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# DYNAMIC ANALYSIS OF A G+3 BUILDING USING INDIAN STANDARD CODE METHOD AND TIME HISTORY METHOD

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## ABSTRACT

Life of a huge number of individuals throughout the globe is at stake due to earthquakes. In history of civil engineering the structures were mainly designed by considering only static load factor. But in the field of civil engineering it is observed that the structures are not only depends upon static load as well as it depends upon seismic loads, wind loads, snow loads etc. depending upon the type of structure, dimension of the structures, location or zone of the structure, type of ground profile etc. Hence it is a process to analyse a structure for different types of loads and to design a structure for critical load case of which dynamic load is one of the most important load for the structure should be analysed and designed. In this paper there is an attempt has been made for dynamic analysis of a multi-storey (G+3) frame using Indian standard code method (Seismic co-efficient method), response spectrum method and time history analysis method. IS 1893:2002 (part-1) has been recommended for seismic co-efficient method and response spectrum method to calculate base shear and storey shear force for different zone (II, III, IV, V). for time history analysis, four earthquake data from previous earthquakes, like 1940 El-Centro, Kobe, Mexico City, and Bhuj. Study focuses to evaluate the base shear, storey shear forces of different floors at different zones and plot the time history curves of different earthquakes through time history analysis. Entire procedure was solved by using MAT-LAB programing. The BHUJ earthquake is originated from zone V so its displacement and base shear values from time history analysis are less than the Indian standard code method, which is safe.

**KEYWORDS:** Seismic Co-Efficient Method), Response Spectrum Method and Time History Analysis Me

## INTRODUCTION

Vibration of structure due to earthquake, wind or rotating machines are very common and they are getting complicated nowadays. The impact of these vibrations accounts for loss of live and/or property. Earthquakes have been occurring from many years and will continue to occur in the future too. It might happen in remote, underdeveloped territories where harm posed will be insignificant. It is difficult to avoid earthquakes, but it is possible to mitigate the effects of strong earthquakes leading to loss of life, injuries and damage. The earthquake resistance structure can be divided into two categories, rigid structure and flexible structure. First, a structure that is perfectly rigid having no time period, as a result there is no relative displacement between ground and structure during earthquake. Second, a structure that is perfectly flexible having an infinite time period, as a result there is relative displacement between ground and structure during an earthquake. The reduction in spectral acceleration reduces the earthquake induced force into the structure, as a result of which there is less damage.

The structures constructed with good techniques and machines in the recent past have fallen prey to earthquakes leading to enormous loss of life and property and untold sufferings to the survivors of the earthquake hit area, which has compelled the engineers and scientists to think of innovative techniques and methods to save the buildings and structures from the destructive forces of earthquake. In the recent past have provided enough evidence of performance of different type of structures under different earthquake conditions and at different foundation conditions as a food for thought to the engineers and scientists. This has given birth to different type of techniques to save the structures from the earthquakes.

## STATIC ANALYSIS OF A G+3 BUILDING

Here a four storey (G+3) RC building has been analysed by equivalent static lateral force method, response spectrum method as per IS 1893:2002 (Part-I). The problem illustrates the step by step procedure to determine the vertical distribution of base shears, natural frequencies (Eigen values), natural periods and mode shapes (Eigen Vectors) and storey shear forces at different floor levels in zone II, III, IV, V. One of the plane frames is in transverse direction. The purpose of the design is that the building is symmetric in elevation and planned as shown in figure 1.

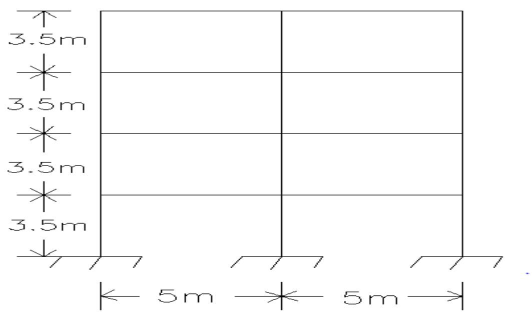


**Figure 1: Elevation of Plane Frame Structure**

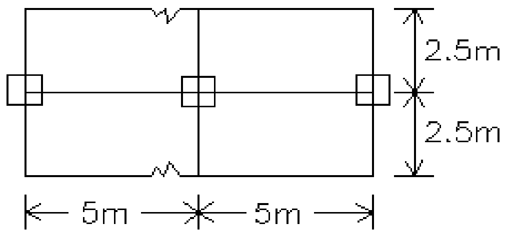


**Figure 2: Plan Showing the Columns & Beams at Floor Levels of Plane Frame**

**Table 1: The Preliminary Building Data Required for the Analysis are Assumed**

| **1. Type of Structure** | **Multi Storey Rigid Jointed Plane Frame (Special RC Moment Resisting Frame)** |
|---|---|
| 2. Seismic Zone | II, III, IV, V |
| 3. Number of stories | Four, (G+3) |
| 4. Floor height | 3.5m |
| 5. Infill wall | 250mm thick including plaster in transverse and 150mm in longitudinal direction. |
| 6. Imposed load | 3.5 $KN/m^2 KN/m^2$ |
| 7. Materials | Concrete M20 & reinforcement Fe 415 |
| 8. Size of columns | 250mm × × 450mm |
| 9. Size of beams | 250mm ×× 400mm in transverse & 250mm ×× 350mm in longitudinal direction. |

| Table 1: Condt | |
|---|---|
| 10. Depth of slab | 100mm thick. |
| 11. Specific weight of RCC | 25 KN/ $m^3 m^3$ |
| 12. Specific weight of infill | 20 KN/ $m^3 m^3$ |
| 13. Type of soil | Rock |
| 14. Response spectra | As per IS 1893 (Part-1): 2002 |
| 15. Time History | Compatible to IS 1893 (Part-1): 2002 spectra at rocky site for 5% damping. |

**Table 2: Base Shear in-Between Zone II, III, IV, V**

| Base Shear ($V_B V_B$) | Zone II (Low) | Zone III (Moderate) | Zone IV (Severe) | Zone (Very Severe) |
|---|---|---|---|---|
| $Q_1$ | 1.79481KN | 2.87170 KN | 4.30755 KN | 6.46133 KN |
| $Q_2$ | 7.17925 KN | 11.48680 KN | 17.23020 KN | 25.84530 KN |
| $Q_3$ | 16.15331 KN | 25.84530 KN | 38.76795 KN | 58.15193 KN |
| $Q_4$ | 16.52274 KN | 26.43639 KN | 39.65458 KN | 59.48187 KN |
| $Q_i$ | 41.65012 KN | 66.64019 KN | 99.96029 KN | 149.94043 KN |

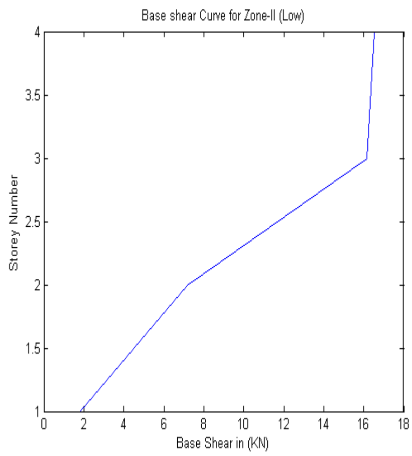


**Figure 3: Base Shear Curve for Zone-II**

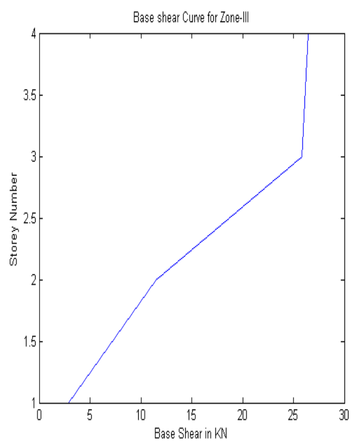


**Figure 4: Base Shear Curve for Zone-III**

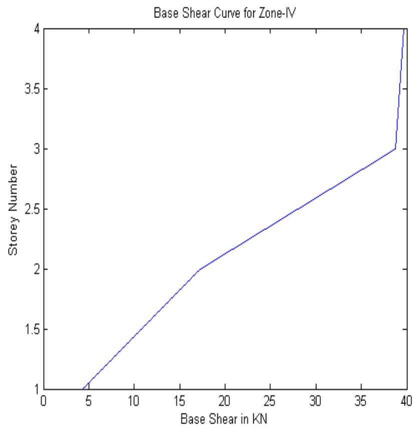


**Figure 5: Base Shear Curve for Zone-IV**

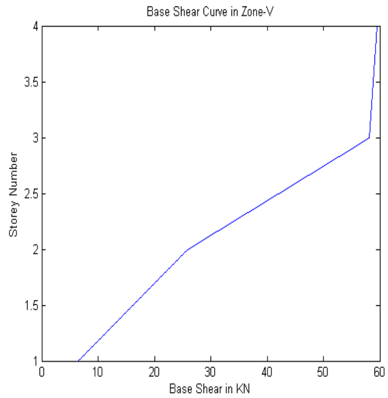


**Figure 6: Base Shear Curve for Zone-V**

## MAT LAB CODING

### To Evaluate Values

```
m=inp;
fori=1:1:7
n(i)=inp(i,2);
l(i)=inp(i,3);
w(i)=inp(i,4);
d(i)=inp(i,5);
uw(i)=inp(i,6);
end
wi=0.0;
for j=1:1:7
wte(j)=n(j).*l(j).*w(j).*d(j).*uw(j);
```

```
wi=wi+wte(j);
end
op=(wi.*1000)/9.81;
fori=1:1:7
m1(i,1)=n(i);
m1(i,2)=l(i);
m1(i,3)=w(i);
m1(i,4)=d(i);
m1(i,5)=uw(i);
m1(i,6)=wte(i);
if(i>=2)
 m1(i,7)=0;
else
 m1(i,7)=wi(i);
end
 end
printmat(m1,'eslfm','1st 2nd 3rd 4th 5th 6th 7th','no_column length width depth unit_wtwtcwi');
wi4=0.0;
k1=0.0;
k2=0.0;
k3=0.0;
k4=0.0;
for j=1:1:6
if(l(j)==3.5)
 k1=l(j)/2;
else
k1=l(j);
end
if(w(j)==3.5)
```

```
k2=w(j)/2;
else
k2=w(j);
end
if(d(j)==3.5)
 k3=d(j)/2;
else
k3=d(j);
end
 wte4(j)=n(j). *k1. *k2. *k3. *uw(j);
 wi4=wi4+wte4(j);
end
op2=(wi4.*1000)/9.81;
z=0.10/0.16/0.24/0.36;
ift=1;
r=5;
h=14;
code=[2,0.075,0.75];
t=code(2).*power(h, code(3));
sag=1/t;
ah=(z.*ift.*sag)/(2*r);
tsw=(3.*wi)+wi4;
vb=ah.*tsw;
scm=inp2;
hi(1:4)=scm(1:4,3);
swjhj2=wi.*(power(hi(1),2)+power(hi(2),2)+power(hi(3),2))+wi4.*power(hi(4),2);
for i3=1:1:3
if(i3==1)
tab_bs(i3,1)=z;
```

```
tab_bs(i3,2)=ift;
tab_bs(i3,3)=r;
tab_bs(i3,4)=code(i3);
tab_bs(i3,5)=t;
tab_bs(i3,6)=h;
tab_bs(i3,7)=sag;
tab_bs(i3,8)=ah;
tab_bs(i3,9)=tsw;
else
tab_bs(i3,1)=0;
tab_bs(i3,2)=0;
tab_bs(i3,3)=0;
tab_bs(i3,4)=code(i3);
tab_bs(i3,5)=0;
tab_bs(i3,6)=0;
tab_bs(i3,7)=0;
tab_bs(i3,8)=0;
tab_bs(i3,9)=0;
end
end
printmat(tab_bs,'Base shear calculation ','sl1 sl2 sl3','Z I R CODE T h Sa/g Ah w ');
for i2=1:1:4
if(i2<=3)
 qi(i2)=(vb.*(wi.*power(hi(i2),2)))/swjhj2;
else qi(i2)=(vb.*(wi4.*power(hi(i2),2)))/swjhj2;
end
```

**Mat Lab Coding (to Plot the Curves)**

```
function [ ] = base shear plot( )
bs=load('C:\Users\acer\Desktop\ABMATLAB\base shear plot.txt');
```

storey=(1:1:4);

plot(bs, storey);

end

## CALCULATION OF RESPONSE SPECTRUM METHOD THROUGH MAT-LAB CODING OF ABOVE PROBLEM

**Results of Analysis**

**Table 3**

| Storey Shear Forces for Four Modes | Zone II (Low) | Zone III (Moderate) | Zone IV (Severe) | Zone V (Very Severe) |
|---|---|---|---|---|
| $V_{i1} = \begin{matrix} V_{11} \\ V_{21} \\ V_{31} \\ V_{41} \end{matrix}$ | 29.21 29.21<br>24.92 24.92<br>16.98 16.98<br>6.55 6.55 KN | 46.74 46.74<br>39.88 39.88<br>27.17 27.17<br>10.48 10.48 KN | 70.1170.11<br>59.8259.82<br>40.7540.75<br>15.7315.73 KN | 10.5110.51<br>8.9738.973<br>6.1136.113<br>2.3602.360 KN |
| $V_{i2} = \begin{matrix} V_{12} \\ V_{22} \\ V_{32} \\ V_{42} \end{matrix}$ | 20.49 20.49<br>−33.63 −33.63<br>−77.47 −77.47<br>−58.89 −58.89 KN | 3.27 3.27<br>−5.38 −5.38<br>−12.39−12.39<br>−9.42 −9.42 KN | 4.91 4.91<br>−0.80 −0.80<br>−18.59−18.59<br>−14.13−14.13 KN | 7.377 7.377<br>−12.10−12.10<br>−27.89−27.89<br>−21.20−21.20 KN |
| $V_{i3} = \begin{matrix} V_{13} \\ V_{23} \\ V_{33} \\ V_{43} \end{matrix}$ | 20.34 20.34<br>−4.59−4.59<br>12.07 12.07<br>25.90 25.90 KN | 32.55 32.55<br>−7.35−7.35<br>19.31 19.31<br>41.44 41.44 KN | 48.82 48.82<br>−11.03−11.03<br>28.97 28.97<br>62.16 62.16 KN | 73.24 73.24<br>−16.55−16.55<br>43.45 43.45<br>93.24 93.24 KN |
| $V_{i4} = \begin{matrix} V_{14} \\ V_{24} \\ V_{34} \\ V_{44} \end{matrix}$ | −20.44−20.44<br>−63.15−63.15<br>11.08 11.08<br>−74.88−74.88 KN | −3.27 −3.27<br>−10.10−10.10<br>1.773 1.773<br>−11.98−11.98 KN | −0.49 −0.49<br>−15.15 −15.15<br>2.659 2.659<br>−17.97 −17.97 KN | −7.359−7.359<br>−22.73−22.73<br>3.989 3.989<br>−26.95−26.95 KN |

**Storey Shear Forces Curves for Different Zones**

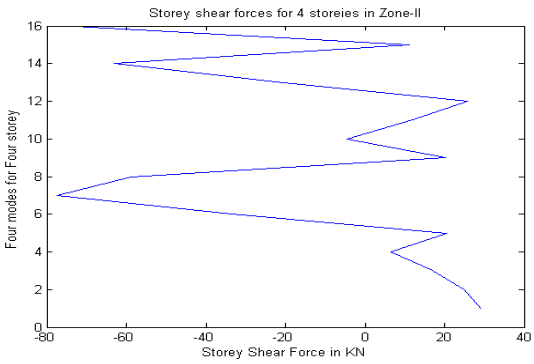


**Figure 7: Storey Shear Force Curve for Zone-II**

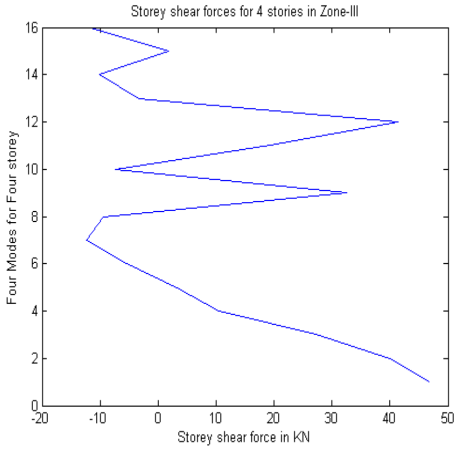


**Figure 8: Storey Shear Force Curve for Zone-III**

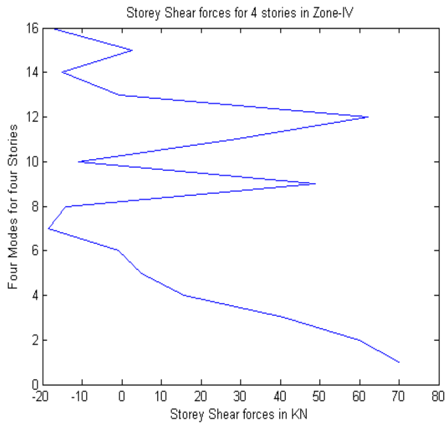


**Figure 9: Storey Shear Force Curve for Zone-IV**

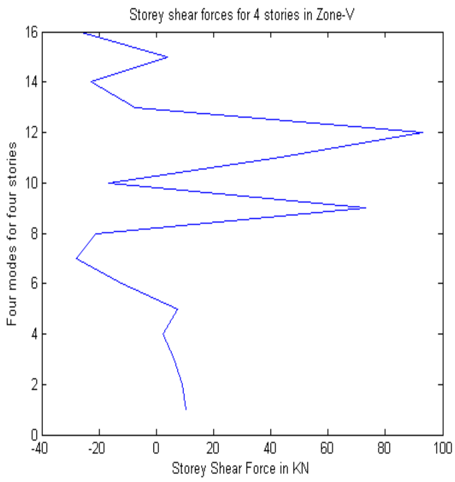


**Figure 10: Storey Shear Force Curve for Zone-V**

**Mat Lab Coding (To Evaluate the Values)**

```
fori=1:1:4
 m2(i,1)=vb;
if(i==4)
m2(i,2)=wi4;
else
m2(i,2)=wi;
end
m2(i,3)=hi(i);
m2(i,4)=swjhj2;
 m2(i,5)=qi(i);
end
printmat(m2,'dlf','Q1 Q2 Q3 Q4 ','vbwi hi swjhj2 Oi');
rsm(op, op2, l(1), w(1),wi,wi4);
end
m1=x1.*power(10,6);
m4=x4.*power(10,6);
mass=[m1,0,0,0;0,m1,0,0;0,0,m1,0;0,0,0,m4]
wi=we;
wi4=we2;
fck=20;
e=5000.*power(fck,(1/2))
i=((b).*power(d,3))/12
k=(3.*(12.*e.*i))/(power(3.5,3));
k1=k;
k2=k;
k3=k;
k4=k;
stiff=[(k1+k2),(-k2),0,0;(-k2),(k2+k3),(-k3),0;0,(-k3),(k3+k4),(-k4);0,0,(-k4),k4]
```

```
[v,w] = eig(stiff,mass);
w=w.*power(10,12);
format long
np3=load('C:\Users\acer\Desktop\AB MATLAB\q.txt');
for j1=1:1:4
q1(j1)=inp3(1,j1);
q2(j1)=inp3(2,j1);
q3(j1)=inp3(3,j1);
q4(j1)=inp3(4,j1);
end
q1
q2
q3
q4
inp3
for i1=1:1:4
p(i1)=((wi.*(inp3(1,i1)+inp3(2,i1)+inp3(3,i1)))+(wi4.*inp3(4,i1)))/((wi.*(power(inp3(1,i1),2)+power(inp3(2,i1),2)+power(inp3(3,i1),2)))+(wi4.*power(inp3(4,i1),2)));
end
p
sum=0;
for i1=1:1:4
M(i1)=(power(((wi.*(inp3(1,i1)+inp3(2,i1)+inp3(3,i1)))+(wi4.*inp3(4,i1))),2))/(9.81.*((wi.*(power(inp3(1,i1),2)+power(inp3(2,i1),2)+power(inp3(3,i1),2)))+(wi4.*power(inp3(4,i1),2))));
sum=sum+M(i1);
end
M
mcvm(1)=M(1)/sum;
mcvm(2)=M(2)/sum;
```

```
mcvm(3)=M(3)/sum;

mcvm(4)=M(4)/sum;

mcvm=mcvm.*100;

mcvm

w1(1)=power(w(1,1),(1/2));

w1(2)=power(w(2,2),(1/2));

w1(3)=power(w(3,3),(1/2));

w1(4)=power(w(4,4),(1/2));

for j1=1:1:4

t(j1)=(2.*3.14)/w1(j1);

end

% t=uint32(t)

z=0.10/0.16/0.24/0.36;

ift=1;

r=5;

sag=1/t(1);

ah(1)=(z.*ift.*sag)/(2*r);

ah(2)=(z.*ift.*2.5)/(2*r);

ah(3)=(z.*ift.*2.5)/(2*r);

ah(4)=(z.*ift.*2.5)/(2*r);

ah

g=9.81;

for j3=1:1:4

if(j3<4)

qi1(j3,1)=ah(1).*inp3(j3,1).*p(1).*m1.*g;

qi2(j3,1)=ah(2).*inp3(j3,2).*p(2).*m1.*g;

qi3(j3,1)=ah(3).*inp3(j3,3).*p(3).*m1.*g;

qi4(j3,1)=ah(4).*inp3(j3,4).*p(4).*m1.*g;

else
```

```
qi1(j3,1)=ah(1).*inp3(j3,1).*p(1).*m4.*g;
qi2(j3,1)=ah(2).*inp3(j3,2).*p(2).*m1.*g;
qi3(j3,1)=ah(3).*inp3(j3,3).*p(3).*m1.*g;
qi4(j3,1)=ah(4).*inp3(j3,4).*p(4).*m1.*g;
end
end
qi1
qi2
qi3
qi4
for j4=1:1:4
temp=0;
temp1=0;
temp2=0;
temp3=0;
for j5=j4:1:4
temp=temp+qi1(j5,1);
temp1=temp1+qi2(j5,1);
temp2=temp2+qi3(j5,1);
temp3=temp3+qi4(j5,1);
end
vi1(j4,1)=temp;
vi2(j4,1)=temp1;
vi3(j4,1)=temp2;
vi4(j4,1)=temp3;
end
vi1
vi2
vi3
```

```
vi4
end
end
```

**Mat Lab Coding (To Plot the Storey Shear Forces Graphs)**

```
function [ ] = storey shear( )
ss=load('C:\Users\acer\Desktop\AB MATLAB\storeyshear.txt');
storey= (1:1:16);
 plot (ss, storey);
end
```

## TIME HISTORY ANALYSIS

**Calculation of Modal Matrix**

**STEP-1**

The equation of motion for a multi degree of freedom system in matrix form can be expressed as -

$$[m]\ddot{x} + [c]\dot{x} + [k]x = -\ddot{x}g(t)\,[m]I[m]\ddot{x} + [c]\dot{x} + [k]x = -\ddot{x}g(t)\,[m]I \quad (1)$$

Where,

[m] = mass matrix;

[k] = stiffness matrix

[c] = damping matrix

[I] = Unit vector

$\ddot{x}g(t)\,\ddot{x}g(t)$ = Ground Acceleration

More clearly it can be represented as follows:

$$[M]\ddot{x} + [C]\dot{x} + [K]x = [\,P(t)][M]\ddot{x} + [C]\dot{x} + [K]x = [\,P(t)] \quad (2)$$

Where,

[M], [C], [K] are the diagonal zed modal mass matrix, modal damping matrix, and modal stiffness matrix respectively. And {P effective (t)} is the effective modal force vector.

$$K = \begin{bmatrix} k1+k2 & -k2 & 0 & 0 \\ -k2 & k2+k3 & -k3 & 0 \\ 0 & -k3 & k3+k4 & -k4 \\ 0 & 0 & -k4 & k4 \end{bmatrix}\begin{bmatrix} k1+k2 & -k2 & 0 & 0 \\ -k2 & k2+k3 & -k3 & 0 \\ 0 & -k3 & k3+k4 & -k4 \\ 0 & 0 & -k4 & k4 \end{bmatrix} \quad (3)$$

$$M=\begin{bmatrix} M1 & 0 & 0 & 0 \\ 0 & M2 & 0 & 0 \\ 0 & 0 & M3 & 0 \\ 0 & 0 & 0 & M4 \end{bmatrix}\begin{bmatrix} M1 & 0 & 0 & 0 \\ 0 & M2 & 0 & 0 \\ 0 & 0 & M3 & 0 \\ 0 & 0 & 0 & M4 \end{bmatrix} \quad (4)$$

$$\omega_n=\begin{bmatrix} \omega 1 & 0 & 0 & 0 \\ 0 & \omega 2 & 0 & 0 \\ 0 & 0 & \omega 3 & 0 \\ 0 & 0 & 0 & \omega 4 \end{bmatrix}\omega_n=\begin{bmatrix} \omega 1 & 0 & 0 & 0 \\ 0 & \omega 2 & 0 & 0 \\ 0 & 0 & \omega 3 & 0 \\ 0 & 0 & 0 & \omega 4 \end{bmatrix} \quad (5)$$

**Calculation of Acceleration**

**STEP-2**

The compatible time history $\{\ddot{x}g(t)\}\ddot{x}g(t)\}$ as per spectra of IS: 1893 (Part-1)-2002 for 2% damping at rocky soil strata is given in below figure which is plotted in between time vs acceleration for 1940 El-Centro, Kobe, Mexico City and Bhuj earthquakes.

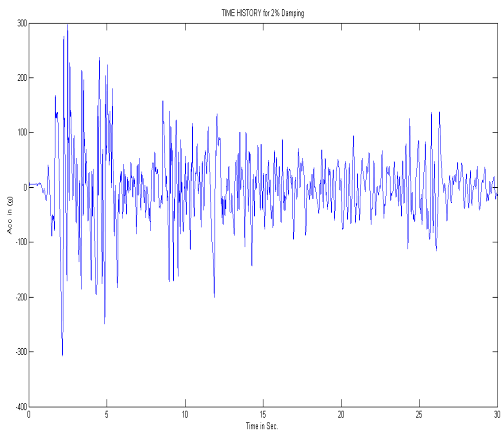

**Figure 11: Compatible Time History as per Spectra for El-Centro (1940) of 2% Damping**

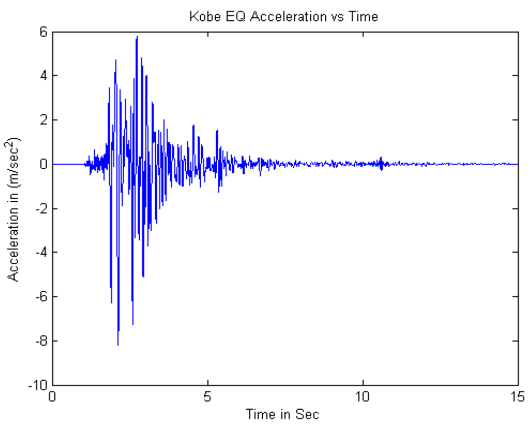


**Figure 12: Compatible Time Histories as per Spectra for Kobe of 2% Damping**

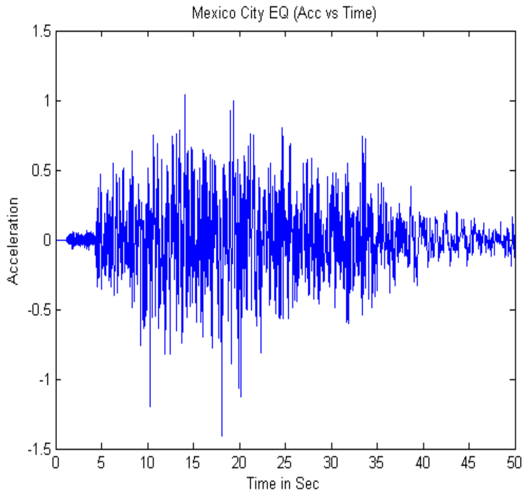


**Figure 13: Compatible Time Histories as per Spectra for Mexico City of 2% Damping**

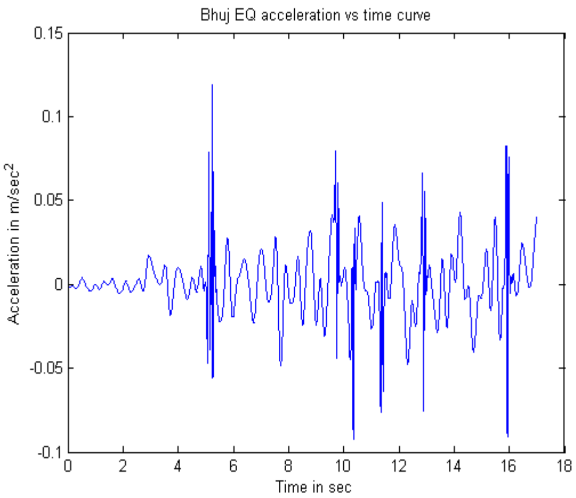


**Figure 14: Compatible Time History as per Spectra for Bhuj of 2% Damping**

**Mat-Lab Coding (for El-Centro 1940)**

```
ac=load('C:\Users\acer\Desktop\AB MATLAB\acceleration1.txt');

time=(0:0.005:30);

plot(time,ac);

end
```

**Mat-Lab Coding (for Kobe)**

```
function [ ] = kobeacc( )

ac=load('C:\Users\acer\Desktop\AB MATLAB\Kobe acc.txt');

time=(0:0.005:15);

plot(time,ac);
```

```
end
```

**Mat-Lab Coding (for Mexico-City)**

```
function [ ] = mxcoacc( )
ac=load('C:\Users\acer\Desktop\AB MATLAB\mexicocity acc.txt');
time=(0:0.005:50);
plot(time,ac);
end
```

**Mat-Lab Coding (for Bhuj)**

```
function [ ] = bhujacc( )
ac=load('C:\Users\acer\Desktop\AB MATLAB\bhuj acc.txt');
 time=(0:0.005:17);
 plot(time,ac);
end
```

**Displacement Responses for Different Floors**

For this uncontrolled responses it is solved by Piece-wise linear interpolation Method to get the displacements of different floor ( $q_1, q_2, q_3, q_4 q_1, q_2, q_3, q_4$) levels. Through this process we can easily solved it and as well as get the responses for the different floors. It is shown in figure below.

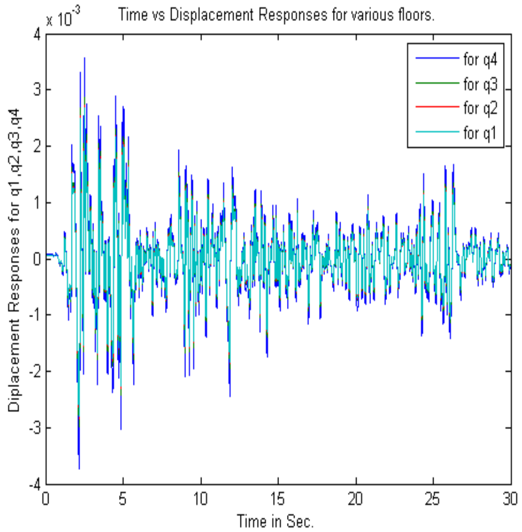


**Figure 15: Response History of El-Centro for $q_1, q_2, q_3, q_4 q_1, q_2, q_3, q_4$ vs Time**

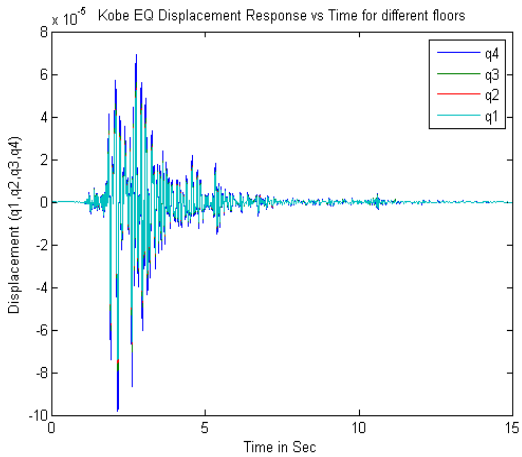


Figure 16: Response History of Kobe for $q_1, q_2, q_3, q_4 q_1, q_2, q_3, q_4$ vs Time

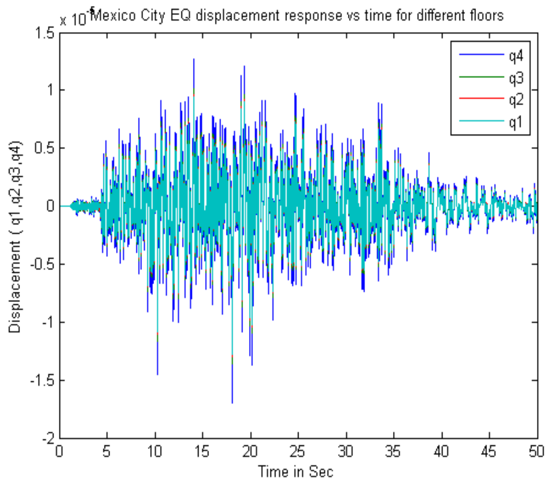


Figure 17: Response History of Mexico-City for $q_1, q_2, q_3, q_4 q_1, q_2, q_3, q_4$ vs Time

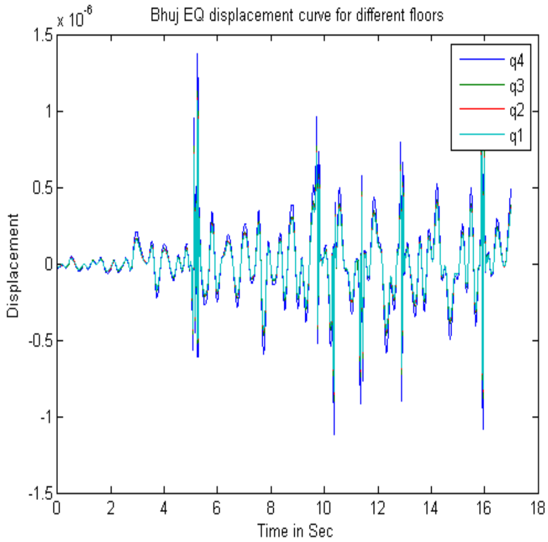


Figure 18: Response History of Bhuj for $q_1, q_2, q_3, q_4 q_1, q_2, q_3, q_4$ vs Time

**Mat-Lab Coding (1940 El-Centro)**

```
f='input €?';
€='damping ratio';
€=0.002;
g='input(t)?';
t='time interval';
t=0.005;
h=‘input (k)?’
e='input wn?’
wn=[9.00,25.63,38.40,45.44];
k= [81, 657, 1475, 2065];
Fore=1:1:4
wd(i)=(wn(i).*power(1-power(p,2),(1/2)));
end
fori=1:1:4
A(i)=(exp(-p.*wn(i).*t)).*(p/power(1-power(p,2),(1/2)).*sin(wd(i).*t)+cos((wd(i).*t)));
B(i)=(exp(-p.*wn(i).*t)).*(power(wd(i),-1).*sin(wd(i).*t));
c(i)=(1/k(i)).*(((2.*p)/(wn(i).*t))+exp(-p.*wn(i).*t)).*((((1-2.*power(p,2))/(wd(i).*t))-(p/power((1-
p),2))).*(sin(wd(i).*t))-(1+((2.*p)/wn(i).*t)).*(cos(wd(i).*t)));
D(i)=(1/k(i)).*((1-(2.*p)/wn(i).*t)+exp(-
p.*wn(i).*t)).*(((2.*power(p,2))/wd(i).*t).*sin(wd(i).*t))+((2.*p)/wn(i).*t).*cos(wd(i).*t);
At(i)=-exp(-p.*wn(i).*t).*(wn(i)/power((1-power(p,2)),(1/2)).*sin(wd(i).*t));
Bt=(exp(-p.*wn(i).*t)).*((cos(wd(i).*t)-(p/((power((1-power(p,2)),(1/2)).*(sin(wd(i).*t)))))));
Ct(i)=(1/k(i)).*(((-1/t)+exp(-p.*wn(i).*t))).*((((wn(i)/power((1-power(p,2)),(1/2)))+(p/(t.*power((1-
power(p,2)),(1/2))))))).*(sin(wd(i).*t))+(1/t).*(cos(wd(i).*t));
Dt(i)=(1/k(i).*t).*(1-exp(-p.*wn(i).*t)).*(p/power((1-power(p,2)),(1/2)).*sin(wd(i).*t)+cos((wd(i).*t)));
end
A
B
```

```
c
D
At
Bt
Ct
Dt
end
pp=load('C:\Users\acer\Desktop\AB MATLAB\pii.txt');
fori=1:1:6001
for k=1:1:4
cpi(i,k)=pp(i).*c(k);
end
end
time=(0:0.005:30);
fori=2:1:6001
for k=1:1:4
 dpi(i,k)=pp(i).*D(k);
end
end
fori=1:1:6001
aui(i+1,1:4)=A(1:4).*dpi(i,1:4);
end
ui(1,1:4)=dpi(1:4);
bui(1,1:4)=B(1:4).*dpi(1,1:4);
fori=1:1:6000
for j=1:1:4
ui(i+1,j)=aui(i,j)+bui(i,j)+cpi(i,j)+dpi(i+1,j);
end
bui(i+1,1:4)=B(1:4).*ui(i,1:4);
```

```
end
clc;
ui(1,1:4);
plot(time,ui);
end
```

**Mat-Lab Coding (for Kobe)**

```
function [ ] = kobedisplacement( )
f='input p?';
p='damping ratio';
p=0.002;
g='input(t)?';
t='time interval';
t=0.005;
h='input(k)?';
e='input wn?';
wn=[9.00,25.63,38.40,45.44];
k=[81,657,1475,2065];
fori=1:1:4
wd(i)=(wn(i).*power(1-power(p,2),(1/2)));
end
fori=1:1:4
A(i)=(exp(-p.*wn(i).*t)).*(p/power(1-power(p,2),(1/2)).*sin(wd(i).*t)+cos((wd(i).*t)));
B(i)=(exp(-p.*wn(i).*t)).*(power(wd(i),-1).*sin(wd(i).*t));
c(i)=(1/k(i)).*(((2.*p)/(wn(i).*t))+exp(-p.*wn(i).*t)).*((((1-2.*power(p,2))/(wd(i).*t))-(p/power((1-
p),2))).*(sin(wd(i).*t))-(1+((2.*p)/wn(i).*t)).*(cos(wd(i).*t)));
D(i)=(1/k(i)).*((1-(2.*p)/wn(i).*t)+exp(-
p.*wn(i).*t)).*(((2.*power(p,2))/wd(i).*t).*sin(wd(i).*t))+((2.*p)/wn(i).*t).*cos(wd(i).*t);
At(i)=-exp(-p.*wn(i).*t).*(wn(i)/power((1-power(p,2)),(1/2)).*sin(wd(i).*t));
Bt=(exp(-p.*wn(i).*t)).*((cos(wd(i).*t)-(p/((power((1-power(p,2)),(1/2)).*(sin(wd(i).*t)))))));
```

```
Ct(i)=(1/k(i)).*(((-1/t)+exp(-p.*wn(i).*t))).*((((wn(i)/power((1-power(p,2)),(1/2))+(p/(t.*power((1-
power(p,2)),(1/2))))))).*(sin(wd(i).*t))+(1/t).*(cos(wd(i).*t));

Dt(i)=(1/k(i).*t).*(1-exp(-p.*wn(i).*t)).*(p/power((1-power(p,2)),(1/2)).*sin(wd(i).*t)+cos((wd(i).*t)));

end

A

B

c

D

At

Bt

Ct

Dt

pp=load('C:\Users\acer\Desktop\AB MATLAB\Kobe acc.txt');

fori=1:1:3001

for k=1:1:4

cpi(i,k)=pp(i).*c(k);

end

end

time=(0:0.005:15);

fori=2:1:3001

for k=1:1:4

 dpi(i,k)=pp(i).*D(k);

end

end

fori=1:1:3001

aui(i+1,1:4)=A(1:4).*dpi(i,1:4);

end

ui(1,1:4)=dpi(1:4);

bui(1,1:4)=B(1:4).*dpi(1,1:4);
```

```
fori=1:1:3000
for j=1:1:4
ui(i+1,j)=aui(i,j)+bui(i,j)+cpi(i,j)+dpi(i+1,j);
end
bui(i+1,1:4)=B(1:4).*ui(i,1:4);
end
clc;
ui(1,1:4);
plot(time,ui);
end
```

**Mat-Lab Coding (for Mexico City)**

```
function [] = mxcocity displacement( )
f='input p?';
p='damping ratio';
p=0.002;
g='input(t)?';
t='time interval';
t=0.005;
h='input(k)?';
e='input wn?';
wn=[9.00,25.63,38.40,45.44];
k=[81,657,1475,2065];
fori=1:1:4
wd(i)=(wn(i).*power(1-power(p,2),(1/2)));
end
fori=1:1:4
A(i)=(exp(-p.*wn(i).*t)).*(p/power(1-power(p,2),(1/2)).*sin(wd(i).*t)+cos((wd(i).*t)));
B(i)=(exp(-p.*wn(i).*t)).*(power(wd(i),-1).*sin(wd(i).*t));
c(i)=(1/k(i)).*(((2.*p)/(wn(i).*t))+exp(-p.*wn(i).*t)).*((((1-2.*power(p,2))/(wd(i).*t))-(p/power((1-
```

```
p),2))).*(sin(wd(i).*t))-(1+((2.*p)/wn(i).*t)).*(cos(wd(i).*t)));

D(i)=(1/k(i)).*((1-(2.*p)/wn(i).*t)+exp(-
p.*wn(i).*t)).*(((2.*power(p,2))/wd(i).*t).*sin(wd(i).*t))+((2.*p)/wn(i).*t).*cos(wd(i).*t);

At(i)=-exp(-p.*wn(i).*t).*(wn(i)/power((1-power(p,2)),(1/2)).*sin(wd(i).*t));

Bt=(exp(-p.*wn(i).*t)).*((cos(wd(i).*t)-(p/((power((1-power(p,2)),(1/2)).*(sin(wd(i).*t)))))));

Ct(i)=(1/k(i)).*(((-1/t)+exp(-p.*wn(i).*t))).*((((wn(i)/power((1-power(p,2)),(1/2)))+(p/(t.*power((1-
power(p,2)),(1/2))))))).*(sin(wd(i).*t))+(1/t).*(cos(wd(i).*t));

Dt(i)=(1/k(i).*t).*(1-exp(-p.*wn(i).*t)).*(p/power((1-power(p,2)),(1/2)).*sin(wd(i).*t)+cos((wd(i).*t)));

end

A

B

c

D

At

Bt

Ct

Dt

pp=load('C:\Users\acer\Desktop\AB MATLAB\mexicocity acc.txt');

fori=1:1:10001

for k=1:1:4

cpi(i,k)=pp(i).*c(k);

end

end

time=(0:0.005:50);

fori=2:1:10001

for k=1:1:4

 dpi(i,k)=pp(i).*D(k);

end

end
```

```
fori=1:1:10001
aui(i+1,1:4)=A(1:4).*dpi(i,1:4);
end
ui(1,1:4)=dpi(1:4);
bui(1,1:4)=B(1:4).*dpi(1,1:4);
fori=1:1:10000
for j=1:1:4
ui(i+1,j)=aui(i,j)+bui(i,j)+cpi(i,j)+dpi(i+1,j);
end
bui(i+1,1:4)=B(1:4).*ui(i,1:4);
end
clc;
ui(1,1:4);
plot(time,ui);
end
```

**Mat-Lab Coding (for Bhuj)**

```
unction [ ] = bhujdisplacement( )
f='input p?';
p='damping ratio';
p=0.002;
g='input(t)?';
t='time interval';
t=0.005;
h='input(k)?';
e='input wn?';
wn=[9.00,25.63,38.40,45.44];
k=[81,657,1475,2065];
fori=1:1:4
wd(i)=(wn(i).*power(1-power(p,2),(1/2)));
```

```
end
fori=1:1:4
A(i)=(exp(-p.*wn(i).*t)).*(p/power(1-power(p,2),(1/2)).*sin(wd(i).*t)+cos((wd(i).*t)));
B(i)=(exp(-p.*wn(i).*t)).*(power(wd(i),-1).*sin(wd(i).*t));
c(i)=(1/k(i)).*(((2.*p)/(wn(i).*t))+exp(-p.*wn(i).*t)).*((((1-2.*power(p,2))/(wd(i).*t))-(p/power((1-
p),2))).*(sin(wd(i).*t))-(1+((2.*p)/wn(i).*t)).*(cos(wd(i).*t)));
D(i)=(1/k(i)).*((1-(2.*p)/wn(i).*t)+exp(-
p.*wn(i).*t)).*(((2.*power(p,2))/wd(i).*t).*sin(wd(i).*t))+((2.*p)/wn(i).*t).*cos(wd(i).*t);
At(i)=-exp(-p.*wn(i).*t).*(wn(i)/power((1-power(p,2)),(1/2)).*sin(wd(i).*t));
Bt=(exp(-p.*wn(i).*t)).*((cos(wd(i).*t)-(p/((power((1-power(p,2)),(1/2)).*(sin(wd(i).*t)))))));
Ct(i)=(1/k(i)).*(((-1/t)+exp(-p.*wn(i).*t))).*((((wn(i)/power((1-power(p,2)),(1/2)))+(p/(t.*power((1-
power(p,2)),(1/2))))))).*(sin(wd(i).*t))+(1/t).*(cos(wd(i).*t));
Dt(i)=(1/k(i).*t).*(1-exp(-p.*wn(i).*t)).*(p/power((1-power(p,2)),(1/2)).*sin(wd(i).*t)+cos((wd(i).*t)));
end
A
B
c
D
At
Bt
Ct
Dt
pp=load('C:\Users\acer\Desktop\AB MATLAB\bhuj acc.txt');
fori=1:1:3401
for k=1:1:4
cpi(i,k)=pp(i).*c(k);
end
end
time=(0:0.005:17);
```

```
fori=2:1:3401
for k=1:1:4
dpi(i,k)=pp(i).*D(k);
end
end
fori=1:1:3401
aui(i+1,1:4)=A(1:4).*dpi(i,1:4);
end
ui(1,1:4)=dpi(1:4);
bui(1,1:4)=B(1:4).*dpi(1,1:4);
fori=1:1:3400
for j=1:1:4
ui(i+1,j)=aui(i,j)+bui(i,j)+cpi(i,j)+dpi(i+1,j);
end
bui(i+1,1:4)=B(1:4).*ui(i,1:4);
end
clc;
ui(1,1:4);
plot(time,ui);
end
```

**Velocity Responses (for El-Centro)**

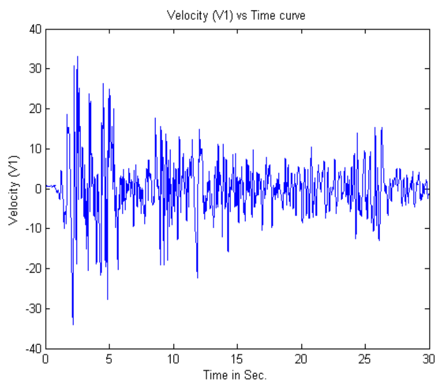


**Figure 19: Velocity (V1) vs Time**

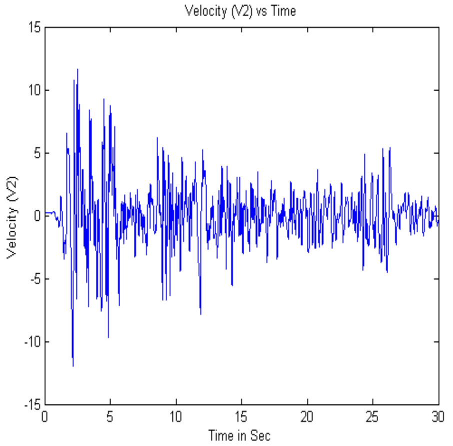


**Figure 20: Velocity (V2) vs Time**

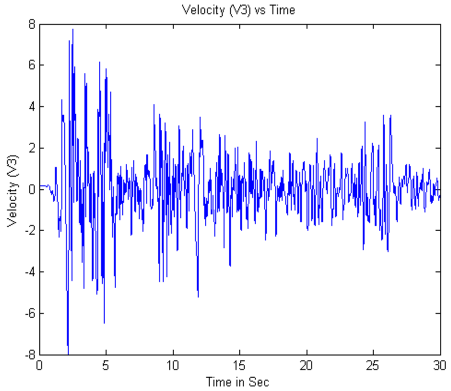


**Figure 21: Velocity (V3) vs Time**

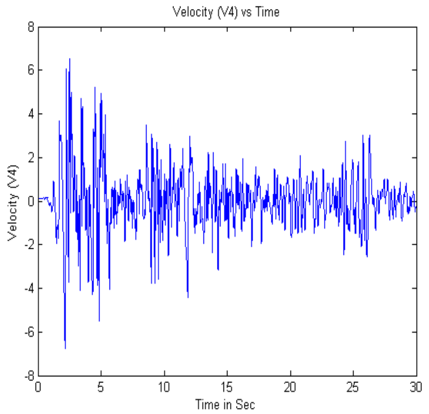


**Figure 22: Velocity (V4) vs Time**

**Mat-Lab Coding**

```
fori=1:1:6001
for j=1:1:4
 velocity(i,j)=ac(i)/wn(j);
```

```
end

end

time=(0:0.005:30);

plot(time,velocity(1:6001,1&2&3&4));
```

**Velocity Responses (for Kobe)**

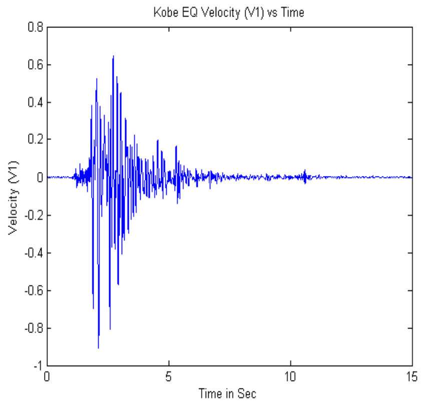


**Figure 23: Velocity (V1) vs Time**

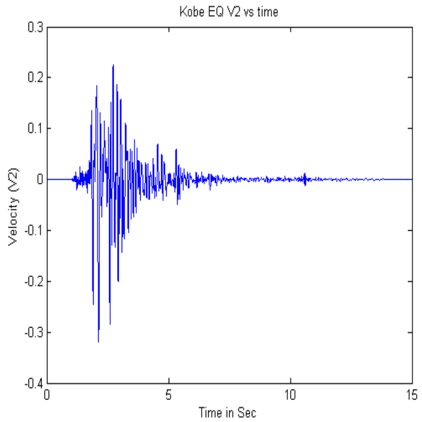


**Figure 24: Velocity (V2) vs Time**

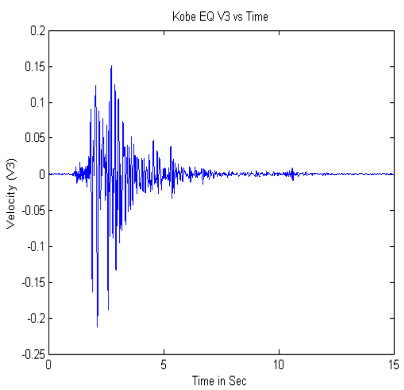


**Figure 25: Velocity (V3) vs Time**

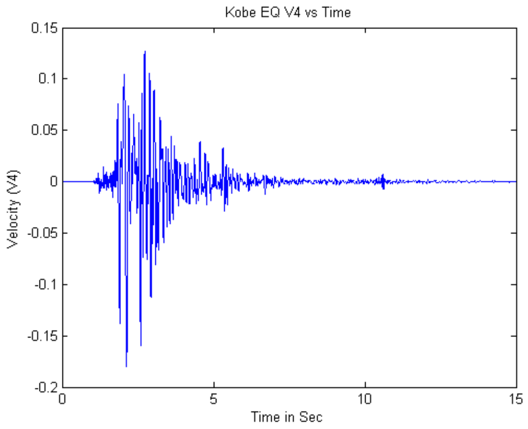


**Figure 26: Velocity (V4) vs Time**

**Velocity Responses (for Mexico City)**

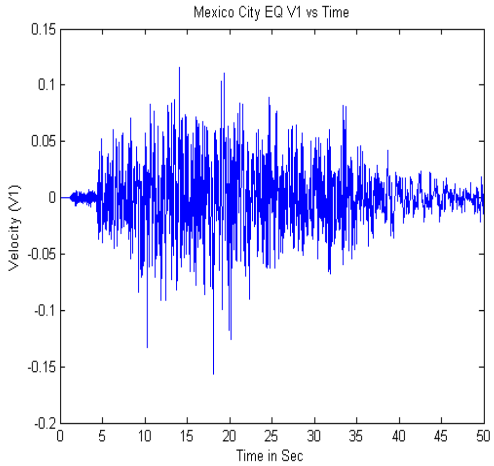


**Figure 27: Velocity (V1) vs Time**

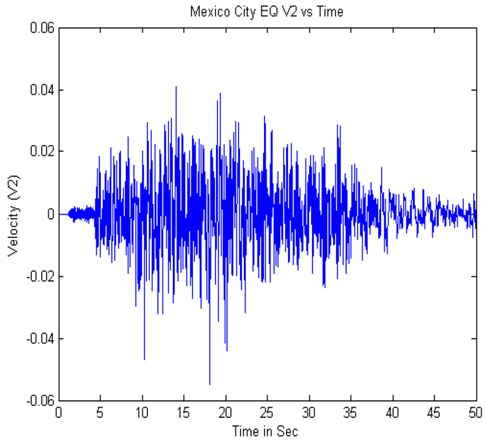


**Figure 28: Velocity (V2) vs Time**

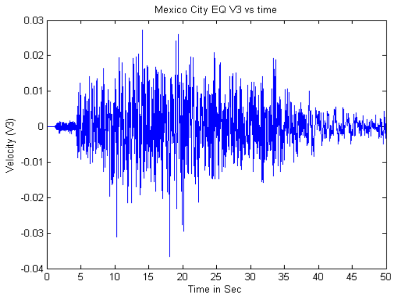


**Figure 29: Velocity (V3) vs Time**

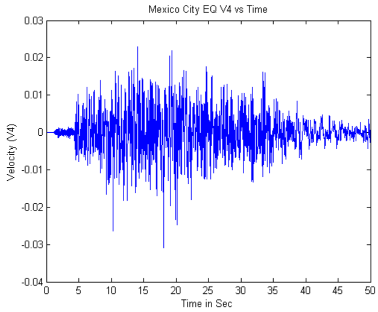


**Figure 30: Velocity (V4) vs Time**

**Mat-Lab Coding (for Kobe)**

```
function [ ] = kobevelocity( )

ac=load('C:\Users\acer\Desktop\AB MATLAB\Kobe acc.txt');

wn=load('C:\Users\acer\Desktop\AB MATLAB\wn.txt');

fori=1:1:3001

for j=1:1:4

vel(i,j)=ac(i)/wn(j);

end

end

time=(0:0.005:15);

plot(time,vel(1:3001,1));

end
```

**Mat-Lab Coding (for Mexico City)**

```
function [ ] = mxcoctyvelocity( )

ac=load('C:\Users\acer\Desktop\AB MATLAB\mexicocity acc.txt');

wn=load('C:\Users\acer\Desktop\AB MATLAB\wn.txt');
```

```
fori=1:1:10001
for j=1:1:4
vel(i,j)=ac(i)/wn(j);
end
end
time=(0:0.005:50);
plot (time,vel(1:10001,4));
end
```

**Velocity Responses (for Bhuj)**

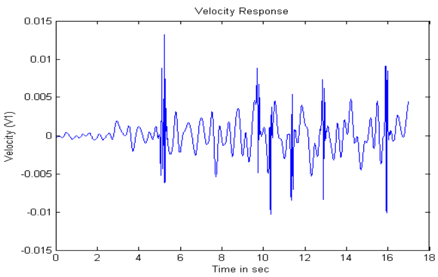


**Figure 31: Velocity (V1) vs Time**

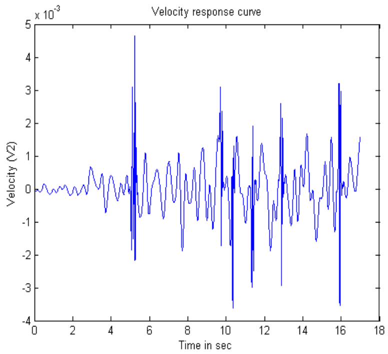


**Figure 32: Velocity (V2) vs Time**

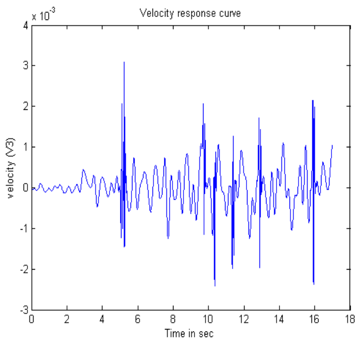


**Figure 33: Velocity (V3) vs Time**

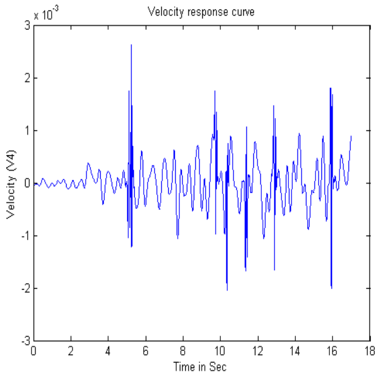


**Figure 34: Velocity (V4) vs Time**

**Mat-Lab Coding (for Bhuj)**

```
function [ ] = bhujvelocity( )
ac=load('C:\Users\acer\Desktop\AB MATLAB\bhuj acc.txt');
wn=load('C:\Users\acer\Desktop\AB MATLAB\wn.txt');
fori=1:1:3401
for j=1:1:4
vel(i,j)=ac(i)/wn(j);
end
end
time=(0:0.005:17);
plot(time,vel(1:3401,4));
end
```

## CONCLUSIONS

Based on the investigation carried out in the forgoing chapters on Dynamic analysis of a G+3 RC frame, following conclusion is derived.

- Significant seismic response of the structure (G+3) RC frame.
- We evaluate the lateral base shear of the building in different zone, II, III, IV, V by seismic co-efficient method (IS 1893:2002 part-1) and compared with each other and concluded that as the zone increases the base shear values increases also.
- To get the storey shear forces of each mode of the building, a step by step procedure of response spectrum analysis are conducted and plotted those through mode shapes for different zones, II, III, IV, V.
- Up-to above portion it is concluded as a static analysis of the frame through Indian standard code method by using

Mat-Lab (2013a).

- After getting these, we plot the time history responses of the building for different earthquakes (El-Centro, Kobe, Mexico-City &Bhuj). From here we generate the acceleration, velocity, and displacement curves for above earthquakes by using Linear Interpolation Method, as well as comparing them with each other.
- This time history response is known as Dynamic analysis of the building.
- At last we can easily say that time history analysis is more accurate than codal method because of, here we get the actual responses for the different earthquakes.
- As well as we know that the BHUJ earthquake is originated from zone V so its displacement and base shear values from dynamic analysis are less than the Indian standard code method, which is more accurate.

## REFERENCES


1. Chandiwala Anuj, "Earthquake analysis of building configuration with different position of shear wall" ISSN 2250-2459, ISO 9001:2008 certified journal, volume 2, issue 12, December 2012.
2. Agrawal. S. Ashis and Charkha. D. S, "Study of Optimizing Configuration of Multi-Storey Building Subjected to Lateral Loads by Changing Shear Wall Location" proceedings of international conference on advances in architecture and civil engineering (aarcv 2012), 21st – 23rd june 2012 287 paper id sam137,vol. 1
3. Mohan. R, "Dynamic Analysis of RCC Buildings with Shear Wall" International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 04, No 06 SPL, October 2011, pp 659-662.
4. RahangdaleHimalee, Satone. R. S, " Design and Analysis of Multi storied Building with Effect of Shear Wall" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622, Vol. 3, Issue 3, May-Jun 2013, pp.223-232.
5. YUN, hyun-do, CHOI, Chang-sik and LEE, li-hyung, "Earthquake performance of high strength concrete structural walls with boundary elements" 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada August 1-6, 2004, Paper No. 1182.
6. Anshuman. S, BhuniaDipendu, Ramjiyani. B, "Solution of Shear Wall Location in Multi-Storey Building"international journal of civil and structural engineering, volume 2, no 2, 2011.
7. ChandurkarPriya, Dr.Pajgade. P. S, "Seismic analysis of RCC building with and without shear wall" International Journal of Modern Engineering Research (IJMER), Vol. 3, Issue. 3, May - June 2013 pp-1805-1810
8. Harne. R. Varsha, "Comparative study of strength of RC Shear wall at different location on multi storied residential building" International Journal of Civil Engineering Research. ISSN 2278-3652 Volume 5, Number 4 (2014), pp. 391-400
9. Kappos. J. A and Panagopoulos. G (2004), "Performance-based Seismic Design of 3dr/c Buildings Using Inelastic Static and Dynamic Analysis Procedures", *ISET Journal of Earthquake Technology,* 41(1), 141-158.
10. Andreas J. Kappos, ManafpourAlireza (2001), "Seismic Design of R/C Buildings with the Aid of Advanced

Analytical Techniques", *Engineering Structures, Elsevier,* 23, 319-332.

11. IS 1893 (2000), *"Criteria for Earthquake Design of Structures*–Part 1: *General Provisions and Buildings"* (Fifth revision), Bureau of Indian Standards, New Delhi
12. Shah. J. H and Jain. K. Sudhir (2008), "*Final Report: A -Earthquake Codes IITK-GSDMA Project on Building Codes (Design Example of a Six Storey Building)*", IITK-GSDMA-EQ26-V3.0
13. Salem. M. H, El-Fouly. K. A, Tagel-Din. S. H (2011), "Toward an Economic Design of Reinforced Concrete Structures Against Progressive Collapse", *Engineering Structures,* Elsevier, 33, 3341-3350.
14. Kitayama. K, Otani. S and Aoyama. H (1987), *"Earthquake Resistant Design Criteria for Reinforced Concrete Interior Beam-column Joints",* Published in the Proceedings, Pacific Conference on Earthquake Engineering, Wairakei, New Zealand, August, 5-8, 1,315-326.
15. Arslan. H. M, Korkmaz. H. H (2007), "What is to be Learned from Damage and Failure of Reinforced Concrete Structures during Recent Earthquakes in Turkey?", *Engineering FailureAnalysis,* Elsevier, 14, 1–22.
16. Agarwal Pankaj and Shrikhande Manish (2006), "Earthquake Resistant Design of Structures", ISBN 978-81-203-2892-1, PHI Learning Private Limited.
17. Kima Hyun-Su, Dong-GuenLeea, Kyong Kim. C(2005), "Efficient three-dimensional seismic analysis of a high-rise building structure with shear walls", Engineering structures 27 (2005) 963–976.
18. Wakchaure M.R, Ped S (2012), "Earthquake Analysis of High Rise Building with and Without Infilled Walls", International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 2.
19. Patil. S. A and Kumbhar. D. P (2013), "Time history analysis of multi storied RC buildings for different seismic intensities", international journal of structural and civil engineering research, ISSN 2319 – 6009, vol. 2, no. 3.
20. Dorji. J and Thambitrtnam. D. P (2009), "Modelling and Analysis of Infilled Frame Structures under Seismic Loads", the Open Construction and Building Technology Journal. Bentham Science Publisher, Vol. 3.