Performance of a Structure under Different Ground Motions

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Abstract— Structural dynamic is a mandatory graduate level course for structural engineering student all around the world. In civil engineering structures are mostly designed based on prescriptive methods of standard codes. Usually loads on these structures are of low magnitude which results in elastic structural behavior. However, strong loads such as a sudden earthquake will lead the structure beyond its elastic limit. Generally 4 kinds of earthquake ground motions are considered such as Fault Normal, Fault Parallel, Near Fault and Far Fault components. In the current study the performance of a structure in a single degree of freedom system is investigated under different ground motions such as Fault normal and Fault parallel component of the ground motion by dynamic time history analysis method and the analysis is done in the SEISMOSTRUCT software developed by the SEISMOSOFT Company. The Acceleration, Velocity and displacement curves have been drawn for both Fault Normal and Fault Parallel component of Far Fault and Near Fault ground motion. The values of acceleration, velocity, displacement have been found in every 0.005 seconds, also the values of Peak Ground Acceleration, Peak Ground Velocity and Peak Ground Displacement has been determined for both components. The values of PGA, PGV, PGD obtained for fault normal component are higher than the values obtained for the fault parallel component of the ground motion, also the frequencies of fault normal component of ground motion are more than that of the fault parallel component of ground motion. The values of Peak Ground Acceleration, Peak Ground Velocity and Peak Ground Displacement of Fault Normal and Fault parallel components don't differ much for Far Fault earthquake ground motions, but they differ much for Near Fault Earthquake ground motions. The response spectrum curves are different for each kind of earthquake ground motions, hence it means that the structure have different responses to each kind of earthquake ground motions.

Key words: Structural dynamic, Fault Normal, Fault Parallel, Near Fault and Far Fault components, PGA, PGV, PGD

I. INTRODUCTION

A quake is the aftereffect of a startling arrival of vitality in the Earth's hull that makes seismic waves. The seismicity or seismic activity of a zone alludes to the recurrence, sort and size of quakes honed over some undefined time frame. Tremors are estimated utilizing comments from seismometers. The minute extent is the most widely recognized scale on which seismic tremors more prominent than around 5 are accounted for the whole globe. The a greater number of tremors littler than extent 5 expressed by national seismological observatories are estimated for the most part on the neighborhood size scale, likewise alluded to as the Richter greatness scale. These two scales are numerically comparable over their scope of authenticity. Extent 3 or lower tremors are generally relatively unnoticeable or powerless and greatness 7 and over conceivably causes serious harm over bigger zones, subject to their profundity. The biggest quakes in memorable periods have been of greatness somewhat more than 9, in spite of the fact that there is no limit to the conceivable size. The latest extensive tremor of size 9.0 or bigger was a 9.0 size quake in Japan in 2011 (as of March 2014), and it was the significant Japanese seismic tremor since records began. Power of shaking is estimated on the altered scale. The shallower a seismic tremor (otherwise called a shudder, tremor or quake) is the aftereffect of a sudden arrival of a quake, the more annihilation to structures it causes, all else being equivalent. At the Earth's surface, seismic tremors show themselves by trembling and now and then removal of the ground. At the point when the epicenter of an extensive seismic tremor is arranged seaward, the seabed might be uprooted satisfactorily to cause a tidal wave. Seismic tremors can likewise trigger avalanches, and once in a while volcanic development.

II. OBJECTIVE OF PAPER

To consider the distinctions in auxiliary reactions against various tremor ground movements and we analyze the outcomes as takes after:

- Far-field/Near-field
- Fault-parallel/Fault-ordinary
- To perform dynamic time history investigation on a structure in single level of flexibility framework with the utilization SEISMOSTRUCT programming.
- To analyze the related Response Spectrums for Fault Normal and Fault Parallel parts of the two sorts of seismic tremor ground movements.

III. STRATEGIES FOR AUXILIARY INVESTIGATION

At the point when the quantity of obscure responses or the quantity of inward powers outperforms the quantity of balance conditions existing with the end goal of investigation, the structure is known as a statically uncertain structure. Numerous structures are statically uncertain. This indeterminacy might be because of extra backings or additional individuals, or by the general type of the structure. While breaking down any uncertain structure, it is vital to fulfill balance, similarity, and power removal conditions for the structure.

A. Force method

The force method is used to calculate the response of statically indeterminate structures to loads and/or imposed deformations. The method is based on transforming a given structure into a statically determinate

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B. Displacement Method

The immediate removal strategy is another method that can be utilized to examine uncertain structures. This strategy can be summed up and is regularly utilized as a part of basic investigation programming. In this strategy, all degrees of flexibility of a structure are controlled, i.e. "bolted", and the part settled end powers are computed because of any connected loads on the part. As in minute circulation, every level of flexibility is then autonomously discharged, i.e."un-bolted", and the part end powers are resolved because of an utilization of a unit dislodging that compares to every level of opportunity.

C. Slope deflection method

The slope deflection method is a structural analysis method for beams and frames introduced in 1914 by George A. Maney.[1] The slope deflection method was widely used for more than a decade until the moment distribution method was developed. In the book, "The Theory and Practice of Modern Framed Structures", written by J.B Johnson, C.W. Bryan and F.E. Turneaure, it is stated that this method was first developed, "by Professor Otto Mohr in Germany, and later developed independently by Professor G.A. Many".

D. Moment distribution method

N the moment distribution method, every joint of the structure to be analyzed is fixed so as to develop the fixed-end moments. Then each fixed joint is sequentially released and the fixed-end moments (which by the time of release are not in equilibrium) are distributed to adjacent members until equilibrium is achieved. The moment distribution method in mathematical terms can be demonstrated as the process of solving a set of simultaneous equations by means of iteration.

E. Kani's method

Kani's method of structural analysis was developed by Gasper Kani. Kani was a lecturer in structural theory during WWII. After the war he worked as a building contractor. Kani developed a method of iteration for statically indeterminate structures. It is an approximate method that can save a great deal of time compared to moment distribution method, especially when considering structural floors with a couple of storey's or more.

IV. SEISMICANALYSIS

A. Time History Analysis:

Dynamic investigation characterizes time-subordinate relocations and powers because of dynamic burdens or nodal increasing velocities. It can be executed on direct or nonlinear models, and Linear or nonlinear harmony conditions are understood by the Newark-beta technique. Speeding up capacities can likewise be utilized for seismic investigation. For this situation it is recommended to get appropriate seismic accelerograms and allocate these capacities to help hubs to look at the impacts of the quake. Its drawback is that it can't be joined with other load writes consequently. In time history examination there are various approaches to numerically incorporate the principal condition of movement. A large number of these are examined in course readings including the referenced writings incorporated into this archive. Visual Analysis utilizes the Newark technique for numerical joining which is known as a speculation of the straight increasing speed strategy.

B. Distinction amongst THA and RSA:

Time history investigation gives more exact outcomes than the reaction range examination and can be utilized regardless of whether nonlinear components are characterized in the model. In time history investigation the auxiliary reaction is computed at various ensuing time moments. At the end of the day, time histories of the basic reaction to an accepted info are acquired and an outcome. Accordingly range examination the time advance of reaction can't be processed. Just the most extreme reaction is anticipated. No information is accessible likewise about the time when the most extreme reaction happens.

C. About the Software:

SEISMOSTRUCT is Finite Element bundle fit for ascertaining the substantial removal conduct of room outlines under static or dynamic stacking, dealing with both geometric nonlinearities and material inelasticity. Solid, steel and FRP material models are existing, together with a gigantic library of 3D components that can be utilized with a wide assortment of pre-characterized steel, concrete and composite segment designs. The program has been broadly quality-checked and approved, as portrayed in its Verification Report. A portion of the more indispensable highlights of SeismoStruct are appeared in what takes after.

V. RESULT & DISCUSSION

A. Design

Above all else a basic structure was planned in single level of flexibility framework with length equivalent to 10000mm and mass equivalent to 2000 N from a versatile material. It's having a square cross segment of 500mm*500mm.

B. Input Data

After that the ground movement information was downloaded from PEER solid movement database. The examination are performed for 2 sets of ground movement records (FN and FP) for the "Oroville 1975/08/08 07:00" seismic tremor at 1543 DWR Garage station. The increasing speed time history was recorded for like clockwork.

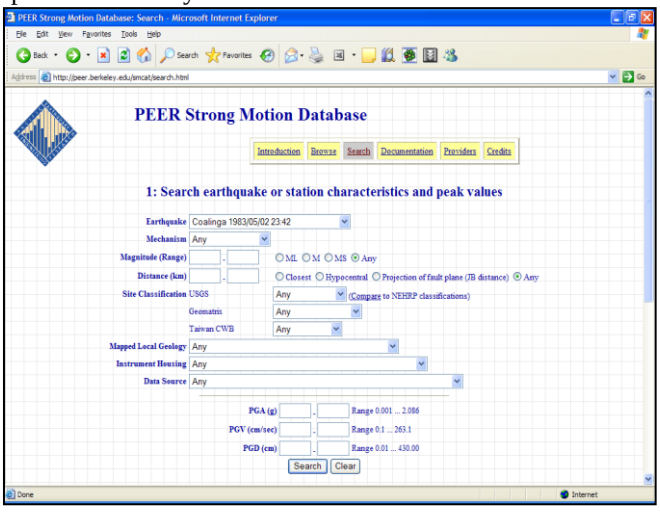

Fig. 1:

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C. Output data

1) Time History Analysis

The impact of the downloaded input ground movement information has been researched on the structure (SDF framework) utilizing the dynamic time history investigation. Subsequent to playing out the dynamic time history examination we have the yield information for both blame typical and blame parallel parts of Far Fault ground movements , and furthermore the bends for (increasing speed, speed and removal) versus time were acquired which are appeared in the accompanying figures:

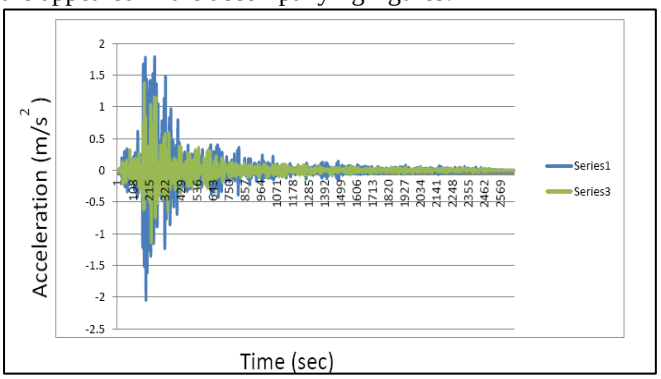

Fig. 2: Acceleration curve (Fault Normal & fault parallel)

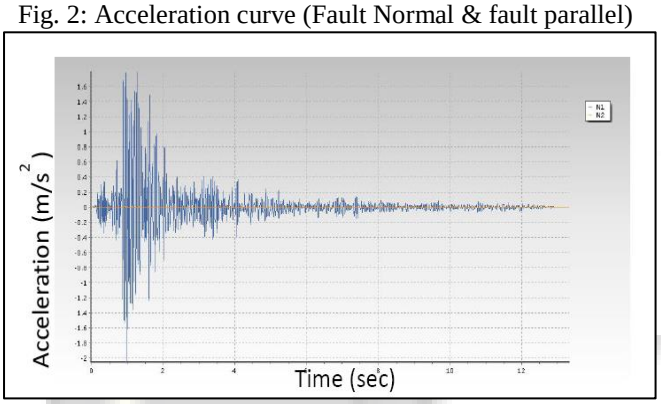

Fig. 3: Acceleration curve (Fault Normal)

At long last the estimations of PGA, PGV and PGD for Fault Normal Ground movement and Fault Parallel parts of far blame Ground movements are arranged underneath

Parameters	Fault Normal Ground motion	Fault Parallel Ground motion
PGA	0.1823 g	0.12 g
PGV	0.0171 m/s	0.0110 m/s
PGD	0.000206 m	0.000325 m

D. Response Spectrum Analysis

Presently, the impact of the downloaded input ground movement information has been explored on the structure (SDF framework) utilizing the reaction range examination. In the wake of performing reaction range examination we have the yield information for both blame ordinary and blame parallel segments of Far Fault ground movements, and furthermore the reaction range bends were acquired which are appeared in the accompanying figures:

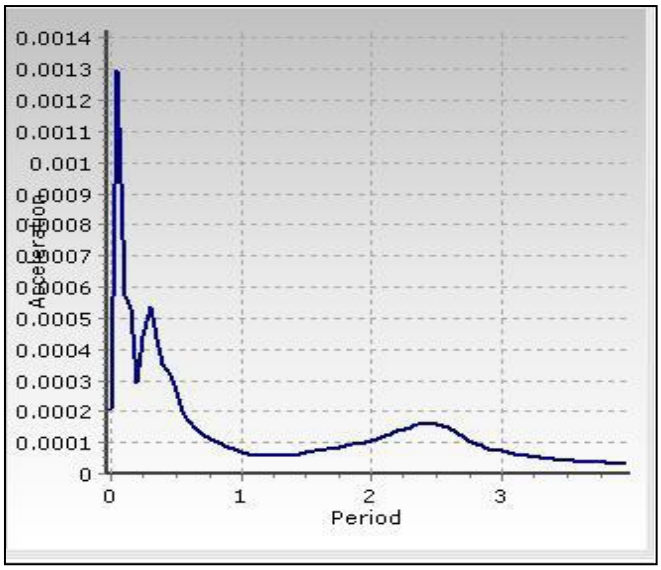

Fig. 4: Response spectrum curve (Fault normal)

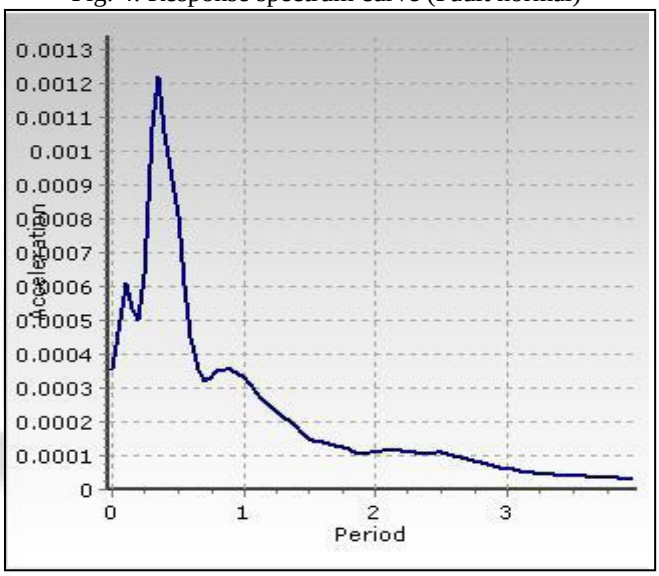

Fig. 5: Response spectrum curve (Fault parallel)

VI. CONCLUSION

A. Summery

In the present examination the execution of a structure in a solitary level of flexibility framework is researched under various ground movements, for example, Fault typical and Fault parallel part of the ground movement by unique time history investigation technique and the examination is done in the SEISMOSTRUCT programming created by the SEISMOSOFT Company.

The Acceleration, Velocity and uprooting bends have been drawn for both Fault Normal and Fault Parallel part of Far Fault and Near Fault ground movement. The estimations of increasing speed, speed, uprooting have been found in at regular intervals, likewise the estimations of Peak Ground Acceleration, Peak Ground Velocity and Peak Ground Displacement has been resolved for the two parts.

At long last the reaction range bends have been drawn for every sort of quake ground movements.

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VII. CONCLUSION

- The estimations of Peak Ground Acceleration, Peak Ground Velocity and Peak Ground Displacement acquired for blame ordinary part are higher than that of blame parallel segment.
- The frequencies for blame ordinary segment are higher than that of the blame parallel.
- The estimations of Peak Ground Acceleration, Peak Ground Velocity and Peak Ground Displacement of Fault Normal and Fault parallel segments don't contrast much for Far Fault seismic tremor ground movements, yet they vary much for Near Fault Earthquake ground movements.
- The reaction range bends are distinctive for every sort of seismic tremor ground movements, subsequently it implies that the structure have diverse reactions to every sort of quake ground movements.

VIII. FUTURE SCOPE

In this study I discuss single degree of freedom but in future modeled the structure malty degree of freedom system in SEISMOSTRUCT software and analyzed it for fault normal and fault parallel component of ground motion.

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