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Analysis of multistory office building subjected to near & far field earthquake

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ABSTRACT

Analysis of Multistory office RCC building subjected to Field earthquake. The study of seismic analysis of 20 story RCC office building considering different seismic intensities is administrated and the seismic response of such building is studied. The RCC building is sculptured with the assistance of CSI E-Tabs Software Package. The necessary dynamic characteristic of the earthquake is peak ground acceleration frequency content and period. These characteristic finding out the behavior of structure under seismic masses. The strength of the ground motion supported on PGA, frequency content and the way long the shaking continues. Ground motion has totally different frequency content resembling low, intermediate and high. Earthquake ground motion is considered in two type of condition Near Fault and Far Fault. In this current study the performance of the structure is investigated under two different ground motion conditions which are near and far from the epic center (Near Fault and Far Fault) in both normal and parallel component direction by the time history analysis method and the results are shown in terms of Acceleration, Base shear, Velocity and story displacement.

Keywords: Ground motion, Near-field and far field, Earthquake, Time history analysis, Chi-Chi earthquake, El Centro earthquake

1. INTRODUCTION

Nowadays in all over the world demand of the multistory building, high-rise building and commercial building due to increase in urbanization and helical population and an earthquake (quake, tremor or temblor) are having the potential for causing the greatest damage to all the structure. Earthquake powers are irregular in nature and unusual, the designing method should be honed for analyzing structures under the action of these forces. Earthquake causes a distinctive shaking power at various areas and the damage promoted in these areas is additionally unique along these parameters area this is important to build any type of structure which is earthquake resistant at a specific level of force or intensity of shaking of the structure. The same magnitude of the earthquake is predicted in the various intensities, therefore, it is most important to study the various seismic behaviors for different seismic intensities in terms of various responses.

Near Fault earthquake (the structure is near from epic center of the earthquake): Points in the earth whose distance from the center of an earthquake is less than a specific level. Some exploration thinks about the separation of 50 Km and some others 15 km. These style of the associated earthquake that is occurring close to a fault have long amount pulse maps with one or additional velocity. In last few years ago important near field many earthquake motions have been recorded but some of the earthquake motion has been recorded examples are North-Bridge 1994 and Chi-Chi 1999.

Far Fault earthquake (a structure located far from the epic center earthquake): Points in the earth whose distance from the center of an earthquake is far than a specific level. Some exploration thinks about the separation of above 50 Km. The values of Peak Ground Acceleration, Peak Ground Velocity and Peak Ground Displacement of Fault Normal and Fault parallel components don't differ for a far-field earthquake but they differ much for the near-field earthquake in vertical component (parallel component).

It is diagnosed that the characteristics of near-discipline earthquake ground motions are unique from those record in the far field. For determination of the seismic response of multistory office building, it is necessary to carry out seismic analysis of the structure using the different available method.

1.1 Different Analysis procedures are as follows:

Linear Dynamic Analysis: In this one multimode shape of building taken into account also known as Response spectrum analysis.

Linear Static Analysis: It is known as an equivalent static method and it's based on the standard code of practices. Normally design base shear is firstly calculated for whole structure then it distributed along the height of the building. Lateral forces which are obtained then distributed to lateral load resisting element.

Nonlinear static Analysis: It is used to estimate the behavior of structure such as strength, drift capacity, and seismic demand. Checking the adequacy of the existing structure and new structure as well also known as PUSH over analysis.

Time History Analysis (THA) Non-Linear Dynamic Analysis: In Time-history analysis is the behavioral investigation of a structure under a past tremor or wind speeding up information. Time-history is a plot of amplitude (the maximum extent of a vibration or oscillation) or acceleration vs. time. Time history analysis is applicable to both elastic and non-elastic analysis. Time History analysis is applicable to determining the seismic response of the structure under dynamic loading of the representative earthquake. Basically, in time history investigations, we study the behavior of structure for the load which is in time versus acceleration. It's exceptionally hard to do it physically. Software analysis is compulsory.

Kobe Japan 1995: On January 17th at 5.46 am on many of the citizen normally at sleep mode the Japan city of Kobe (which was normally at high risk to earthquake since 1923) was hit by earthquake its result in massive damage to property and loss of life the worst affected area was central part of Kobe region about 5km to 20 km alongside the main docks and port area The area is built on soft and easily moved rocks especially the port itself. Thousands of building was destroyed hundreds of people become homeless. The rehabilitation cost of infrastructure becomes a major problem for the government.



Fig. 1: Kobe Japan 1995

El Centro Earthquake (1940 Imperial depression earthquake): On 19th may 16:16 Pacific daylight time was hit by earthquake having a magnitude of 6.9. The valley is famous for crop growing area, agriculture area, and most fertile area land. At imperial one-third of the building were destroyed and caused million worth of property damage. It was the primary seismic tremors which give achieve proof of surface breaking since the 1906 San Francisco quake.

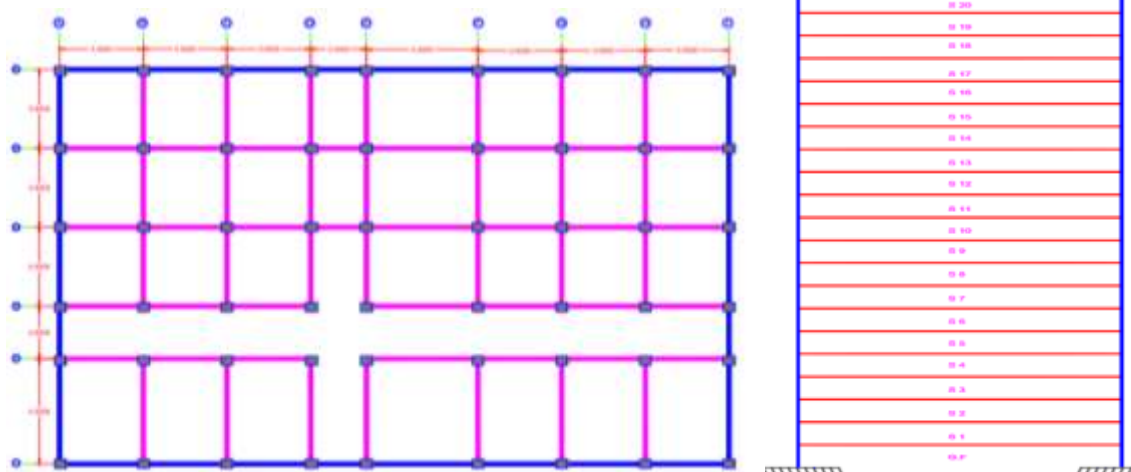


Fig. 2: El Centro

Table 1: Characteristic of near-field ground motion and far field ground motion from the recent large earthquake which is used in the analysis.

| Earthquake | Station | Magnitude | Distance |
|--------------------|---------------------|-----------|----------|
| Kobe, Japan 1995 | Nishi-Akashi, Japan | 6.90 | 7.1 km |
| Kobe, Japan 1995 | MZH, Japan | 6.90 | 70.3 km |
| El Centro Array #9 | Imperial Valley-02 | 6.95 | 7 km |
| El Centro Array #9 | Imperial Valley-02 | 6.95 | 35 km |

2. STRUCTURAL MODELLING AND ANALYSIS



For the study 20 storied masonry RCC building is taken into account. The pure structural geometry plan and dimensions of set up area unit shown in Figure one. The typical Story height of each building is to be considered 3.2 meters. In this multistory office building slab load is considered and the wall load are applied on interior and exterior beams Live a load of applied is provided in accordance to IS 875 Part 2 for seismic weight total dead load 25% of the live load as per table no 8 of IS 1893 Part 1

Live load on the floor: 3 km/ m²

Column size: 600x 600 mm

Slab thickness: 200 mm

The density of concrete: M30

Modulus of elasticity for concrete: 27,368.12 N/mm²

Modulus elasticity for Brick:

Beam size: 230x600 mm

Brick wall thickness: 230mm

The density of Brick: 1900 kg/m³

3. RESULTS AND CONCLUSION

Ground motion causes an earthquake. Structures area unit at risk of ground motion. It damages the structures. So as to require precaution for the injury of structures due to the ground motion so that it's necessary to know the characteristics of the ground motion. The characteristics of ground motion area unit peak ground acceleration, peak ground rate, peak ground displacement, period, and frequency content.

Here 20 stories RCC framed building is studied under high-frequency ground motion subjected near and far from the epic center of an earthquake. Linear time history analysis has performed the output are given in term of story displacement and story acceleration and base shear are studied. The response of each ground motion is subjected to near and far from the epic center of an earthquake is studied.

3.1 Near field earthquake (Kobe Japan)

Kobe, Japan 1995 Nishi-Akashi, Japan Magnitude 6.90 Closest Distance 7.1 km

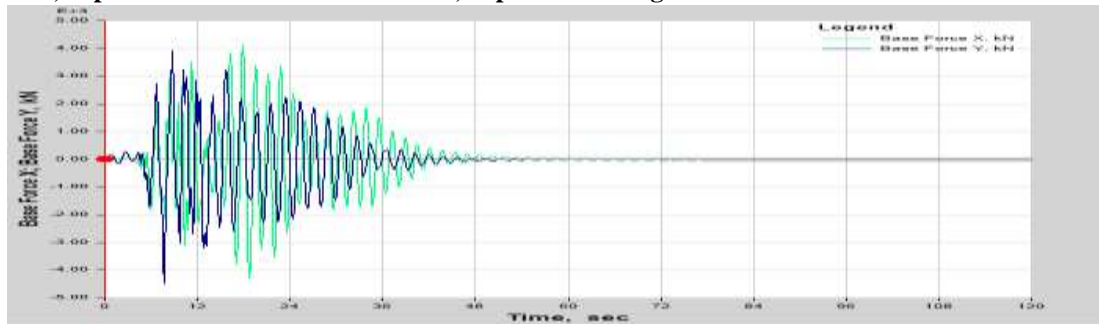


Fig. 3: Base shear vs. time along in X and Y direction

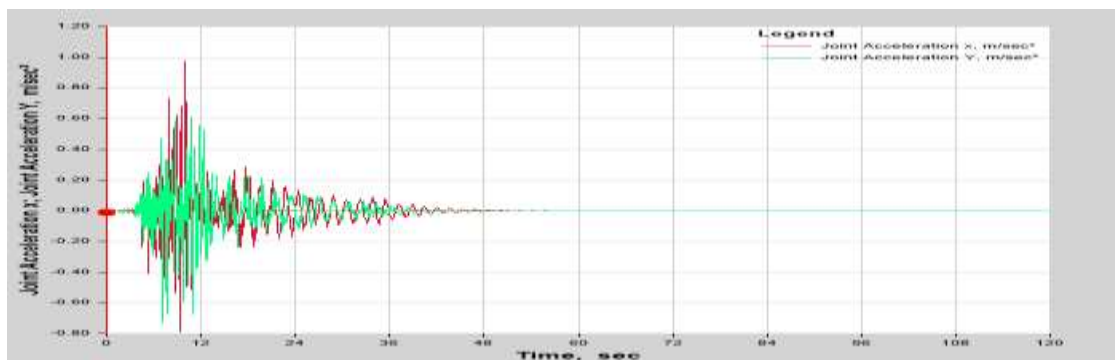


Fig. 4: Acceleration vs. time along in X and Y direction

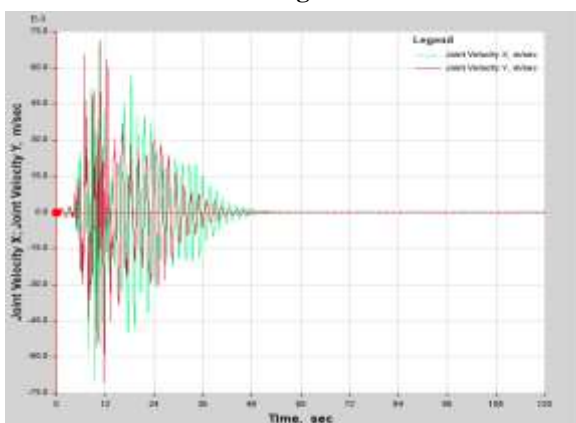


Fig. 5: Joint Velocity in X and Y direction

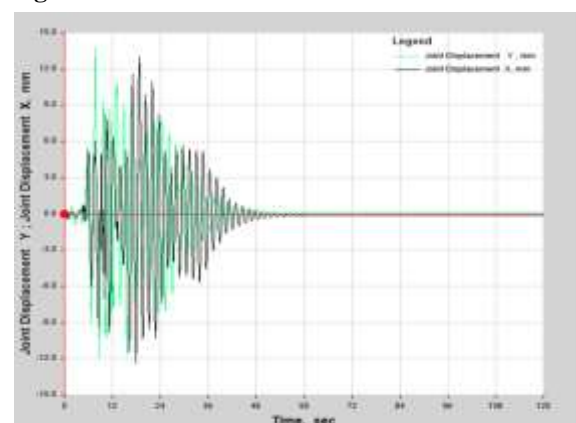


Fig. 6: Joint displacements in X and Y direction

3.2 Far field earthquake (Kobe Japan)

Kobe, Japan 1995 MZH, Japan Magnitude 6.90 Closest Distance 70.3 km

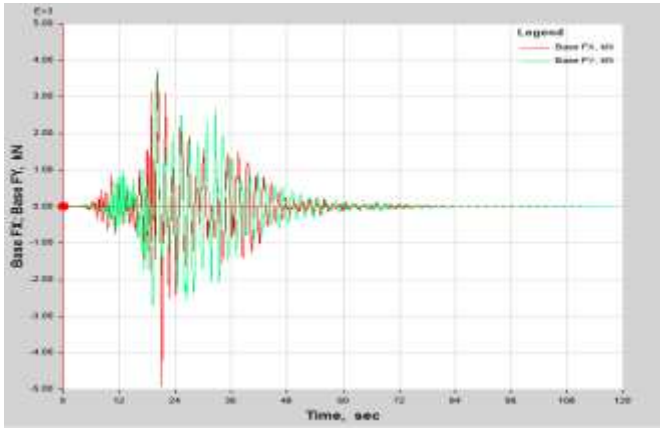


Fig. 7: Base Shear vs. time Along in X and Y Dirⁿ

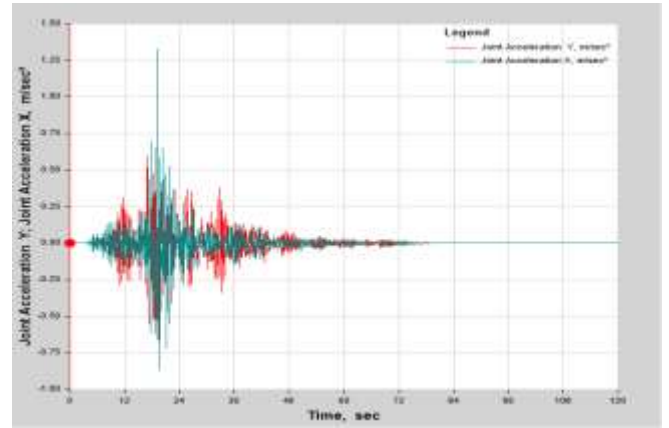


Fig. 8: Acceleration vs. time in X and Y Dirⁿ

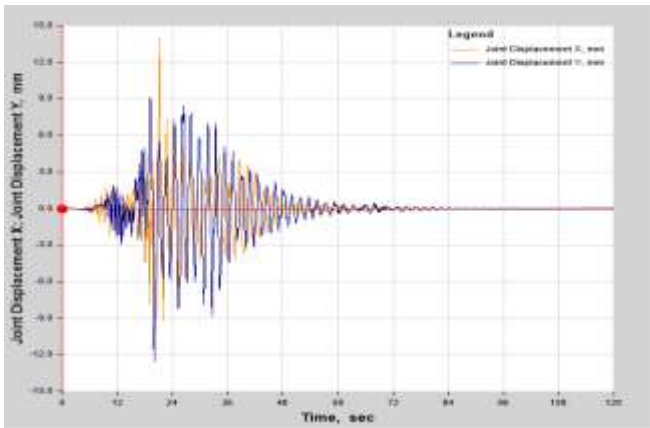


Fig. 9: Joint displacements in X and Y dirⁿ

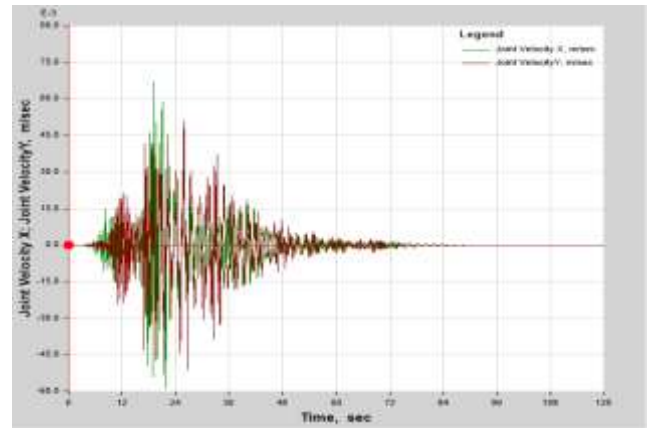


Fig. 10: Joint Velocity in X and Y dirⁿ

3.3 Near field earthquake

El Centro Array #9 Imperial Valley-02 Magnitude 6.95 Closest Distance 6.09 Km

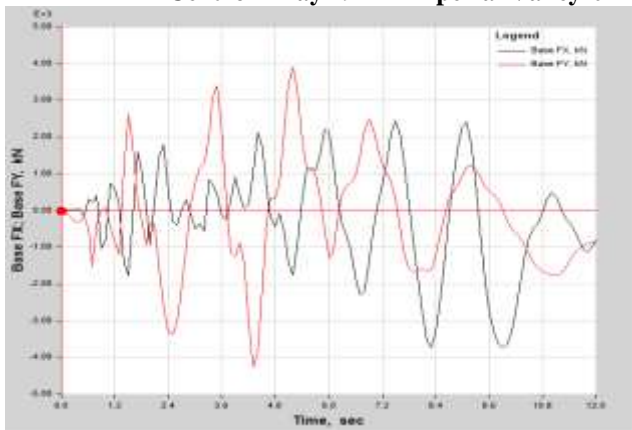


Fig. 11: Base Shear vs. time Along in X and Y Dirⁿ

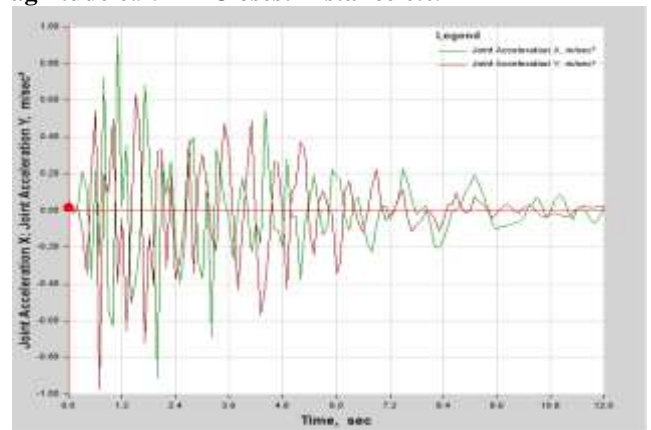


Fig. 12: Acceleration vs. time in X and Y Dirⁿ

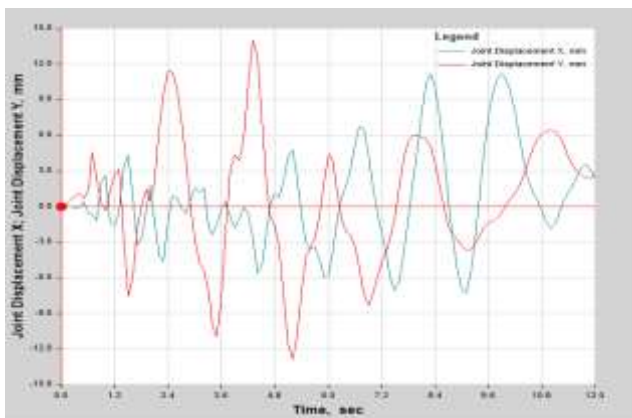


Fig. 13: Joint displacement vs. time in X and Y dirⁿ

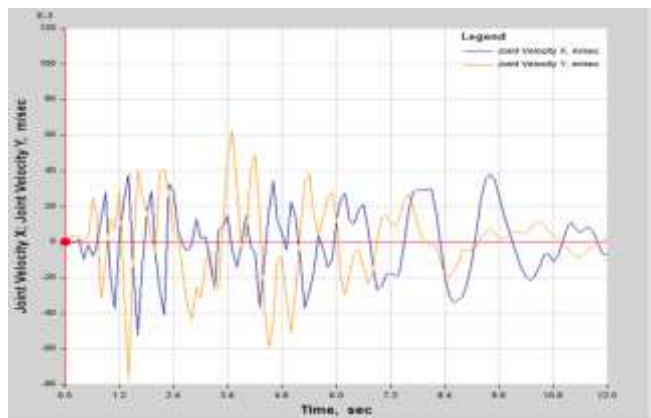


Fig. 14: Joint Velocity vs. time in X and Y dirⁿ

3.4 Far field earthquake

El Centro Array #9 Imperial Valley-01 Magnitude 5 Closest Distance 35 Km

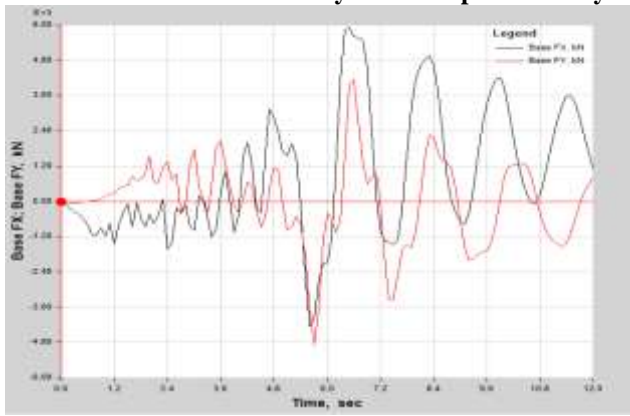


Fig. 15: Base Shear vs. time Along in X and Y Dirⁿ

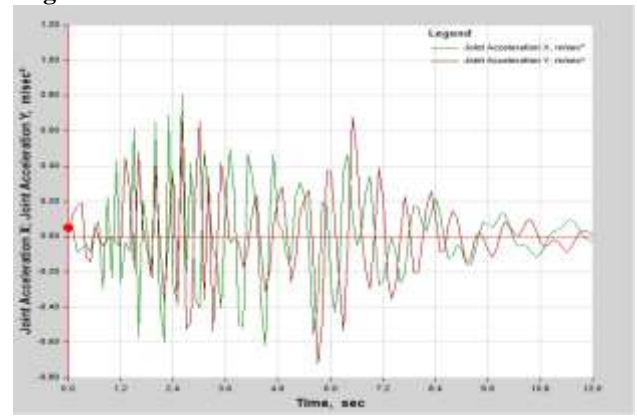


Fig. 16: Acceleration vs. time in X and Y Dirⁿ

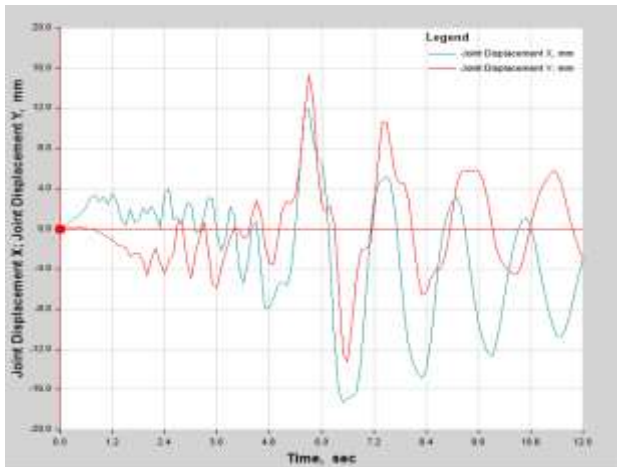


Fig. 17: Joint displacement vs. time in X and Y dirⁿ

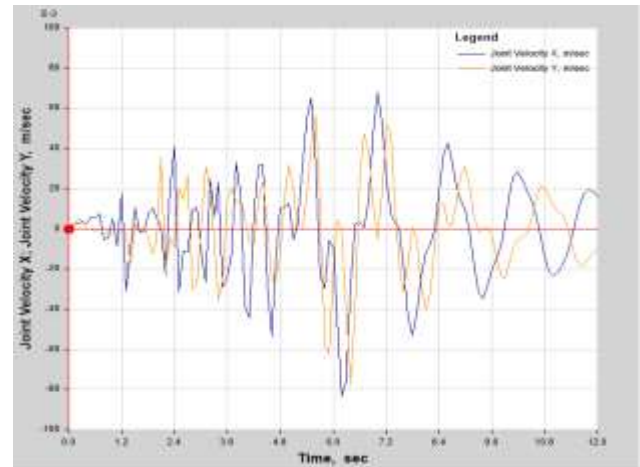


Fig. 18: Joint Velocity vs. time in X and Y dirⁿ

Results obtained from the analysis are shown in pictorial form. The Graphical picture shows that similar variation in seismic response namely in the term of Base shear displacements and the acceleration.

4. CONCLUSION

The values of acceleration, velocity, displacement and base shear have been determined for both components in X (Normal Component) direction and Y parallel component direction. Time history analysis is performed using near the fault and far fault records. All the results are presented in the form of a comparative diagram

According to the result following recommendation is to be found:

From the above graphic picture, it is to be clearly seen that the value of acceleration, velocity, displacement and base shear are obtained for a near-fault earthquake are normally more than far-field earthquake and the value of base shear, velocity, acceleration, and displacement for the normal component are higher than parallel component. The maximums axial force under axial loading forces in the near filed earthquake is more.

Near field earthquake have longer frequency range, axial forces, moment and force in a critical column in a near-field earthquake is more so that as per structural engineering aspect building frame in near-field earthquake having more critical behavior.

As per the above recommendation, it is more important to design any type of RCC frame building under near to the epic center of an earthquake with long period range.

The value base shear, acceleration, displacement and velocity in respect with a time of fault normal and the parallel component direction doesn't make too much difference for far fault earthquake but for a near-fault earthquake, it differs too much.

When we considered the vertical component of the earthquake in case of near and far fault earthquake, the bending moment axial force and base shear variation in the critical column for the near-field earthquake loading is multiple time more than the computed value of the far-field loading earthquake.

In earthquake behavior one of the effective parameters is acceleration time period so that as per the above graphical diagram the near field has large period rather than far-field earthquake acceleration

Near filed earthquake have large peak pulse velocity and more pulse duration that is more dangerous for any type of structure so that the structures near to seismic source have more ductility in order to make the structure free from collapse mechanism under various seismic intensities.

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