Earthquakes are natural hazards that may create serious damage when a structure is not designed properly according to building codes. Base shear force is an estimate of the maximum equivalent lateral force that will occur due to seismic ground motion at the base of a structure.

Figure 1 shows the ground acceleration data as a function of time (also called the acceleration time history data) from 17 August 1999 Marmara earthquake recorded at Sakarya station. Figure 2 shows the base shear force demand of a two story unreinforced masonry building in Istanbul, as shown in Figure 3, as a function of peak ground acceleration (PGA) exposed to the earthquake with data in Figure 1. As an additional note, PGA is defined as a measure of earthquake intensity on the ground and it is an important hazard parameter in the field of earthquake engineering. It is also used in the design of building structures. If the base shear force demand of a building is larger than the shear force capacity at the "Serviceability Limit" (V_{b1}= 500 kN), the building is damaged and needs repairing (some cracks occur as shown in Figure 4). Furthermore, if the base shear force demand of a building is larger than the shear force capacity at the "Ultimate Limit" (V_{b2}= 1200 kN), then the building either suffers heavy damage or collapses as shown in Figure 5. In this assignment, you are expected to analyze the building according to the data provided below.

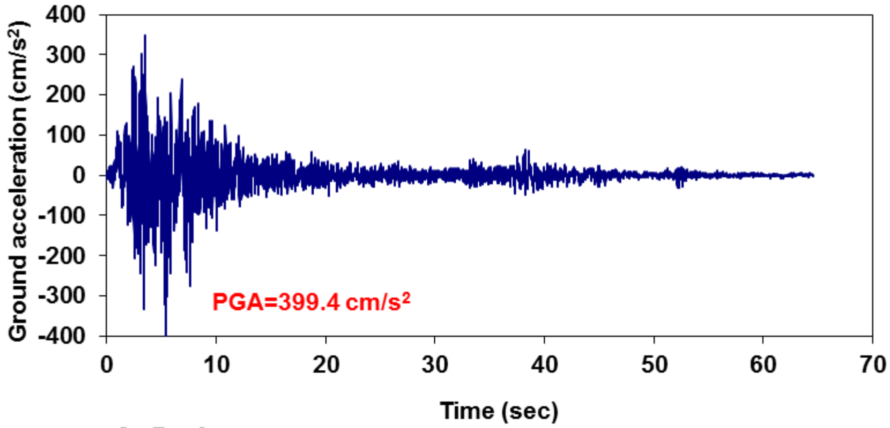


Figure 1: Acceleration time history of Sakarya record from the 17 August 1999 Marmara earthquake

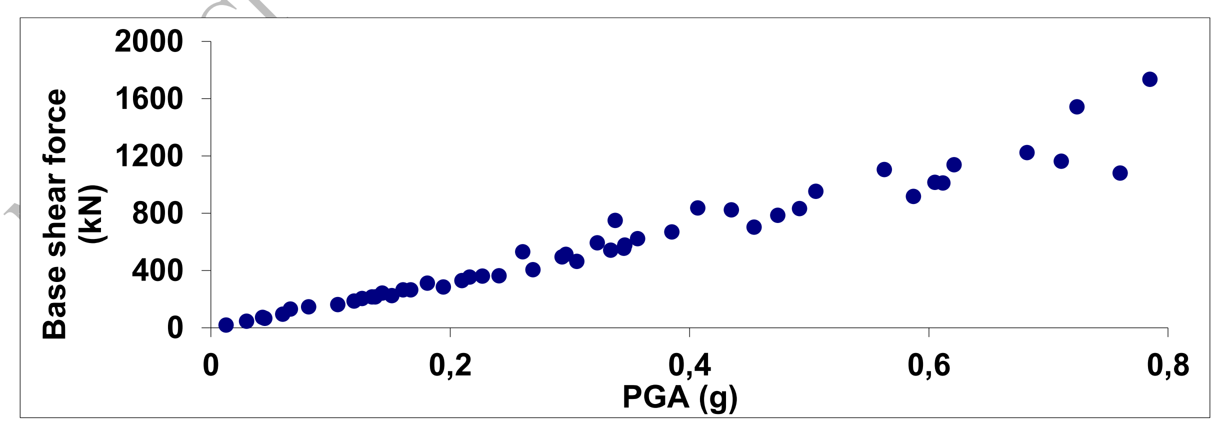
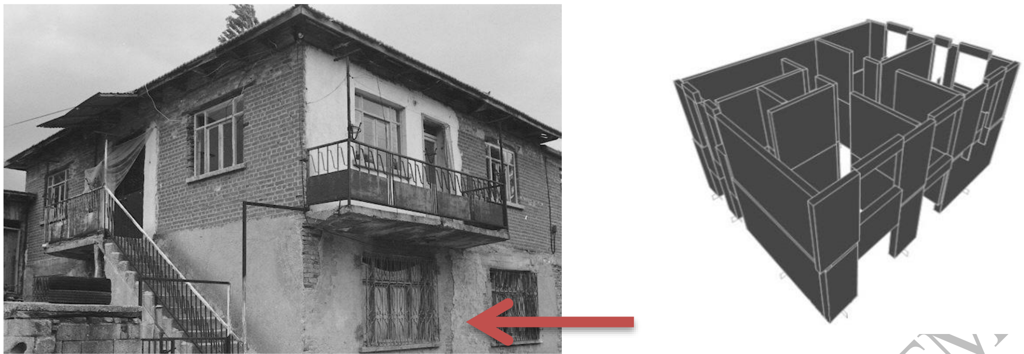


Figure 2: Base shear force demand as a function of PGA



(a) (b)

Figure 3: (a) The masonry building, the arrow shows the acting direction and (b) the model of the building

Figure 4: Damaged masonry building after an earthquake

Figure 5: Collapsed masonry building after an earthquake

PART A:

Data you should download 'lab7_data.zip' from our website, unzip it and copy the file to current directory of the MATLAB (which is usually MATLAB folder under MY DOCUMENTS). The copied data file ('req_data_lab7.dat') consists of 'PGA' and the corresponding 'Base Shear Force Demand' values. To analyze the given data, this time use 'dlmread' command. This command is a similar one which you used last week (ie. 'load' command). Below is an example of the typical use of this command. (You can learn more about this function using 'help dlmread'):

```
data=dlmread('req_data_lab7.dat',';');
```

This command reads the file content and assigns its content to the variable 'data'. Here ';' indicates that the data are separated using semi-colon.

You now have a variable called 'data' which has 50 rows and 2 columns. The first column consists of PGA values and the second column consists of corresponding Base Shear Force Demand.

PART B:

In this part you are expected to fit a line to given the data above using *the least squares fit of a straight line (linear regression)* formulation given in your textbook. Equation 1 and 2 are given below to indicate a relation in the form of **Y=aX+b**:

$$\begin{bmatrix} b \\ a \end{bmatrix} = \begin{bmatrix} N & \sum_{i=1}^{N} x_i \\ \sum_{i=1}^{N} x_i & \sum_{i=1}^{N} x_i^2 \end{bmatrix}^{-1} * \begin{bmatrix} \sum_{i=1}^{N} y_i \\ \sum_{i=1}^{N} (y_i * x_i) \end{bmatrix}$$

By rearranging the formula above, you get:

$$a = \frac{N * \sum_{i=1}^{N} (x_i \ * \ y_i) - \sum_{i=1}^{N} x_i * \sum_{i=1}^{N} y_i}{N * \sum_{i=1}^{N} x_i^2 - (\sum_{i=1}^{N} x_i)^2} \qquad \text{(Eq. 1)}$$

$$b = \bar{y} - a * \bar{x} \qquad \text{(Eq. 2)}$$

where $\bar{x}$ and $\bar{y}$ indicates averages of x and y.

PART C:

In this part you are expected to fit a line to given data using the command ‘regstats’. This command gives a lot of outputs about the data such as A and B coefficients, mean square error, correlation coefficient. Use this command in the following format:

```
reg=regstats(y,x);
```

This code produces a structure called ‘reg’ and by inspecting this variable you may find many outputs in “Variable Editor”. Among those, ‘beta’ gives you the coefficients of the equation (B,A). Please verify the coefficients you found in Part B with Part C. To see the variables you can type:

```
reg.beta;
```

Note that ‘regstats’ can perform other types of regressions . You may read by typing `doc regstats`.

PART D (Optional):

In this part it is asked to find Correlation Coefficient (R^2 analysis) using the following formulas:

$$SS_{tot} = \sum_{i=1}^{N} (y_i - \bar{y})^2 \quad ; \text{ the total sum of squares}$$

$$SS_{err} = \sum_{i=1}^{N}(y_i - f_i)^2 \text{ ; the residual sum of squares}$$

$$\bar{y} = \frac{1}{N} * \sum_{i}^{N} y_i \text{ ; the mean of y values}$$

$$R^2 = 1 - \frac{SS_{err}}{SS_{tot}}$$

Note that "f_i" is the new calculated values of y with the relation obtained in Part B using the x values given in the data. You may compare it with the value calculated by the command `'regstats'` `(regstats.rsquare)`

PART E:

In this part you are asked to find PGA values at serviceability and ultimate limits so that you can understand when the building needs repairing and when the building collapses. The format of reporting these values in the command window is given below:

```
PGA value at Serviceability Limit is XXX.
PGA value at Ultimate Limit is XXX.
```

(Hint: You may use the command `'fprintf'`. Use your fitted line you found in Part B and Part C.)

PART F:

Plot the scattered data and fitted line on the same graph (*You can use the command 'hold on' to plot both)*. Use the command `'scatter'` for plotting the given data as follows:

```
scatter(x,y)
```

Finally, report the PGA value at the Serviceability Limit on the plot using `'text'` and 'num2str' command.

```
variable1 = num2str(number)
text(x,y,z,variable1)
```


==
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