

# Sliding Damage of Chemical Bottles due to Seismic Motion Experimental Testing

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## Experimental Testing

Testing is being initiated with the Quanser Shaker Table in Room 131 of the Engineering Building. A small shelf surface has been built to mount on the table to allow for shaking similar to that expected in a major earthquake. Various sized bottles used for chemical storage have been obtained and preliminary testing has been conducted.

## Preliminary Results

At this time, the testing has just initiated and the following are based on a limited number of tests. Final results are expected to be similar to those presented here, but may change while testing continues.

The coefficient of friction for the bottles appears to be about 0.18 for plastic bottles and 0.26 for glass bottles.

### *Earthquake Ground Motion Studies*

The initial testing was conducted with a record from the 1995 Kobe earthquake in Japan. This earthquake record has a peak ground acceleration of 0.6 g. This would represent the ground motion expected during a major earthquake, but actual shelving in a building may be shaken much stronger.

Tests were conducted with a single application of the ground motion to a single bottle sitting in the middle of the shelf. Three different sized plastic bottles were tested.

**Table 1. Results of testing of a single bottle shaken with the Kobe ground motion**

Amount of Water	Rail Height	No Damage	Tipover	Off Shelf
None	None	3	1	5
	1 inch	10	8	
Half-Full	None	4		
	1 inch	26		
Full	None	4		
	1 inch	26		

The second series of tests were conducted with three applications of the ground motion to a single bottle sitting in the middle of the shelf. The motion was repeated three times because as originally recorded there are only a few spikes of very large acceleration. By repeating the motion, an attempt was made to see the effects of a strong earthquake with several cycles of large acceleration. Three different sized plastic bottles were tested.

**Table 2. Results of testing of a single bottle shaken three times with the Kobe ground motion**

<b>Amount of Water</b>	<b>Rail Height</b>	<b>No Damage</b>	<b>Tipover</b>	<b>Off Shelf</b>
None	None		18	17
Half-Full	None	15		
Full	None	5		10

The third series of tests were conducted with three applications of the ground motion to a row of multiple bottles sitting on the shelf. Three different sized plastic bottles were tested and two different glass bottles.

**Table 3. Results of testing of a row of bottles shaken three times with the Kobe ground motion**

<b>Bottle Material</b>	<b>Rail Height</b>	<b>No Damage</b>	<b>Tipover</b>	<b>Off Shelf</b>
Plastic	None			17
Glass	None			5

From the preliminary results it appears that the arrangement of bottles is more important than the behavior of a single bottle sitting alone. It also seems that a single bottle that is partially or completely full is more stable, particularly when a single spike of large acceleration is applied.

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