_w7.1 rupture at a short-to-moderate distance (R_{rup}=14km). Finally, the Urayasu ground motion in Tokyo bay during the 11 March 2011 Tohoku earthquake exhibits an acceleration amplitude similar to the 4 September 2010 CBGS ground motion, but a significantly larger duration (approx 150s of intense shaking). Clearly, these three different ground motions will affect structures and soils in different ways depending on the vibration characteristics of the structures/soil, and the potential for strength and stiffness degradation due to cumulative effects.

Figure 2 provides a comparison between the arias intensities of the several ground motion records from the three different events. It can be seen that the arias intensities of the ground motions in the Christchurch CBD from the 22 February 2011 earthquake (which is on average AI=2.5m/s) is approximately twice that from the 4 September 2010 earthquake (average AI≈1.25). This is consistent with a factor of approximately 1.6 obtained by Cubrinovski et al. (2011) using the stress-based (i.e.

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PGA-MSF) approach of liquefaction triggering. It can also be seen that the arias intensity of the ground motions recorded in Tokyo during the 2011 Tohoku earthquake are larger than ground motions in the Christchurch CBD from the 4 September 2011 earthquake, but smaller than those of the 22 February 2011 earthquake. Based on the arias intensity liquefaction triggering approach it can therefore be concluded that the ground motion severity, in terms of liquefaction potential, for the Tokyo ground motions is between those ground motions in Christchurch CBD from the 4 September 2010 and 22 February 2011 events.

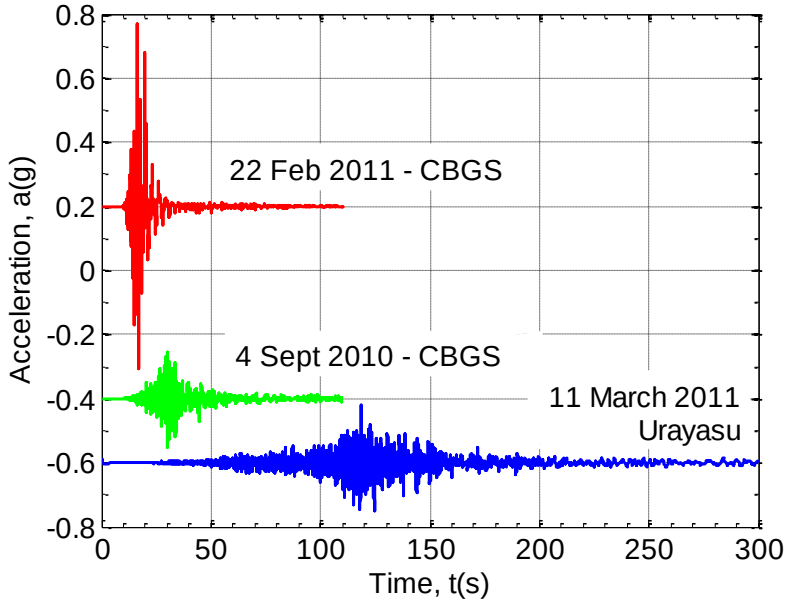

Figure 1: Comparison of the ground motions recorded at Christchurch Botanic Gardens (CBGS) during the 22 February 2011 Christchurch earthquake and the 4 September 2010 Darfield earthquake with the ground motion recorded in Tokyo Bay (Urayasu) during the 11 March 2011 Tohoku earthquake.

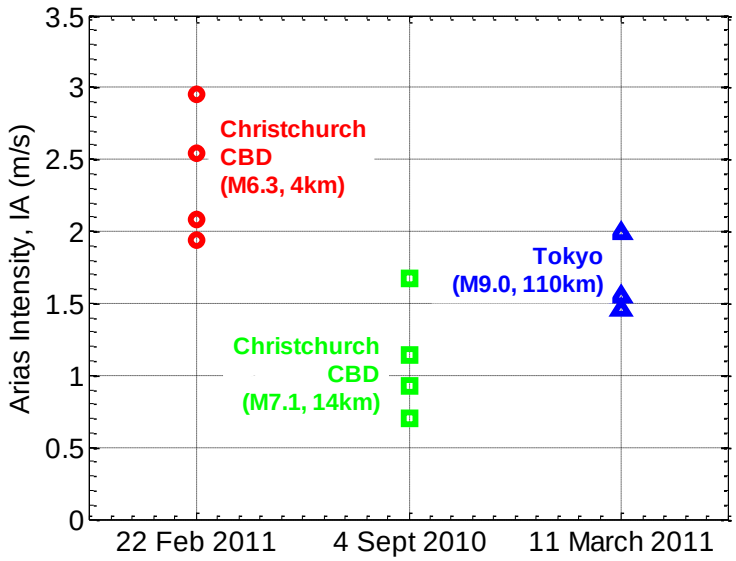

Figure 2: Comparison of the Arias intensity of ground motions in the three different events.

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