1. The Bookshelf Structure

Test Structure Specifics

The structure tested is a three-story frame structure model as shown in Figure 1. The structure is constructed of Unistrut columns and aluminium floor plates. The floors are 1.3 cm (0.5 in) thick aluminium plates with two-bolt connections to brackets on the Unistrut. The base is a 3.8 cm thick (1.5 in) aluminium plate. Support brackets for the columns are bolted to this plate and hold the Unistrut columns. The details of these joints are shown in Figure 2 and Figure 3. Dimensions of the test structure are displayed in Figure 4 and Figure 5. All bolted connections are tightened to a torque of 0.7 Nm (60 inch-pounds) in the undamaged state. Four Firestone air mount isolators, which allowed the structure to move freely in horizontal directions, are bolted to the bottom of the base plate. The isolators are inflated to 140 kPa gauge (20 psig) and then adjusted to allow the structure to sit level with the shaker.

The shaker is coupled to the structure by a 15 cm (6 in) long, 9.5-mm (0.375-in) diameter stinger connected to a tapped hole at the mid-height of the base plate. The shaker is attached at corner D as shown in Figure 5, so that both translational and torsional motions can be excited.

Figure 1. Photo of the full test structure

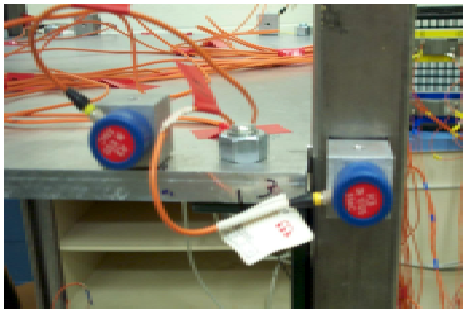

Figure 2. Photo of a joint on the structure showing sensor placement

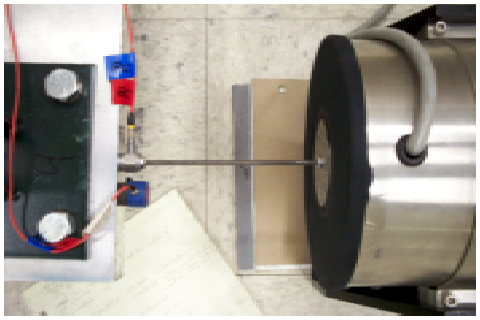

Figure 3. Force transducer that measures the input from the shaker to the base of the structure.

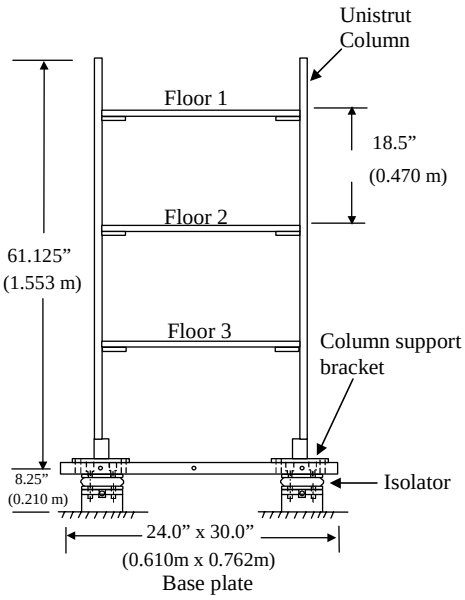

Figure 4. Basic dimensions of the 3 story frame structure

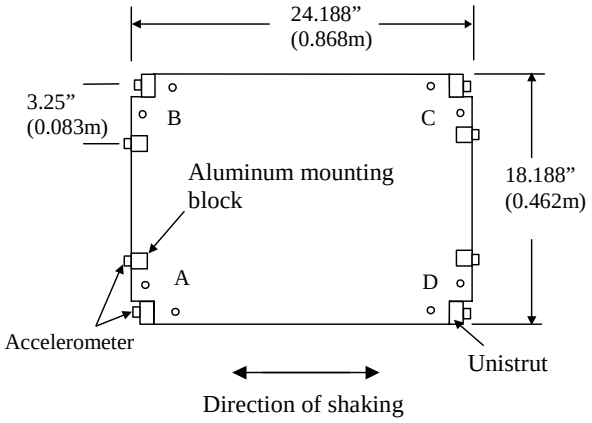

Figure 5. Floor layout as viewed from above

Test Setup and Data Acquisition:

The structure is instrumented with 24 piezoelectric single axis accelerometers, two per joint as shown in Figure 5. Accelerometers are mounted on the aluminum blocks that are attached by hot glue to the plate and column. This configuration allows relative motion between the column and the floor to be detected. The nominal sensitivity of each accelerometer is 1 V/g. A 10 mV/lb force transducer is also mounted between the stinger and the base plate. This force transducer is used to measure the input to the base of the structure. A commercial data acquisition system controlled from a laptop PC is used to digitize the accelerometer and force transducer analog signals. The data sets that were analyzed in the feature extraction and statistical modeling portion of the study were the acceleration time histories.

In each test case, three separate data sets were collected with the shaker input level at 3, 5 or 7 volts. The bandwidth of the shaker and response are also varied from 800 Hz to 3200 Hz in each test case to determine in which frequency bandwidth the damage would be most sensitive. In the damaged cases, the bolts at the joint indicated were loosened and then tightened again to hand tight allowing the plate to move relative to the column. All input from the shaker to the base was random. Each time signal gathered consisted of 8192 points and were sampled at 1600 Hz.

File Descriptions

Undamaged 1: The original state of the structure
Undamaged 2-5: These sets were collected with the structure completely intact after each damage case.
Damage L1C: Data sets containing various states of damage at the 1C location.
Damage L3A: Data sets containing various states of damage at the 3A location.
Damage 1C and 3A: Damage was induced at both locations on the structure.

Naming Convention

Data that was collected during the 2000 Dynamics Summer School, uses the following naming convention:

LXX_DXX_VXX_XXXXXX_XX.mat

LXX is the Damage location. L00 is undamaged; L1C and L3A are single damage locations, while L13 is damage at both locations.

DXX is the Damage level. DB0 indicates that the bolts were removed between the bracket and the plate, DBB indicates the bracket was completely removed, DHT indicates the bolts were left in at a hand tight torque, and D05/D10 indicate that a torque value of 5 or 10 ft. Lbs was left on the bolts.

VXX is the Input level to the shaker. There were three input levels (2,5,8 volts) used in these tests to represent environmental variability.

The next six digits represent the date on which the data was collected and the last digits are the set number.

Channel Description

In each file, a 4096 x 26 Matlab matrix can be found. The 26 columns represent the channels from the data acquisition system.

Channels 1-24 represent the accelerometers placed on the structure. Columns 1 and 2 represent the first pair of sensors across a joint, 3 and 4 are the next and so on. Each sensor position is marked with either a P (Plate) or C (column) to indicate the position relative to the joint.

Channel 25 is the time history of the force transducer that measured the input from the shaker to the structure.

NOTE: Channel 9 did not work, so the sensor signal was recorded on channel 26. Therefore the correct sensor pair for the joint should be 26 and 10.

Channel	Position
1	3BP
2	3BC
3	3AP
4	3AC
5	3CP
6	3CC
7	3DP
8	3DC
26	2BP
10	2BC
11	2AP
12	2AC
13	2CP
14	2CC
15	2DP
16	2DC
17	1BP
18	1BC
19	1AP
20	1AC
21	1CP
22	1CC
23	1DP
24	1DC