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# Simulated Earthquake Seismic Shaking Table Testing Report

正本

Test Number: NCREE-LT-TQM-D-T1601 2017005
Report Date: January 10, 2018

Test Name ：PREFABRICATED WATER TANK EARTHQUAKE TEST

Tested Item： PREFABRICATED WATER TANK
(Brand: PIPECO, Model Number: 2 m × 2 m × 2 m,
Serial Number: N/A)

Applicant Contacts：PIPECO INTERNATIONAL INDUSTRY CO., LTD

Applicant Address：2F., No.8, Sec. 1, Chenggong Rd., Nangang Dist., Taipei City 115, Taiwan (R.O.C.)

Applicant Telephone：+882-2-2788-1099

This equipment has been tested in our laboratory. The results are described herein. This report comprises of 9 pages including attachments and an Appendix. Using separately is invalid.

國家地震工程研究中心 地震模擬實驗室 National Center for Research on Earthquake Engineering

黃世建

Director of NCREE

**National Applied Research Laboratories**
**National Center for Research on Earthquake Engineering**
**Seismic Simulation Laboratory**

# Explanation Relating to Use of Test Report

1. Test applicant may use this report at will only as a whole. It's not allowed to extract or duplicate the results of this report arbitrarily, unless it's approved by the Seismic Simulation Lab, NCREE.
2. The results of this report are valid only to the tested components under specific test items which is shown in contents.
3. If the report is stamped "Republished", the original testing report is declared void.

Cheng-Piao Cheng
Approval signatory

Chi-Hung Wu
Report Author

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2017005

Applicant： PIPECO INTERNATIONAL INDUSTRY CO., LTD / 2F., No.8, Sec. 1, Chenggong Rd., Nangang Dist., Taipei City 115, Taiwan (R.O.C.) /+882-2-2788-1099

Date of Test(s)：May 25, 2017

Equipment Used and Operator：Tri-Axial Earthquake Simulation Shaking Table System.
Test Operators Personnel：Chia-Hsin Hu

Preparation for the Test：

1. The specimen (PREFABRICATED WATER TANK) size was 2 m × 2 m × 2 m. The shaking table was canvassed over with blue and white waterproof canvas to avoid water splashed from the specimen during tests. A full appearance of the specimen is shown in Figure 1.
2. The base of the specimen was fixed on three parallel H-beams with 5 M30 bolts (Figure 2).
3. The specimen was filled with about 85 % capacity of water to a depth of approximate 170 cm as shown in Figure 3.
4. The assembly and installation before tests, disassembly after tests and conveyance were executed by the test applicant.

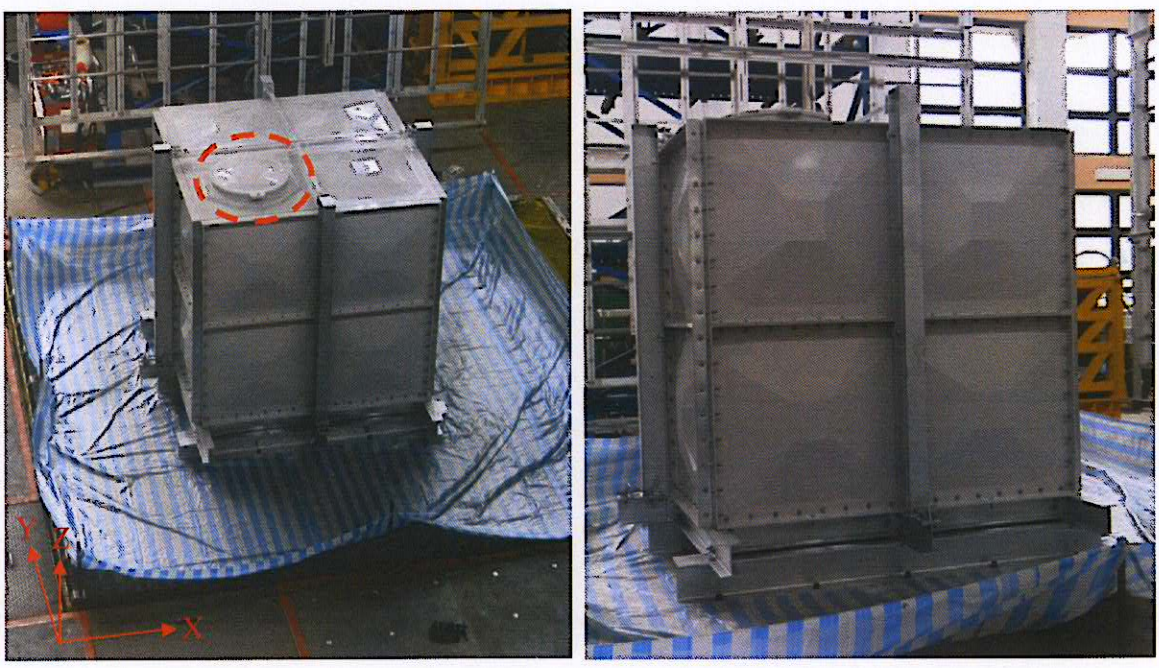


Figure 1：A full appearance of the specimen (PREFABRICATED WATER TANK) is shown in left and right picture, the manhole of the specimen was marked with a red cycle.

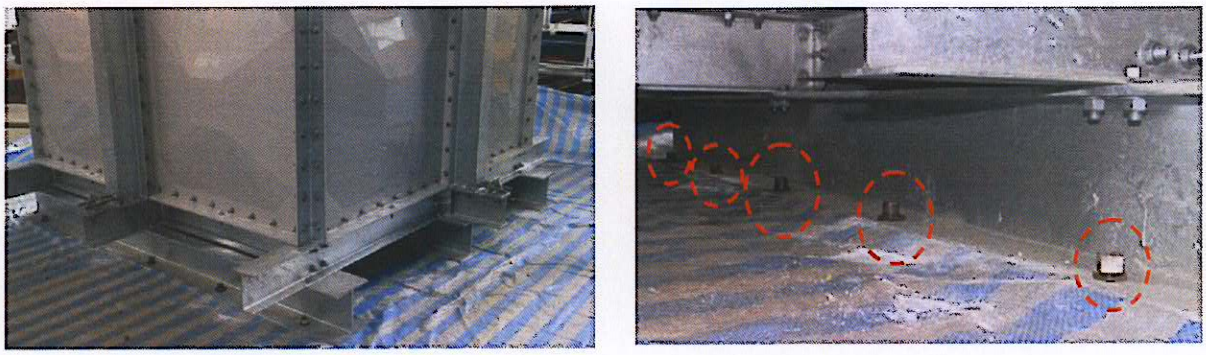

Figure 2：The base of the specimen was fixed on three parallel H-beams, and all H-beams were fixed on the shaking table with 5 M30 bolts and marked with red cycles as shown in right picture.

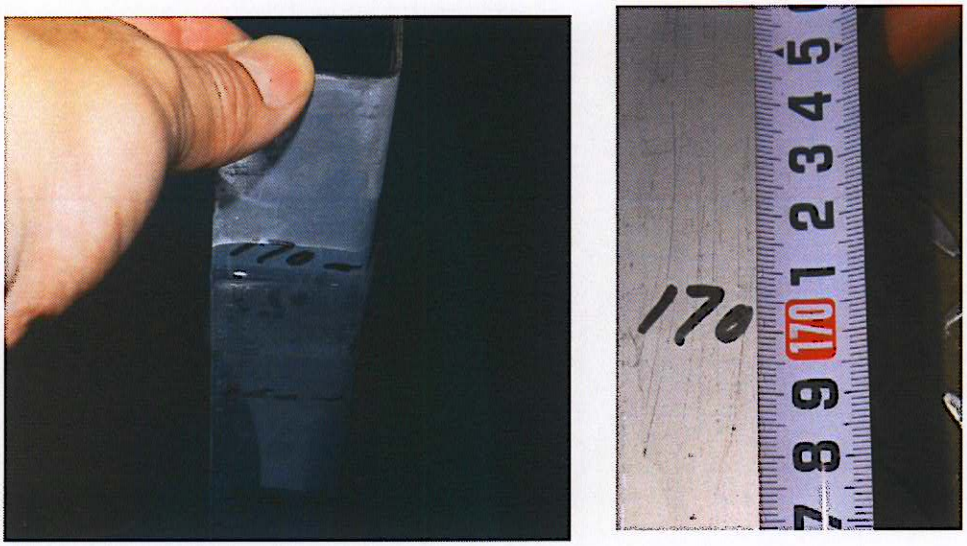


Figure 3：The specimen was filled with about 85 % capacity of water (6.8 tons) to a depth of approximate 170 cm.

**Test Method**： Test method for Earthquake Simulated Seismic vibration stations (NCREE-LT-TQM-B-T01, 2014, version 2.2)：

1. Section 6.1 Natural Earthquake Time History Test.

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Test Item：

The tests are conducted using ground acceleration recorded at the September 21, 1999 Chi-Chi earthquake (station name: TCU 129). The names, direction, intensity, and test information is shown in the following table:

| Test Item | Input Motion | Direction of Earthquake(Shaking table) / Required peak ground acceleration (PGA) (g*) | Seismic intensity** |
|---|---|---|---|
| (1) | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / ≧ 0.250 g<br>Y- axis / ≧ 0.155 g<br>Z- axis / ≧ 0.085 g | 6 (Very strong) |
| (2) | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / ≧ 0.400 g<br>Y- axis / ≧ 0.248 g<br>Z- axis / ≧ 0.136 g | 7 (Great) |
| (3)*** | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / ≧ 1.000 g<br>Y- axis / ≧ 0.372 g<br>Z- axis / ≧ 0.204 g | 7 (Great) |
| (4)**** | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / ≧ 1.500 g<br>Y- axis / ≧ 0.372 g<br>Z- axis / ≧ 0.204 g | 7 (Great) |
| (5) | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / ≧ 2.000 g<br>Y- axis / ≧ 0.372 g<br>Z- axis / ≧ 0.204 g | 7 (Great) |

***1 g = 1000 gal = 9.807 m/s$^2$**

**** The definition of earthquake intensity scale publicized by the Central Weather Bureau on August 1, 2000**

| Intensity Scale | | Peak Ground Acceleration Range(PGA) |
|---|---|---|
| 5 | Strong | 0.08 g to 0.25 g |
| 6 | Very strong | 0.25 g to 0.40 g |
| 7 | Great | Over the 0.40 g |

***** Due to the displacement capacity limit of the shaking table, the maximum PGA value of the Y axis and Z axis keep on 0.372 g and 0.204 g, and the test frequency range from 0.1 Hz to 50 Hz (Shape：0.1 Hz to 50 Hz) when executing test item (1) to (3).**

****** Due to the displacement capacity limit of the shaking table, for X axis can achieve 1.500 g and 2.000 g, the test frequency range from 0.5 Hz to 50 Hz (Shape：0.5 Hz to 50 Hz) when executing test item (4) and (5).**

**Test method or procedure：**

1. Before tests, the test applicant confirmed the completion of the installation of relevant metal components of the specimens.
   1.1 The operation of the Simulated Earthquake Seismic vibration stations system is according to the "Simulated Earthquake Seismic vibration stations Standard Operational Procedures for testing" and "Simulated Earthquake Seismic vibration stations System Evaluation Operational Procedures"
2. Closed the manhole when filled water with depth of approximate 170 cm, and test item (1) to (5) are performed with the tri-axial earthquake simulation shaking table.
3. Once the test items are completed, laboratory personnel and the test applicant perform an assessment of the specimen, from an external viewpoint, to check if the metal components are loose, damaged, or deformed.
4. For the above tests, the data sampling for shaking table system is 256 Hz.

**Test Results：**

1. The achieved input time history data, direction, magnitude, and other information are listed as follows.

| Test Item | Input Motion | Direction of Earthquake (Shaking table) / Achieved PGA (g*) | Seismic intensity | Test Results |
|---|---|---|---|---|
| (1) | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / 0.284 g<br>Y- axis / 0.177 g<br>Z- axis / 0.100 g | 6 (Very strong) | There is no damage or breakage found on the specimen. There is no broken or loosen screw bolts used to fix the specimen. |
| (2) | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / 0.427 g<br>Y- axis / 0.279 g<br>Z- axis / 0.148 g | 7 (Great) | |
| (3) | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / 1.060 g<br>Y- axis / 0.393 g<br>Z- axis / 0.213 g | 7 (Great) | During the test item (3) to (4), some water splashed from the manhole cover plate of the specimen. |
| (4) | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / 1.661 g<br>Y- axis / 0.400 g<br>Z- axis / 0.215 g | 7 (Great) | |

| Test Item | Input Motion | Direction of Earthquake (Shaking table) / Achieved PGA (g*) | Seismic intensity | Test Results |
|---|---|---|---|---|
| (5) | Chi-Chi earthquake (TCU129 station, Taiwan, 9/21/1999) Tri-Axial Seismic Simulation Test | X- axis / 2.245 g<br>Y- axis / 0.405 g<br>Z- axis / 0.239 g | 7 (Great) | During the test item (5), some water splashed from the manhole cover plate of the specimen. |

2. The input motion, transfer function, acceleration and displacement responses of the specimen are shown in Figure 4 to Figure 8.

3. During the test item (3) to (5), some water splashed from the manhole of the specimen (Figure 9).

4. After executing the tri-axial seismic simulations from item (1) to (5), there is no damage or breakage found on the specimen.

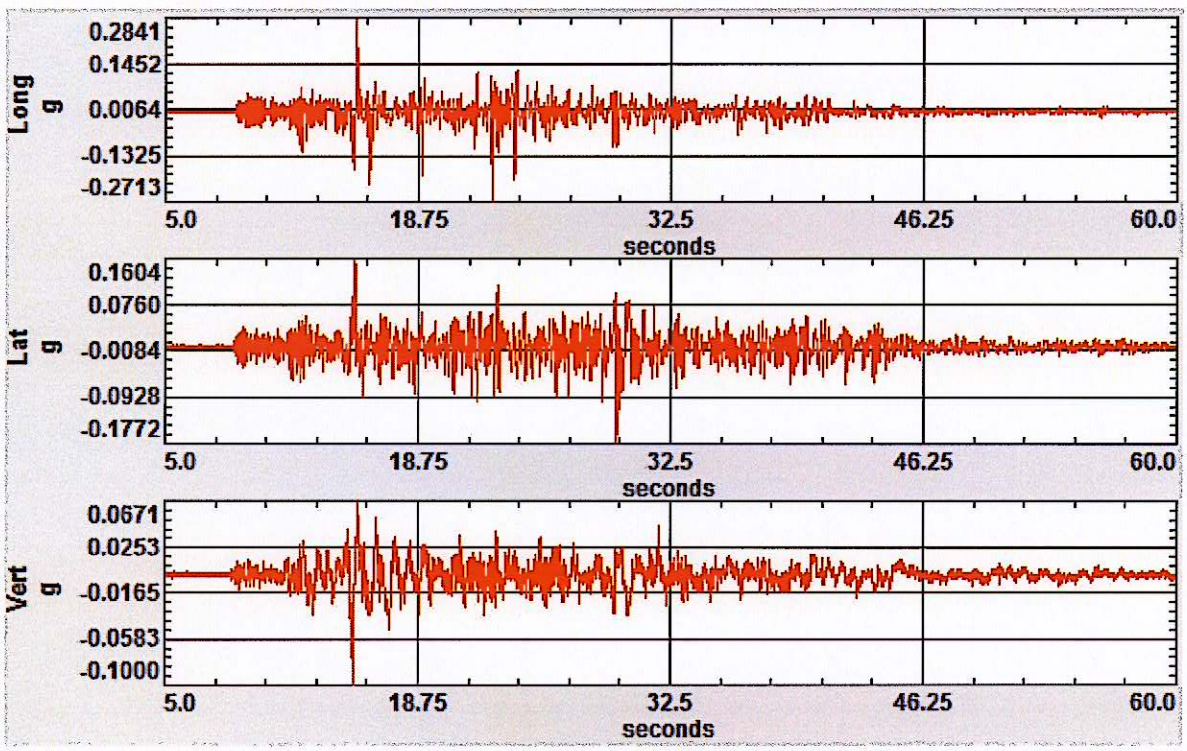


Figure 4：The results of test item (1)：The maximum peak values of the shaking table along X-axis (top plot), Y-axis (second plot), and Z-axis (bottom plot) were 0.284 g, 0.177 g, and 0.100 g.

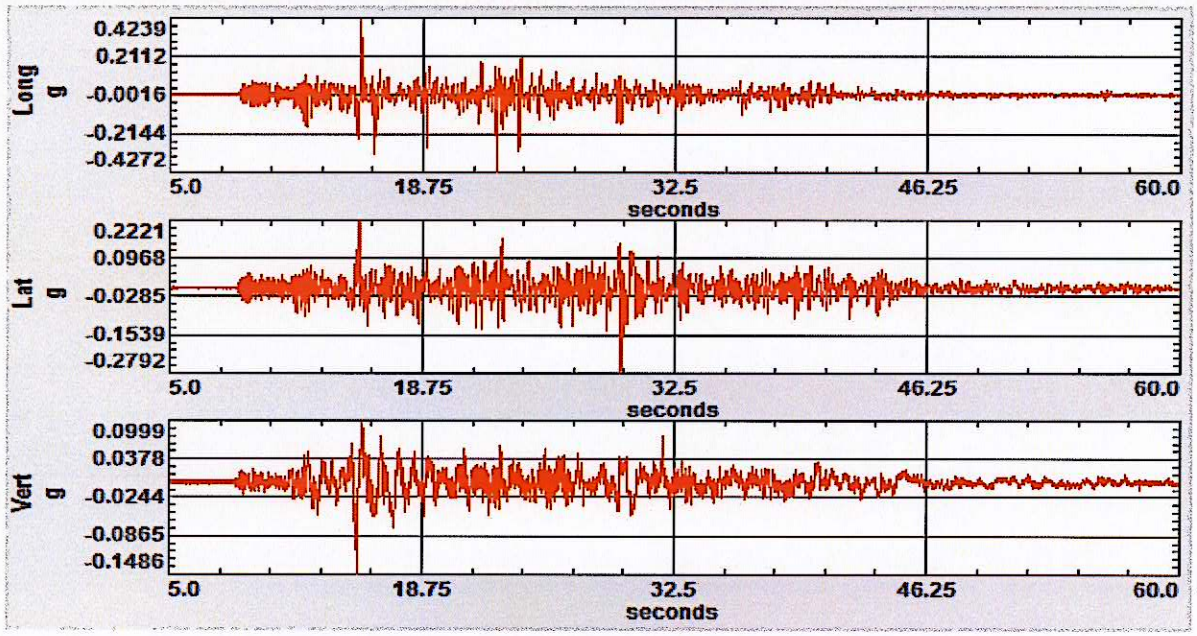


Figure 5 : The results of test item (2) : The maximum peak values of the shaking table along X-axis (top plot), Y-axis (second plot), and Z-axis (bottom plot) were 0.427 g, 0.279 g, and 0.148 g.

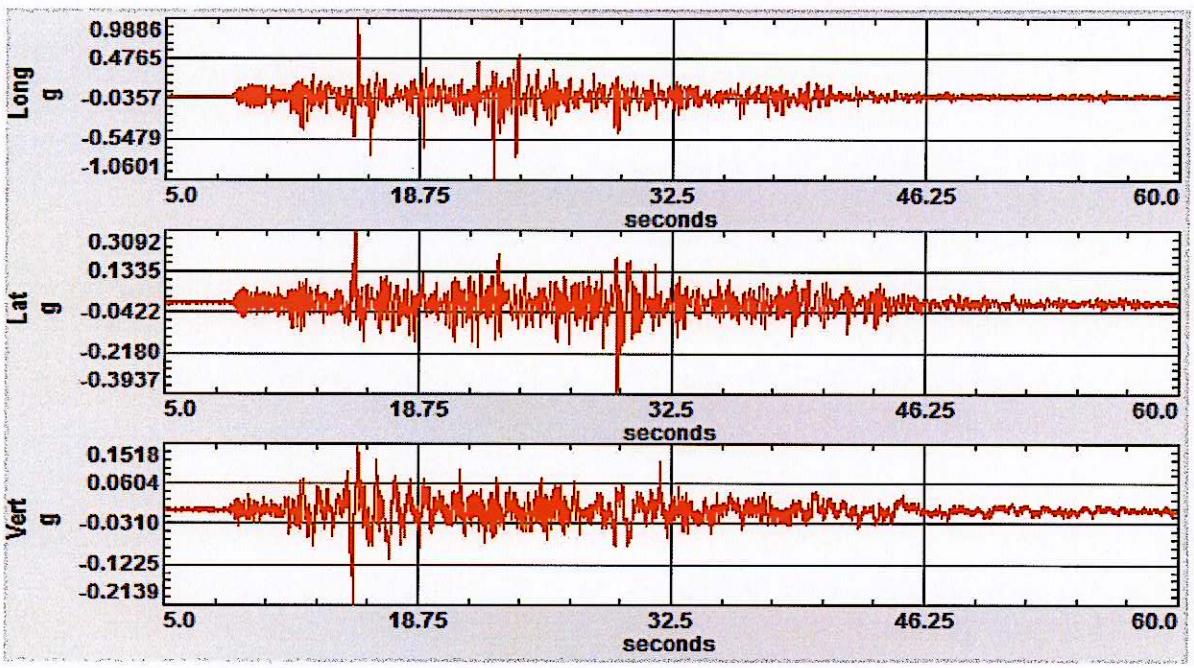


Figure 6 : The results of test item (3) : The maximum peak values of the shaking table along X-axis (top plot), Y-axis (second plot), and Z-axis (bottom plot) were 1.060 g, 0.393 g, and 0.213 g.

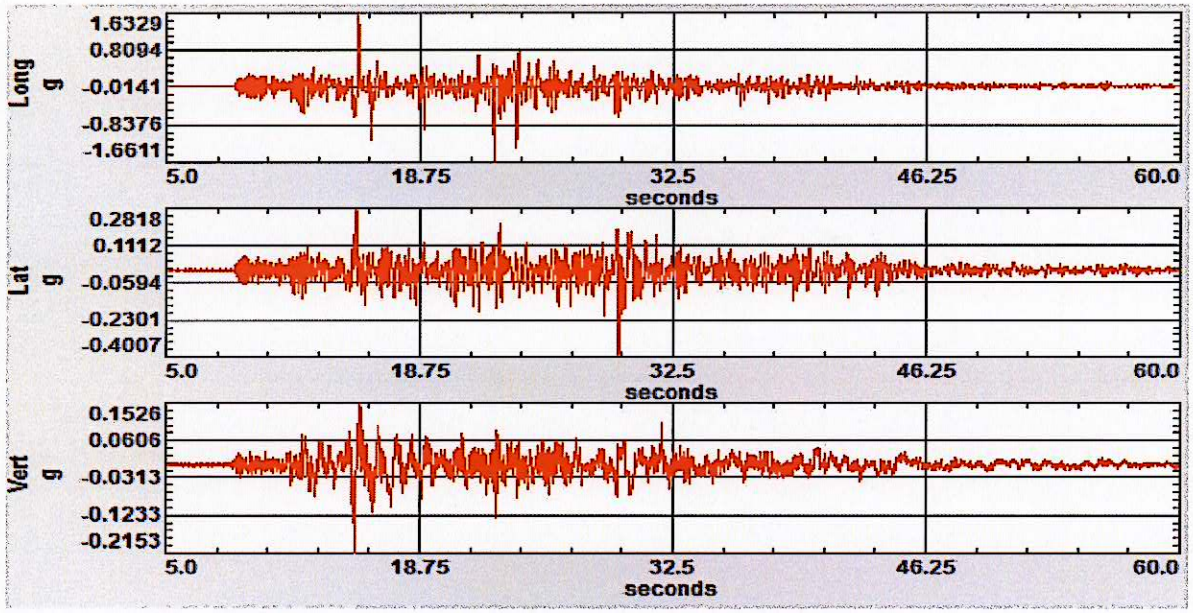


Figure 7 : The results of test item (4) : The maximum peak values of the shaking table along X-axis (top plot), Y-axis (second plot), and Z-axis (bottom plot) were 1.661 g, 0.400 g, and 0.215 g.

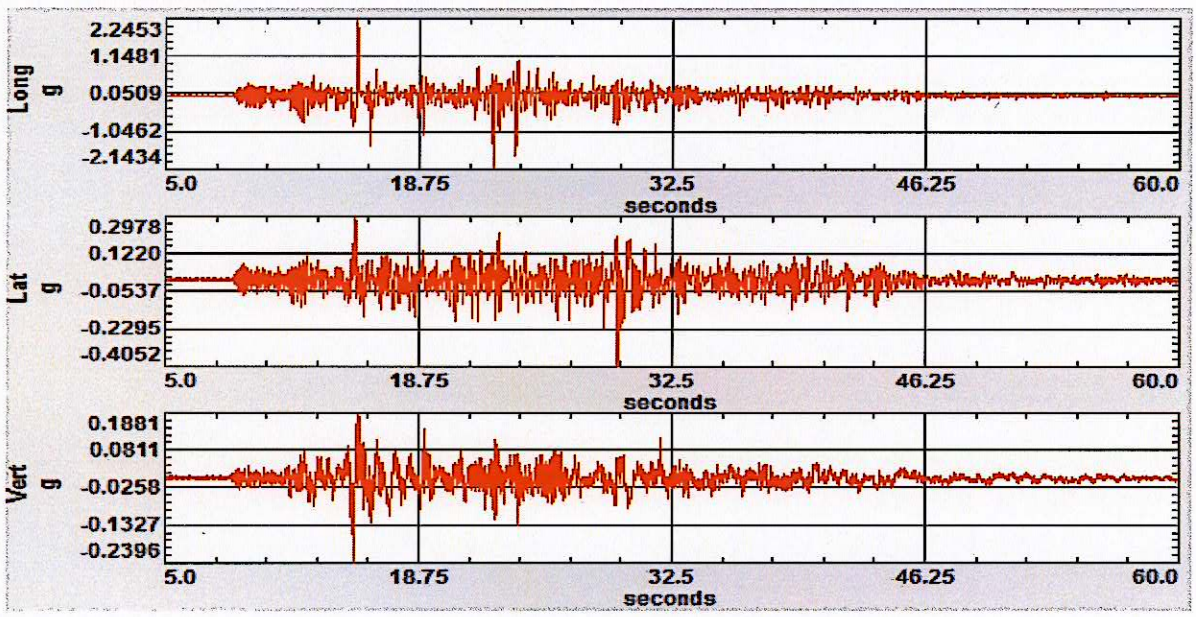


Figure 8 : The results of test item (5) : The maximum peak values of the shaking table along X-axis (top plot), Y-axis (second plot), and Z-axis (bottom plot) were 2.245 g, 0.405 g, and 0.239 g.

Figure 9 : During the test item (5), some water splashed from the manhole of the specimen.

Remarks :

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