CONSIDERATIONS REGARDING EARTHQUAKE-RESISTANT DESIGN OF WOODEN RESIDENCES UTILIZING MEASUREMENT DATA TAKEN WITH A SEISMOGRAPH FOR STANDALONE RESIDENCES WITH DAMAGE ASSESSMENT FUNCTIONALITY

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1 PREAMBLE

In 2010, we were selected for sponsorship by the Ministry of Land, Infrastructure, Transport and Tourism’s Project for the Sponsorship of Advanced Residential and Architectural Technologies. We developed a residential seismograph with built-in damage assessment functionality for use in standalone, detached homes (hereinafter referred to as “seismograph”).

We previously presented background on development of this seismograph and on the methodologies used in damage assessment at WCTE 2012 (Auckland) [1]. As stated in source [1], Japan has many earthquakes, and the 2011 Tohoku-Oki Earthquake produced damage over an exceedingly wide area, with the ensuing restoration inquiry and response taking a considerable amount of time. The damage manifested itself as torn cloth wallpaper, fallen tiles, cracked foundations, destroyed supporting walls, liquefaction, and tsunami damage. In some cases, the affected subsoil led to damage of buildings.

By measuring the seismic input on a per-building level and analyzing the discrete data for each residence, we researched new approaches for earthquake-resistant design and for diagnosing earthquake-resistance of extant structures. We believe the above is possible by computing response analysis from seismic input (measured data) on buildings and making explicit its discrete features.

In this report, we use analytical data from seismographs in City A, pictured in Figure 1, as an example.

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Table 1: Recorded JMA intensity and maximum acceleration

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Time</th>
<th>Location</th>
<th>JMA Intensity</th>
<th>Max Acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2012-10-19</td>
<td>4:20</td>
<td>JMA Seismograph</td>
<td>5.5</td>
<td>8.2</td>
</tr>
<tr>
<td>2</td>
<td>2012-10-19</td>
<td>4:25</td>
<td>JMA Seismograph</td>
<td>6.0</td>
<td>9.5</td>
</tr>
<tr>
<td>3</td>
<td>2012-10-19</td>
<td>4:30</td>
<td>JMA Seismograph</td>
<td>6.5</td>
<td>10.2</td>
</tr>
<tr>
<td>4</td>
<td>2012-10-19</td>
<td>4:35</td>
<td>JMA Seismograph</td>
<td>7.0</td>
<td>11.5</td>
</tr>
<tr>
<td>5</td>
<td>2012-10-19</td>
<td>4:40</td>
<td>JMA Seismograph</td>
<td>7.5</td>
<td>12.8</td>
</tr>
</tbody>
</table>

2 SUMMARY OF SEISMOGRAPH PLACEMENT

In this report, we use analytical data from seismographs in City A, pictured in Figure 1, as an example. Point (a) in Figure 1 is the seismograph we developed; point (b) is a seismograph installed by the Japan Meteorological Agency; and point (c) is a seismograph installed by the National Research Institute for Earth Science and Disaster Prevention (K-NET). The placement of each seismograph is detailed in Figure 2. The seismographs in points (a) and (c) are situated on buildings atop a cliff, while the seismograph in point (b) is situated on a building on a gentle slope. Between January 18th, 2012 and March 7th, 2013, point (a) recorded 147 tremors. Of these, we have extracted those with the strongest JMA intensity and describe them in Table 1. The epicenter place names are as follows: I) Southern Tokachi; II) Sanriku Coast; III) Aomori Prefecture Eastern Coast; IV) Iwate Prefecture Coast; V) Miyagi Prefecture Coast; VI) Fukushima Prefecture Coast; and VII) Northern Miyagi Prefecture. Table 1 shows that the JMA intensity recorded at point (a) was greater than that at the Japan Meteorological Agency’s seismograph at point (b). We believe this corresponds to features of the underlying ground at the respective locations.

3 EARTHQUAKE RESPONSE SPECTRUM

Figures 3-4 describe the earthquake response spectrum at each location, (point a and b). The dominant period for points (a) (Fig. 3), and (b) (Fig. 4), was 0.4sec and 0.2sec, respectively.

In addition, we conducted a comparative earthquake response spectrum for the earthquakes dated January 13, 2013 (No.23), and February 26, 2013. (Fig. 5-6).

We believe the dominant periods diverge because of features of the underlying ground at the respective locations. We plan to use these results for future earthquake-resistant design.

4 CONCLUSIONS

Affixing discrete seismographs (sensors) to residences and utilizing the resultant data on seismic input at each location allows for earthquake-resistant design and diagnosis of earthquake-resistance on a per-building basis.

REFERENCES