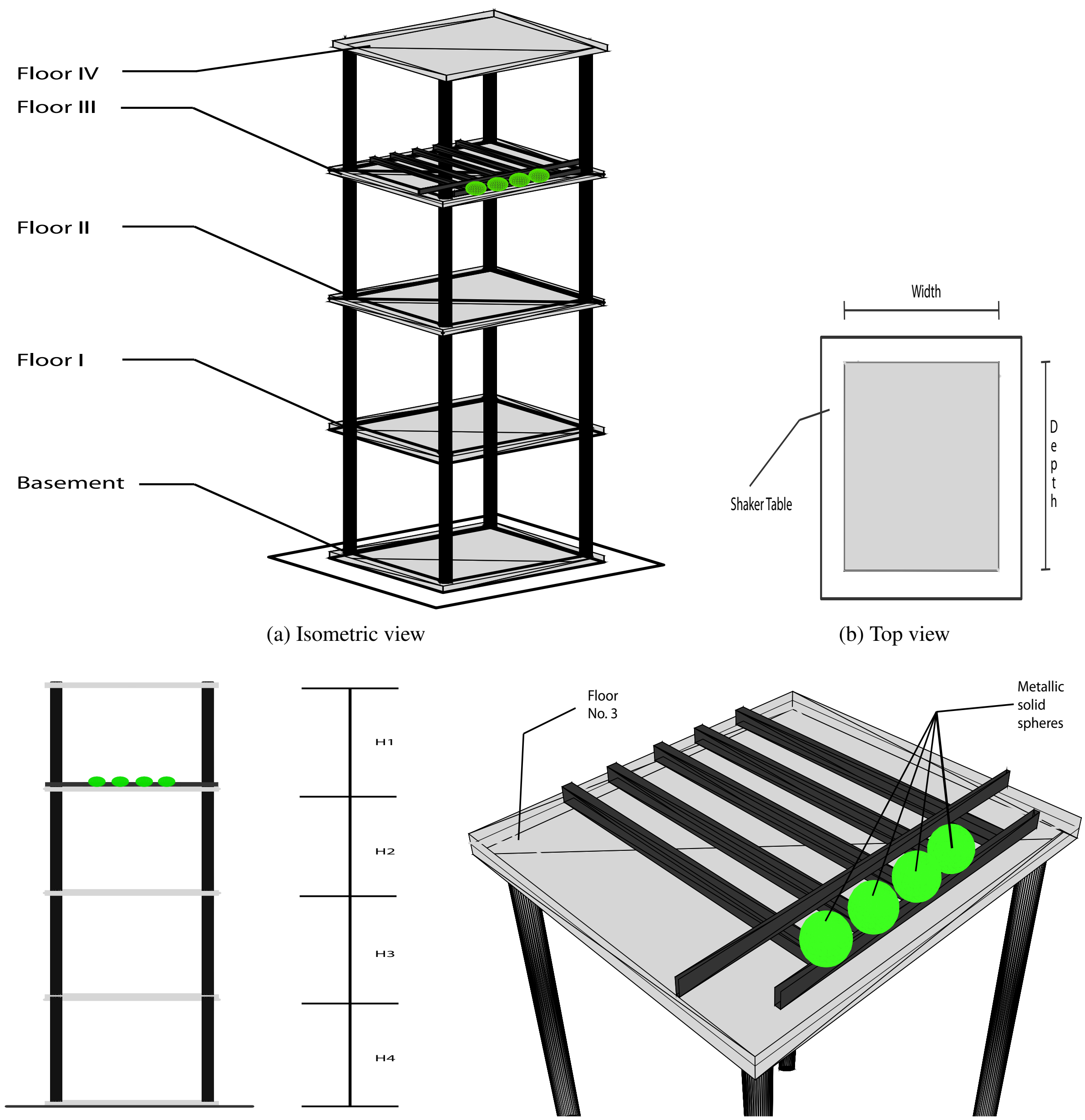
Department of Civil Engineering
University of Southern California

Due Date: 26 November 2012

CE541a Project 6: Structural Control of Multistory Building Model With Impact Dampers

Overview: Develop and use a computational model to match the results of an experimental study of a multistory building model that is subjected to dynamic base excitation and that is provided with nonlinear structural control devices to mitigate its response.

System Characteristics: A schematic diagram of the building model is as shown in Figure 1[1] and all relevant dimensions and material properties are provided in the attachment. The structural control devices consist of a multi-unit impact damper (four dampers of identical mass)



(a) Isometric view (b) Top view

(c) Height of the MDOF (d) Explicit view of impact damper floor (Floor III)

Figure 1: Multistory building model with four impact dampers

[1]Figures not to scale

Experimental Measurements: The structure under consideration was subjected to earthquake-like base excitation, and the following measurements were acquired at the rate of 200 samples per second, for a time duration of 20 seconds:

1. Acceleration response at each story location: $\ddot{x}_1(t), \ddot{x}_2(t), \ddot{x}_3(t)$ and $\ddot{x}_4(t)$.
2. Displacement time history of the shaker table (i.e., $x_0(t)$).
3. Acceleration of the shaker (input to the base of the building model, $\ddot{x}_0(t)$).

Computational Study:

1. Develop a suitable reduced-order mathematical model for the building under discussion. (*Hint:* Generalize the approach used in Project 3).
2. Apply the excitation record $\ddot{x}_0(t)$ in the provided data file, and compute the accelerations and displacements at each sensor location.

Report Requirements:

1. Using the collected data set generated from the experiment, process the measurements to generate the corresponding time-history plots with superimposed curves corresponding to measured (from the experiment) and computed (from the simulation results) accelerations and displacements.
2. Convert all your measurements to engineering units. Generate compound graphs (one for displacements, and one for accelerations) each containing 5 plots (one per sensor location), using identical abscissa and ordinate scales.
3. Interpret the experimental measurements and compare to available analytical results.
4. Evaluate the fidelity of the mathematical model by computing the root-mean-square (RMS) error between all the system accelerations as well as the displacements.
5. Submit all components of the computational package in a zipped directory so that the package can be executed to verify the results contained in the submitted technical report.

Input data: All the required dimension are provided in this project, each of the given data should be used to calculate the mass, stiffness of the floors. The attached data files are in SI units, you need to convert the below for US to SI, and the final displacements, velocities and acceleration should be in SI units.

Floor #	Height (inch)	Column dia. (inch)	Material	
			Slab	Columns
1	H_1=18	$\frac{3}{8}$	Aluminium (AL6061)	Carbon steel (16UNC)
2	H_2=18	$\frac{3}{8}$	Aluminium (AL6061)	Carbon steel (16UNC)
3	H_3=18	$\frac{3}{8}$	Aluminium (AL6061)	Carbon steel (16UNC)
4	H_4=16	$\frac{3}{8}$	Aluminium (AL6061)	Carbon steel (16UNC)

Table 1: Physical properties of the model

1. Diameter of the spherical ball = 2 inches (4 nos.)
2. Weight of the spherical ball = 1.18 lb (4 nos.)

Third floor details:

3. Clamps on the third floor = 0.79 lb each (2 nos.)
4. Aluminum channel (AL6061) bars dimension = 26.5 x 0.3 x 0.8 inches (6 nos.)
5. Aluminum (AL6061) T section rigid wall refer Figure 2.

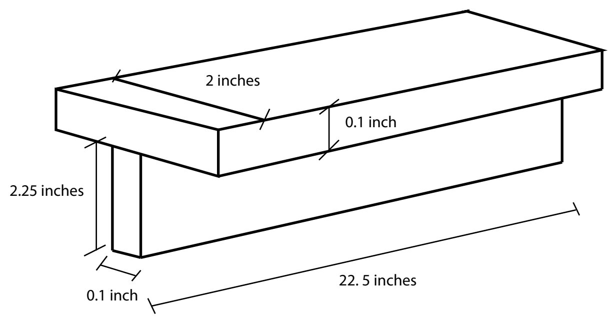


Figure 2: Dimensional details of Aluminum T section rigid wall

Fourth floor details:

6. Aluminum vertical bar = 12 x 1 x 0.1 inches (1 no.)
7. Regular clamp weight = 2.1316 lb (1 no.)

Please note that the dimensions of the slabs are given in figures 3 and 4. Also, use the calFactors.txt as the calibration factors to convert from volts to SI units. Lastly, masri_earthquake_id.txt will be the excitation file.

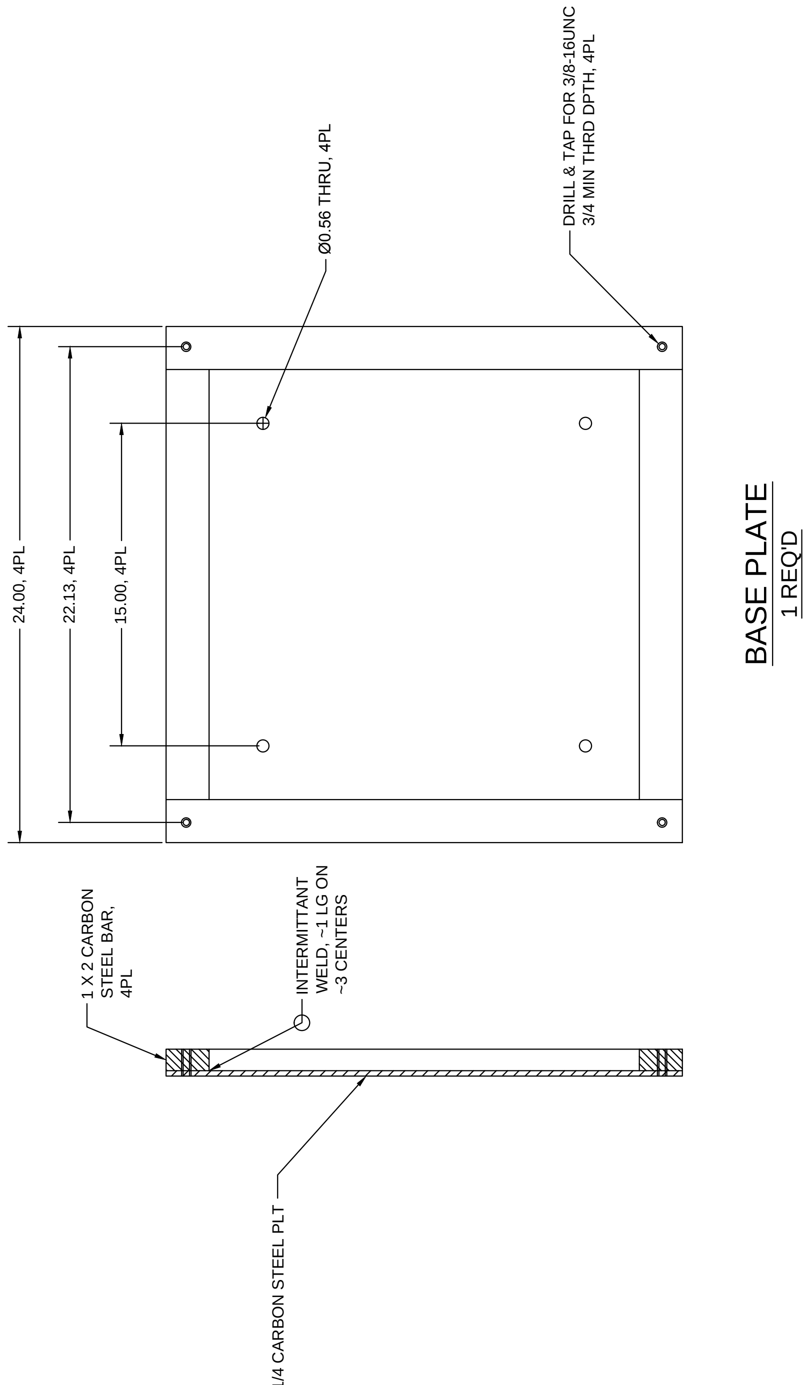


Figure 3: Dimensional details of base plate

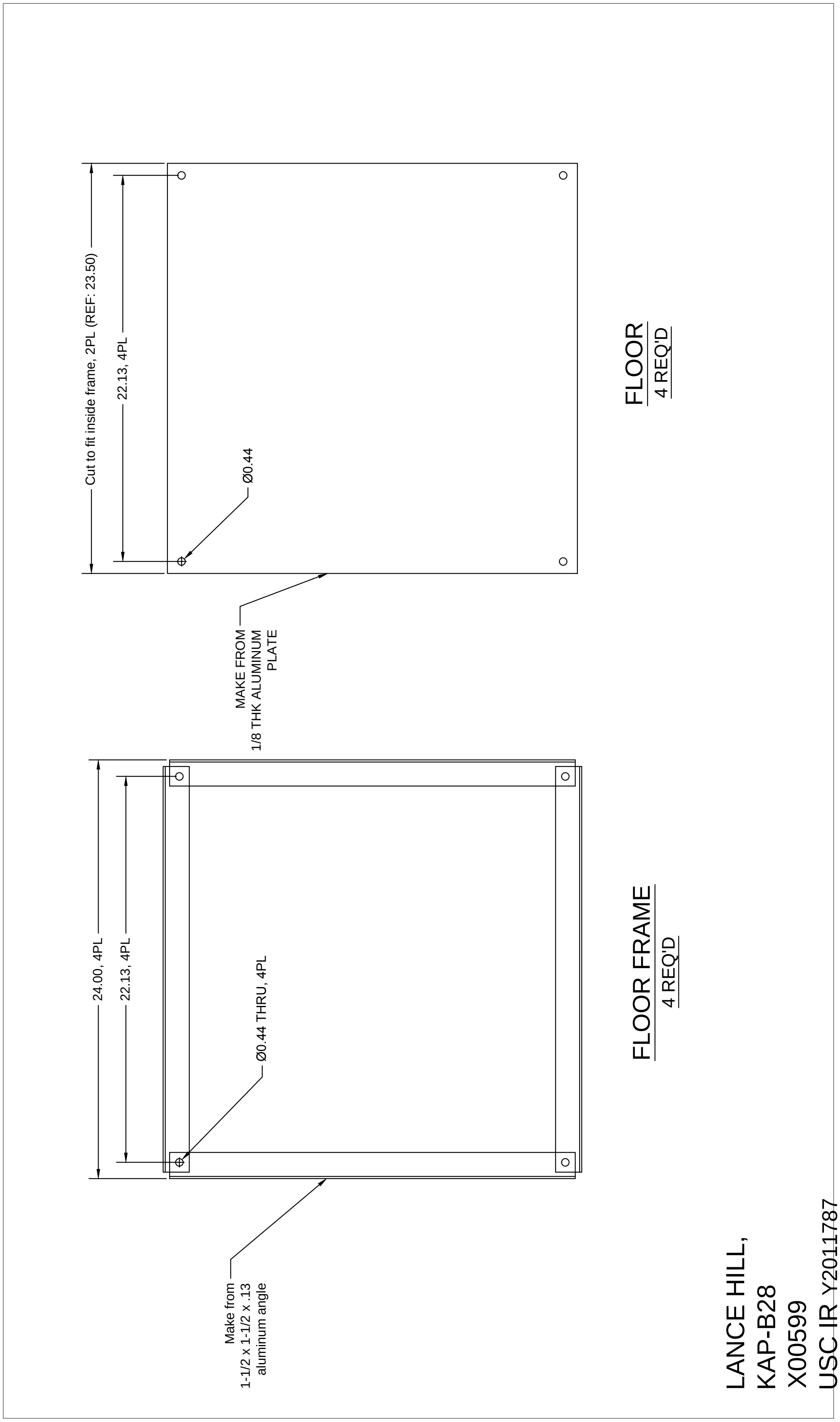


Figure 4: Dimensional details of slab plate on each floor