### Methodology

First, designing the new drum is done using CAD modeling in Fusion 360 and is drum is finished and fabricated. The original drum was completely hollow with plates on the outer edges while the new drum has three plates and allows for the use of ball bearings to help with stiffness.

![Figure 2: New drum left, and original setup right](image)

The next step was modeling the new connection from the MTS actuator to the drum. Original connection had slop and more moving parts than needed. Modal analysis gave different modes of vibration (shape) that corresponds to frequency.

![Figure 3: Connection modal analysis](image)

<table>
<thead>
<tr>
<th>Mode Number</th>
<th>Frequency [Hz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>73.9</td>
</tr>
<tr>
<td>2</td>
<td>77.3</td>
</tr>
<tr>
<td>3</td>
<td>275</td>
</tr>
<tr>
<td>4</td>
<td>295.4</td>
</tr>
<tr>
<td>5</td>
<td>267.8</td>
</tr>
</tbody>
</table>

### Preliminary Results

So far, preliminary results are based on successful simulations and fabrication of the device towards the semi-active control desired. The electric actuators are the reason this device can have semi-active capabilities. Figure 5 below shows static analysis of the base plate and support risers. The forces applied to the model are 2500 lbs. of pulling force with a reactionary force (3250 lbs.) generated at the base. An output of overall base plate displacement is given at 0.0002 in. (upwards) and column displacement of 0.0019 in.

![Figure 5: Static analysis of base plate and system](image)

A test was ran to determine the damping capacity of the friction damper in passive mode, so a comparison can be made to the semi-active device. This test was carried out with different applied forces of 50, 60, and 70 lbs., which gave different damping forces of 0.5 kips, 2 kips, and 5 kips, respectively.

![Figure 6: Force vs. displacement and force vs. displacement hysteresis](image)

Finally, hybrid simulations are running for the current setup and a displacement model is explained next.

### Discussion

The test conducted on the old drum was successful, and the new friction material works well with the surface of the drum. These are the boundary conditions the SABER-FD will be based off of. Hybrid simulations have been conducted and one of the tests of the RSN1176_KOCAEL_YPT150, MCE EQ file is shown below. This graph shows displacement between the first two stories with dampers and without. Reduction = (peak floor displacement with damper - peak floor displacement without the damper)*100/(peak floor displacement without the damper. The new damper can enable civil infrastructural systems to achieve a high level of performance, with minimal damage under severe earthquakes, and the high performance leads to resiliency being achieved.

![Figure 7: RSN1176_KOCAEL_YPT150, MCE](image)

The project will be continued after the summer between the University of South Carolina and Lehigh University, and tests on the SABER-FD will be conducted once the electronic actuators arrive.

### References


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