WORKSAFE TECHNOLOGIES
VALENCIA, CALIFORNIA

OCTO-Base Summary Report

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OCTO-BASE SEISMIC ISOLATION PLATFORMS

1. Introduction

WorkSafe Technologies has recently developed a new seismic isolation system using the same technology as found in their ISO-Base isolation platforms. The OCTO-Base isolation bearing, as shown in Figure 1 is composed of a 14-inch diameter ball-n-cone isolator mounted within an octagonal frame that has overall dimensions of 15 inches.

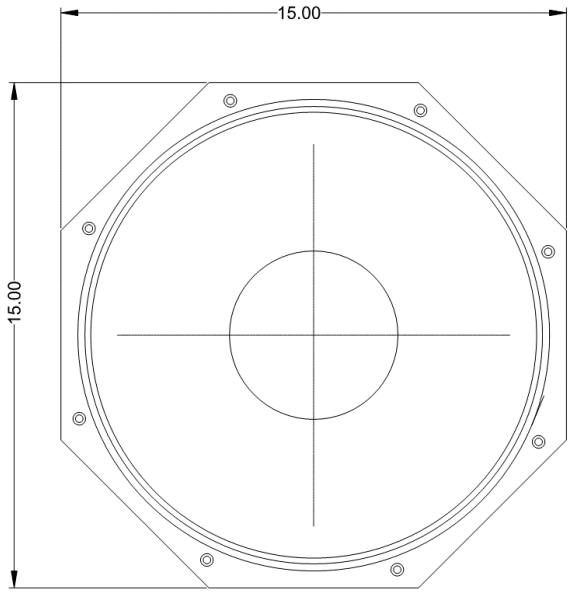

Figure 1 – OCTO-Base Isolation Bearing

The modular design of the OCTO-Base isolator allows the bearing to be arranged in many different configurations, allowing its use in such applications as data center computer racks, UPS systems, electrical gear and other specialty equipment requiring enhanced seismic protection. The individual bearings are connected using steel angles, as shown in Figure 2.

Figure 2 – OCTO-Base Platform Configuration

2. Technical Properties

The OCTO-Base isolation bearing has a displacement capacity of approximately 12.5 inches, which represents an increase of over 60% compared with ISO-Base. The bearing has a maximum slope of 8 degrees, which effectively limits the peak horizontal accelerations above the isolation plane to approximately 25%-30% of gravity depending on bearing axial load. The increase in acceleration over the slope of the dish (14%) is due to the rolling friction provided by the new QuakeCoat dish coating. The rolling friction from QuakeCoat provides significant damping to the system. Based on testing and numerical analysis, the OCTO-Base bearing has a fundamental period of approximately 2.4 seconds. The new QuakeCoat coating has been shown in testing at the University of Oklahoma to provide approximately 25% equivalent viscous damping. The increased bearing size coupled with the new QuakeCoat lining provides a significant improvement in seismic performance when compared with ISO-Base. Based on preliminary calculations, the bearing is capable of providing Immediate Occupancy performance for earthquakes with a one-second design spectral acceleration of 0.87g based on current ASCE 7-10 criteria (or a spectral acceleration of 0.36g at a period of 2.4 seconds), which provides 50% more protection than is currently available with ISO-Base

3. Shake Table Testing

In November of 2015, OCTO-Base was subjected to a series of seismic simulation tests on a three-dimensional shake table in Japan (Urban Renewal Laboratories, Tokyo). Testing was performed for four different configurations and three different earthquake ground motions. A total of twelve shake table tests were conducted. Table 1 provides a summary of the shake table testing.

Table 1 – OCTO-Base 2015 Testing Summary

Test No.	Ground Motion (scale factor)	No. of Isolators	Test Weight (Metric Tons)	Test Weight (lbs)	Weight/Isolator (lbs)
1	NZ (100%)	6	1.0	2205	367
2	NZ (120%)	6	1.0	2205	367
3	Kobe (100%)	6	1.0	2205	367
4	Sendai (100%)	6	1.0	2205	367
5	Kobe (100%)	6	2.0	4409	735
6	Sendai (100%)	6	2.0	4409	735
7	NZ (100%)	4	1.0	2205	551
8	NZ (120%)	4	1.0	2205	551
9	Kobe (100%)	4	1.0	2205	551
10	Sendai (100%)	4	1.0	2205	551
11	Kobe (100%)	4	2.0	4409	1102
12	Sendai (100%)	4	2.0	4409	1102

The four configurations consisted of a six-isolator platform with payloads of one and two metric tons and a four-isolator platform with payloads of one and two metric tons. During all tests the OCTO-Base platform and the payload were instrumented with accelerometers to record accelerations in the two horizontal and vertical directions.

Following the completion of testing, the acceleration time histories of all accelerometers were plotted, including the shake table accelerometers. In general, the OCTO-Base isolators limited the peak horizontal acceleration above the isolators to approximately 0.3g, a significant reduction over the input motion. This is shown in Figure 3, which compares the shake table time history and the isolated platform time history for test 12 in the Y direction.

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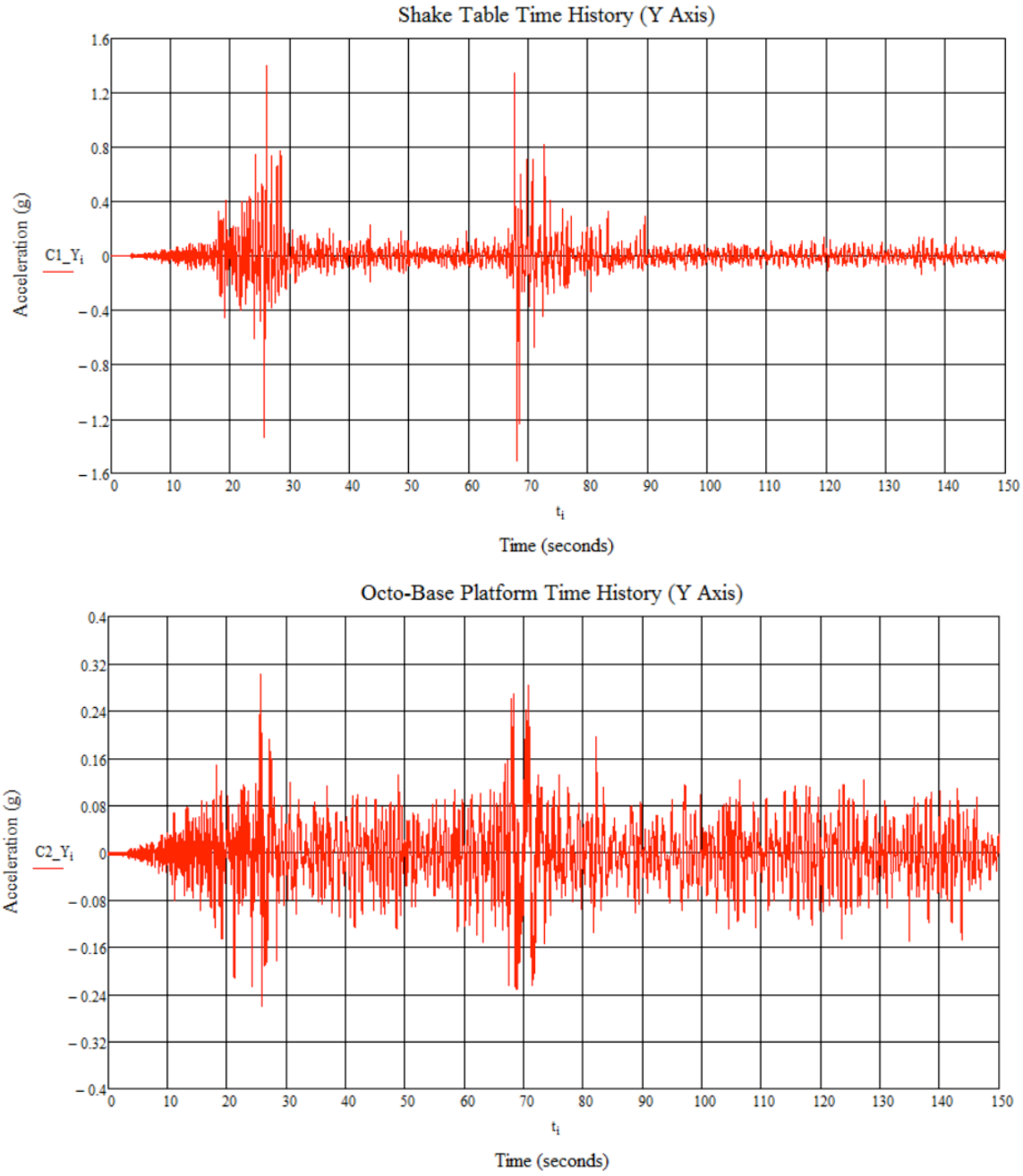

Figure 3 – Test 12 Shake Table and Isolated Platform Acceleration Time History

In addition to plotting the acceleration time histories, response spectra were calculated for all acceleration records. Response spectra were calculated for 5% damping over the period range from 0 to 3 seconds. Figure 4 shows the response spectra for Test 12 in the Y-direction for the shake table and the isolated platform. Again, the response spectra shows that the isolated platform provides a significant reduction in the input accelerations that are transmitted through the isolators to the payload. A reduction in accelerations of as much as four is observed.

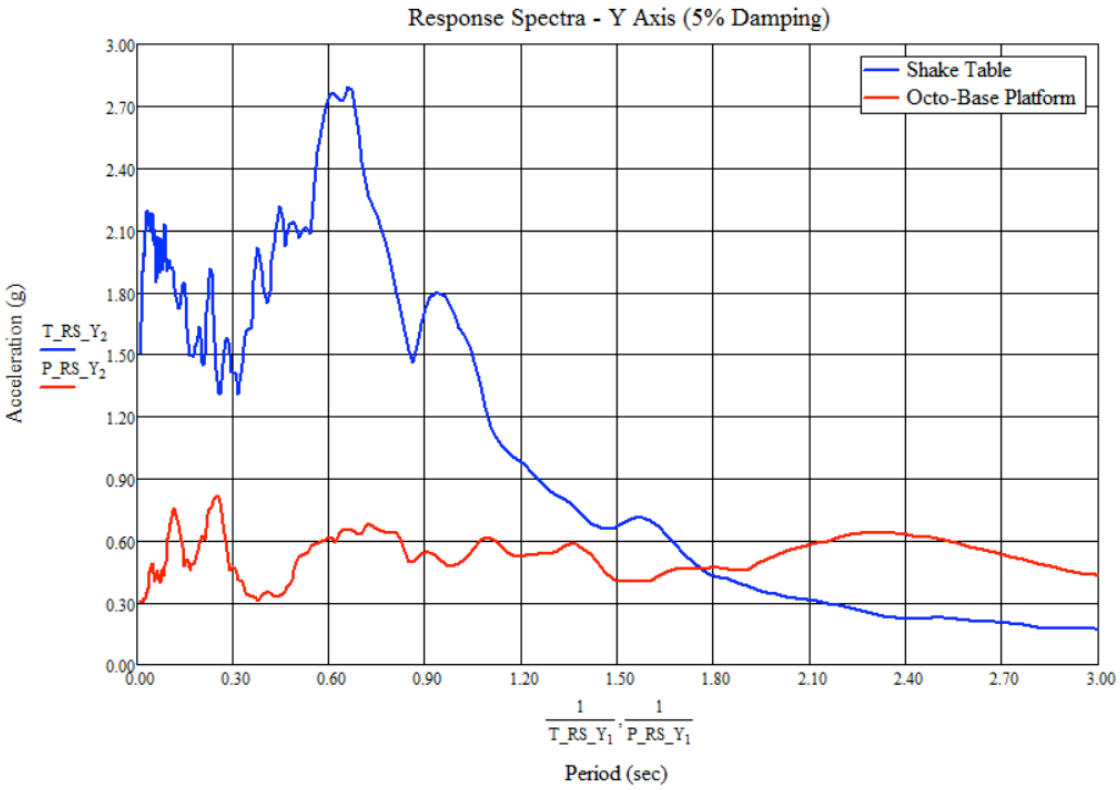

Figure 4 – Test 12 Shake Table and Isolated Platform Response Spectra

Other notable observations from the testing were that no contact between the ball bearing and the rim of the ball-n-cone dish were observed. However, it should be noted that due to limitations of the shake table, the tests were not conducted at the calculated spectral acceleration capacity of the OCTO-Base isolators (0.36g spectral acceleration at a period of 2.4 seconds). The calculated shake table spectral acceleration at a period of 2.4 seconds was only 0.22g.

4. Conclusions

Based on calculations and shake table testing, the OCTO-Base isolation bearing provides enhanced protection when compared with ISO-Base platforms. The larger displacement capacity and new QuakeCoat means that the system provides Immediate Occupancy performance for an earthquake 50% larger than ISO-Base can accommodate, while still limiting the peak accelerations above the isolators to 0.3g. Our calculations show that the system provides full protection for an ASCE 7-10 design spectrum with a one-second spectral acceleration (S_{D1}) of 0.87g. The performance of the system has been verified by shake table testing and shows a significant reduction (excess of four times) in the input accelerations above the isolators.