University of Anbar

College of Engineering

Civil Engineering Department

"INVESTIGATION ON DYNAMIC RESPONSE OF HYBIRD R.C. FRAMES HAVING VARIOUS SUPPORTING SYSTEMS"

A Project Report Submitted in partial fulfillment of the requirements for the Bachelor's Degree in Civil Engineering

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Abstract

After the earthquakes that occurred at the end of last year in Ramadi city and it's impact on buildings so it became necessary to study the impact on buildings and make them resistant to earthquakes, especially buildings such as hospitals. Anbar Province has become within the circle of impact of earthquakes on the ground line, because it has near the earthquake center points like, Halabjha center in Sulymania Province.

In this project, a building with four types of supports hinge, fixed, rubber isolator and the triple friction pendulum isolator (TFP), are studied. These supports are used in framed multi-story buildings, which are concrete, steel and hybrid having ten stories. The analysis of nonlinear dynamic response is adopted using SAP2000 software. Also, modal of analysis is taken for predicting the natural frequencies. The results of drift story for each building and the response spectra for each case are adopted an illustrated for each supporting system. The TFP results were the best drift phenomena. The hybrid is the best selection because they reduced the drift story and response was reduced when it compared with other studied support systems.

The main conclusion of this study which deals with the aim was the response spectra of Ramadi city has been conducted using Halbja-earthquake time history because the center of earth quake near to Ramadi city, it can be used for design for structure within many frequencies

1. Introduction

Earthquakes are catastrophic events that occur mostly at the boundaries of portions of the earth’s crust called tectonic plates. When movement occurs in these regions, along faults, waves are generated at the earth’s surface that can produce very destructive effects [1].

In earthquake engineering, we deal with random variables and therefore the design must be treated differently from the orthodox design. The orthodox viewpoint maintains that the objective of design is to prevent failure; it idealizes variables as deterministic. This simple approach is still valid and applied to design under only mild uncertainty. But when confronted with the effects of earthquakes, this orthodox viewpoint seems so over trustful as to be worthless. In dealing with earthquakes, we must contend with appreciable probabilities that failure will occur in the near future. Otherwise, all the wealth of this world

would prove insufficient to fill our needs: the most modest structures would be fortresses.

In most structures that are subjected to moderate-to-strong earthquakes, economical earthquake resistance is achieved by allowing yielding to take place in some structural members. It is generally impractical as well as uneconomical to design a structure to respond in the elastic range to the maximum expected earthquake-induced inertia forces. Therefore, in seismic design, yielding is permitted in predetermined structural members or locations, with the provision that the vertical load-carrying capacity of the structure is maintained even after strong earthquakes. However, for certain types of structures such as nuclear facilities, yielding cannot be tolerated and as such, the design needs to be elastic [1].

Many researches are studied the dynamic response of reinforced concrete (RC) building, and other structures. However, this study is covered the dynamic response of hybrid (concrete +steel) building having various designed supports.

Kanar, studied the vibration 1-D and 2-D of structure and depended on the stiffness matrices by the MATLAB codes to compute the natural frequency [2]. Barmo1, et al, studied the hybrid building and use friction and rubber for support ,then, compare the result of effect the type of support with drift and time history result by using sap 2000 program[3]. Pisal and Jangid, shown the numerical solving of motion equation by using state space method ,and investigate the effects of parameter number of dampers in MTMFD ,damper frequency spacing ,mass ratio ,tuning ratio,and damper slip force on structure [4]. Naguib, et al, compared between the 40-story steel office building with fixed base and isolation base technology ,and use response spectrum analysis and time history analysis to compared[5].

Varadharajan,et al, shown the irregular building behavior and the torsion effects which generate due to irregularities in building system[6].

Symmetrical buildings with uniform mass and stiffness distribution behave in a fairly predictable manner, whereas buildings that are asymmetrical or with areas of discontinuity or irregularity do not. For such buildings, dynamic analysis is used to determine significant response characteristics such as (1) the effects of the structure’s dynamic characteristics on the vertical distribution of lateral forces; (2) the increase in dynamic loads due to torsional motions; and (3) the influence of higher modes, resulting in an increase in story shears and deformations.

Static methods specified in building codes are based on single-mode response with simple corrections for including higher mode effects. While appropriate for simple regular structures, the simplified procedures do not take into account the full range of seismic behavior of complex structures. Therefore, dynamic analysis is the preferred method for the design of buildings with

unusual or irregular geometry ,Two methods of dynamic analysis are permitted: (1) elastic response-spectrum analysis and (2) elastic or inelastic time-history analysis. The response-spectrum analysis is the preferred method because it is easier to use. The time-history procedure is used if it is important to represent inelastic response characteristics or to incorporate time-dependent effects when computing the structure's dynamic response[1].

2. Research Objective

The main aim of this study is to investigate the dynamic response of multistory hybrid building which supporting by various support types.

Seismic criteria for the design and construction of new structures subjected to earthquake ground motions have goals:

1- Minimize the hazard to life from all structures, by increasing the knowledge of seismic design and analysis techniques.
2- Increase the expected performance of structures having a substantial public hazard due to occupancy or use
3- Know the best type of the modern four supports (fixed, hinge, rubber isolator, and the triple friction pendulum).
4- Investigate the multi story hybrid system to resist the earthquake. Also the benefits for constructing of such system.

3. Analysis and design

SAP 2000 structural engineering and analysis program, this program depends on the theory of finite elements. This program can analyze all simple and complex structures in order linear or nonlinear analyses.

SAP 2000 summarized of Structural Analysis Program ,and is the important program in civil engineering and it product of CSI company in California and it can export and import to many important other programs, such as Auto Cad, and excel, etc. .

building with 10 story with steel ,concrete and hybrid and each one with four support (fixed ,hinge ,rubber and triple friction pendulum) steel and concrete like the pervious steps in frames two story and now show the hybrid with triple friction pendulum (it content of three story concrete and seven are steel that mean one third of ten concrete and the remain are steel).

Step 1: Open the program from START menu.

Step 2: Press on file and the new models as purpose example

Step 3: Check the unit kN/m and press on the grid, as shown in fig.(1).

Step4: enter the data on the table of value of x &y

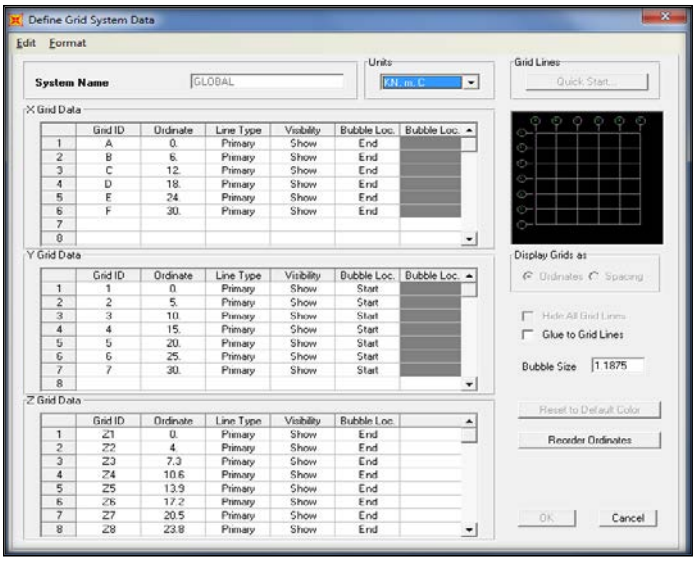


Fig.(1) Define grid system data

Step 5: Define the material as the pervious example but select concrete with f'_c=50 MPA and steel with w_{30*225} (must do the static analysis to check it adamancy), shown in fig. (2),& (3)

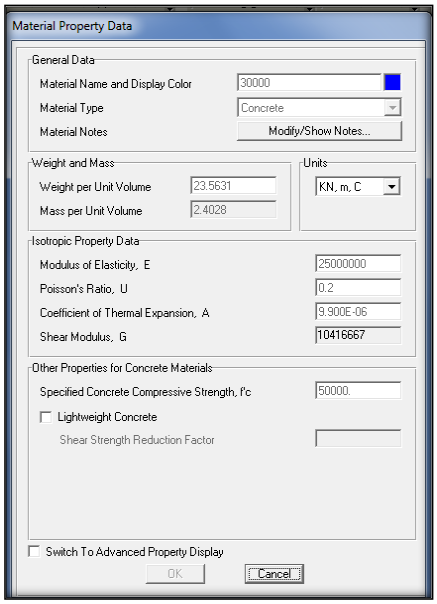


Fig.(2) Material property data

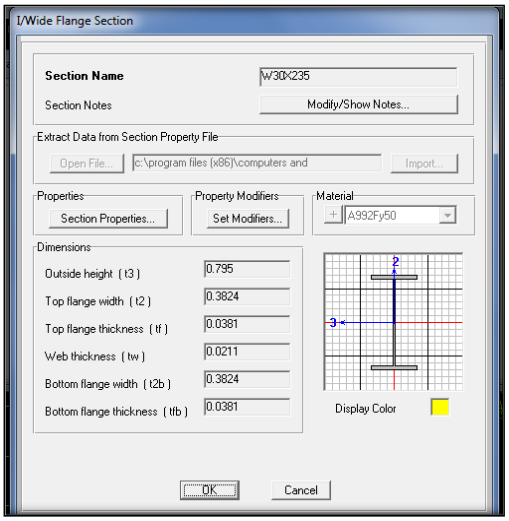


Fig.(3) Wide flange section

Step 6: draw the building and the dimensions of concrete part as shown in fig.(4,5),

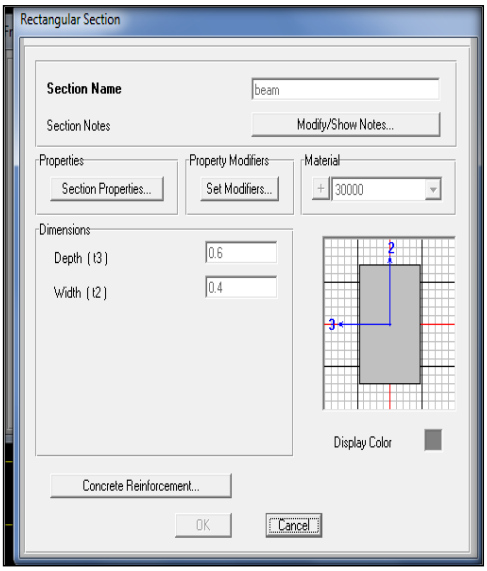


Fig.(4) Rectangular section

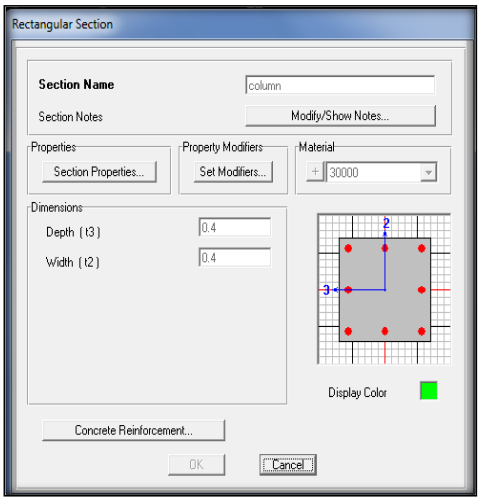


Fig.(5) Rectangular section

Also, from fig.(6) the steel use w_{30*225}

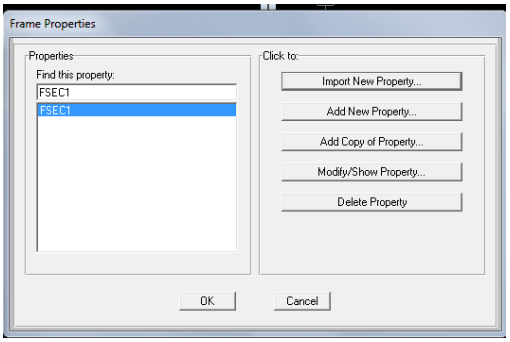
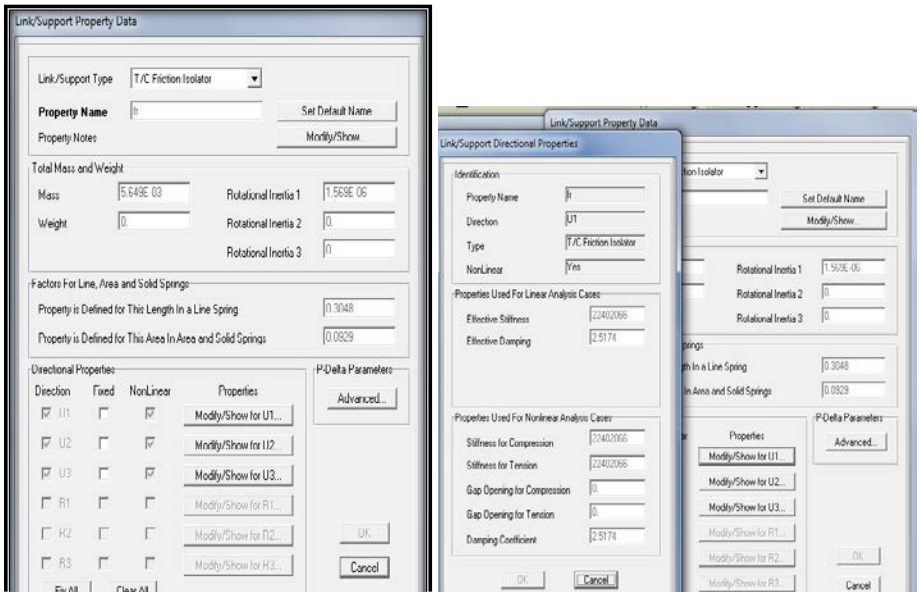


Fig.(6) Determine the section of steel

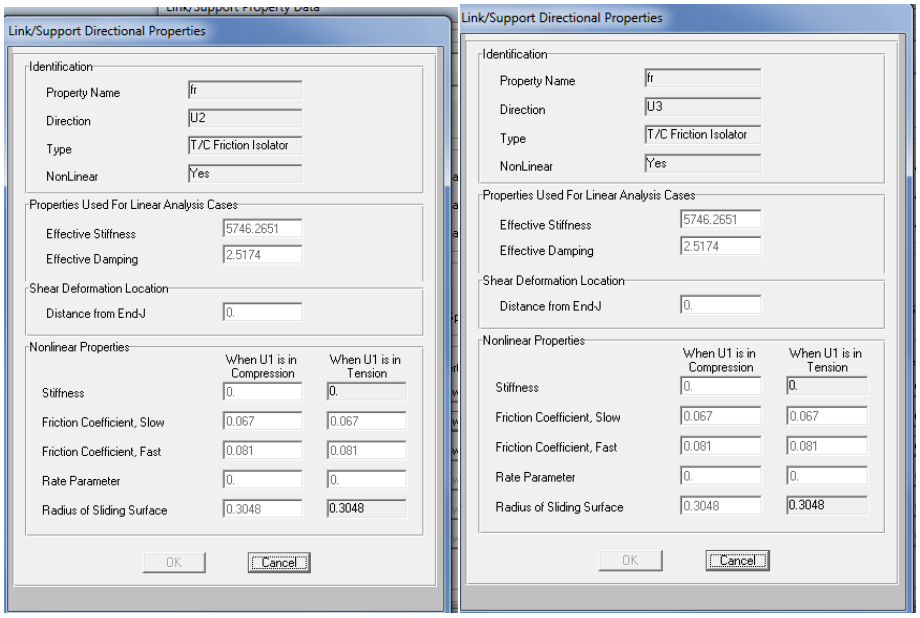
Then draw the building from draw menu then select draw Link /support tendon.

Step7: Define the TFP (Define menu→ section properties → Link/support property)

Press add new property icon then enter the data as shown in figure (7).



Fig(7) Link/support property data] ,and Link/support property data forU_1



(a) (b)

Fig. (8) (a)Link/support property data for U_2 ,and (b) Link/support property data for U_3

Step8: From draw menu select draw 1joint link then do a window on the base to draw the TFP as illustrated in fig.(9).

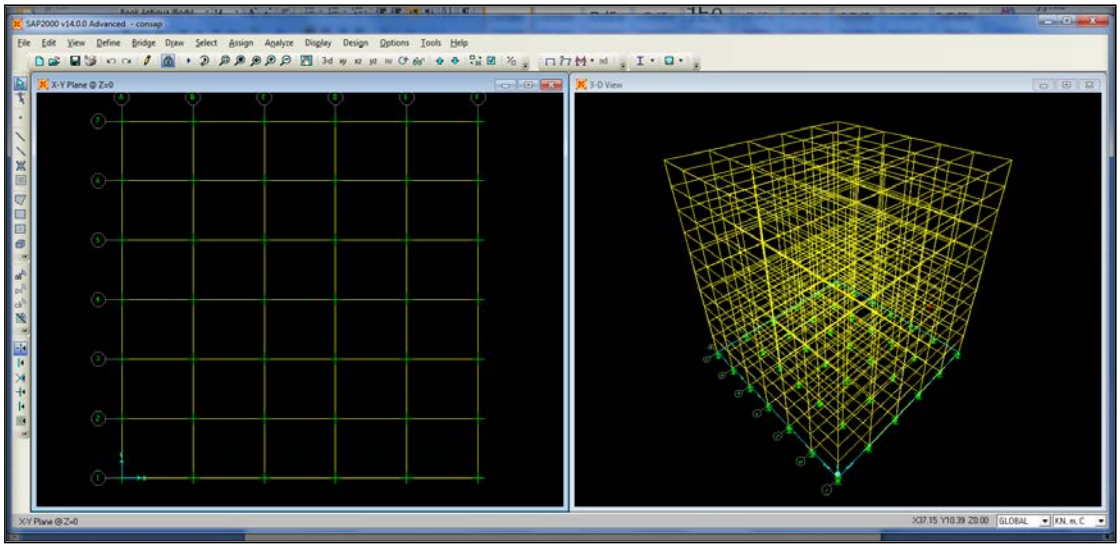
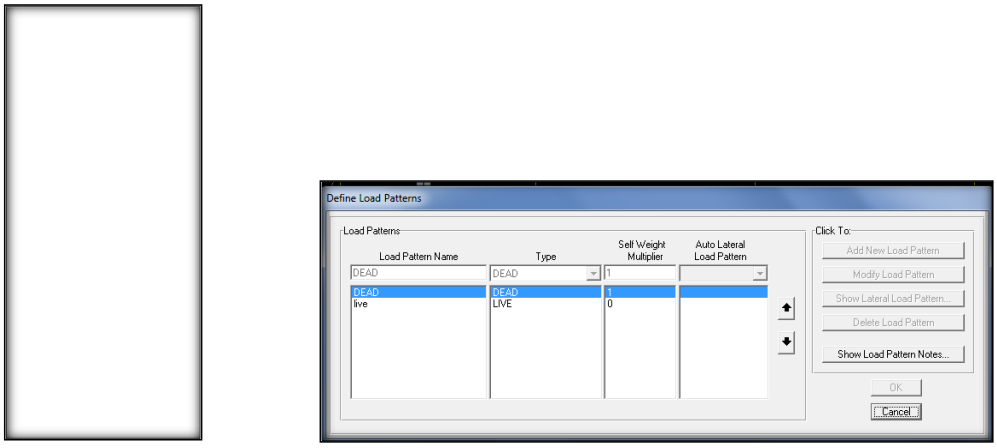


Fig.(9) The building after drawing

Repeat the pervious step for the other support and for the concrete and steel

Eight 9: define the loads: load pattern: define menu select load pattern then enter data as shown in fig.(10).



Fig(10) Load pattern Assignment

Then track the *Time history* : define menu select function then select time history as illustrated figures (11)-(13). The different between the time history of lacc 1 &2 is direction of earthquake effect so from browse select the follow: ,then Press ok in define time history widow.

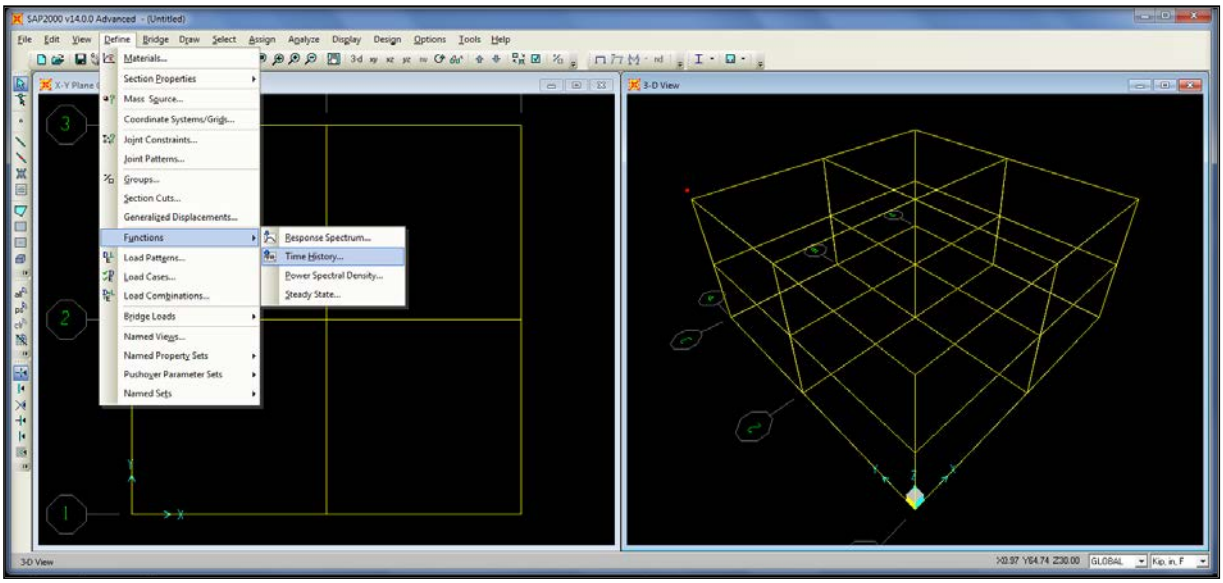


Fig.(11) Expline the path to select the time history

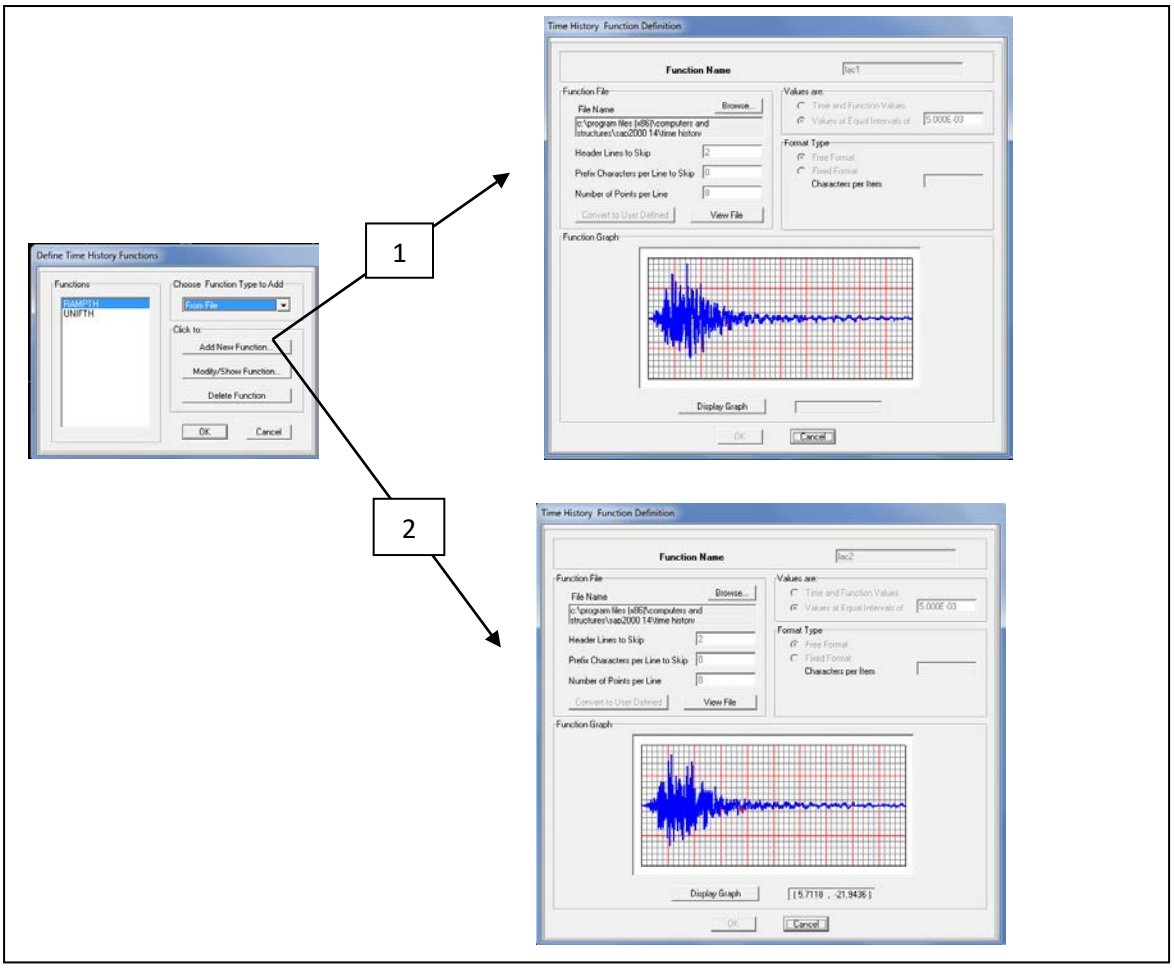


Fig.(12) Explain the time history

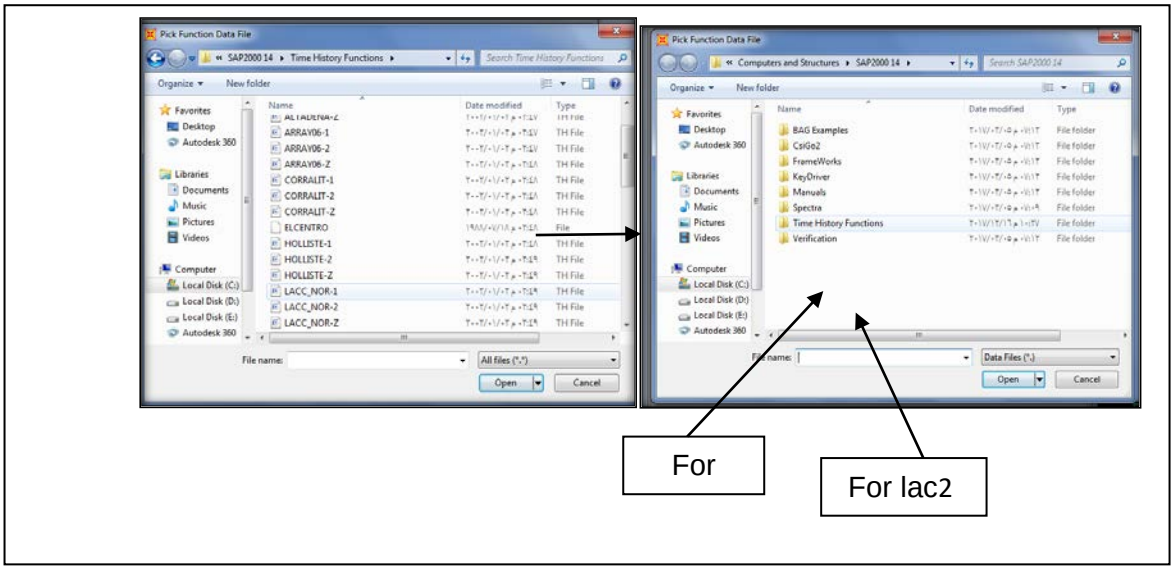


Fig.(13) Show the lacc1 &2 (*Equvilant to Halabjha-earthquake*)

Step 10: Press on (↰) or (Analysis menu ⟶ Run analysis) to start analysis.

4. Results

In this research, the results are issued as drift & number of stories; SD, S_a and S_v &Time. All results are done for hybrid building with various supporting system, also it have many damping ratios that may caused on the response of building.

4.1. The result of drift

4.1.1 Concrete building

The figure (14) shows the effect of drift of each support with number of story, the drift of first stories are high and decrease with the last stories while the hinge is less effect but the first stories have drift higher than the last stories and the rubber have effect less than hinge but the friction is the less effect of them.

4.1.2 Steel building

The steel building is opposite of concrete building where the effect of the earth quake is at the top (last stories) is higher than the first and the large drift is at the rubber support then the hinge in (first story) and the fixed and the safe state is the friction, the figure (15) show these state.

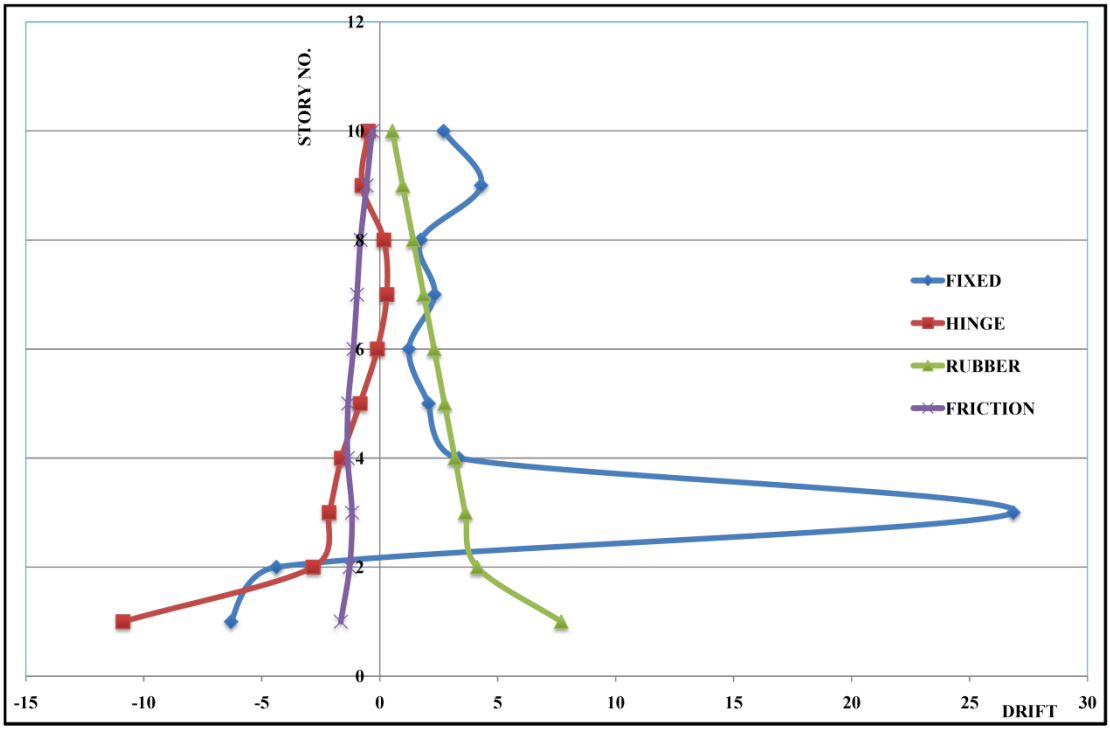


Fig.(14) Concrete's building drift

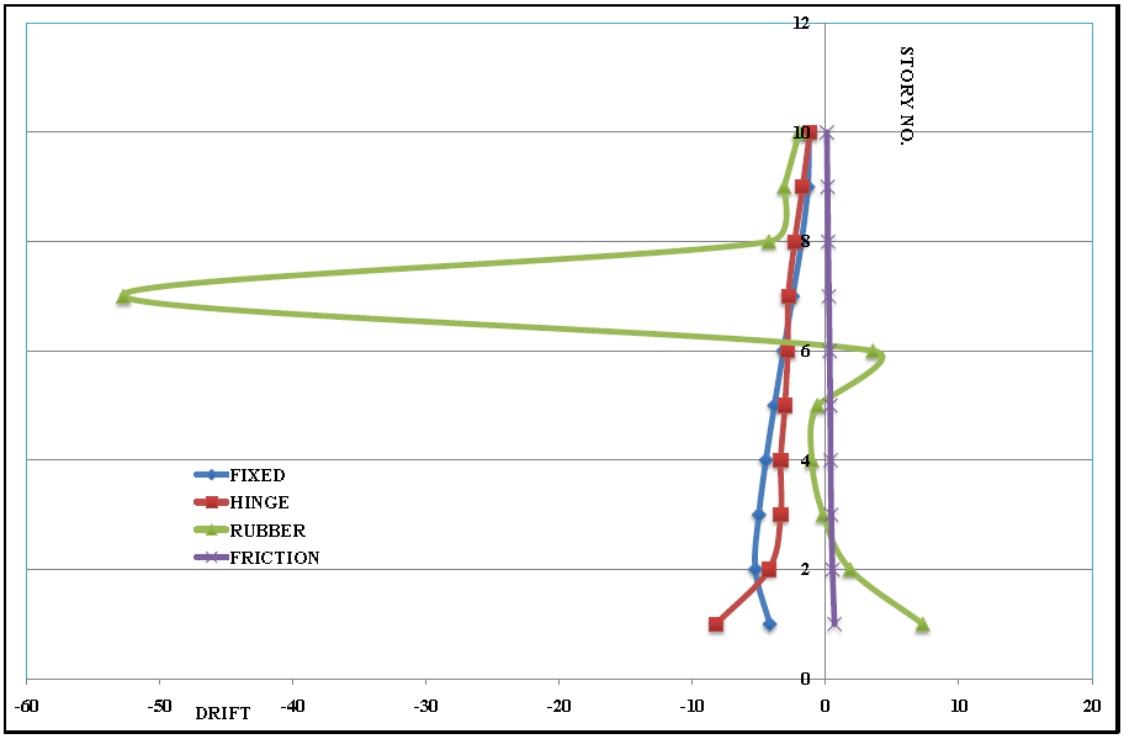


Fig.(15) Steel building drift

4.1.3 Hybird building

From the two results above and explain which that the concrete reduce the effect of drift at last stories so made the first three stories (i.e. one-third of overall height of building) from concrete and the remain seven stories steel and

the results are explain in figure (16). The results have significant enhanced of drift story values when used the hybrid technique systems.

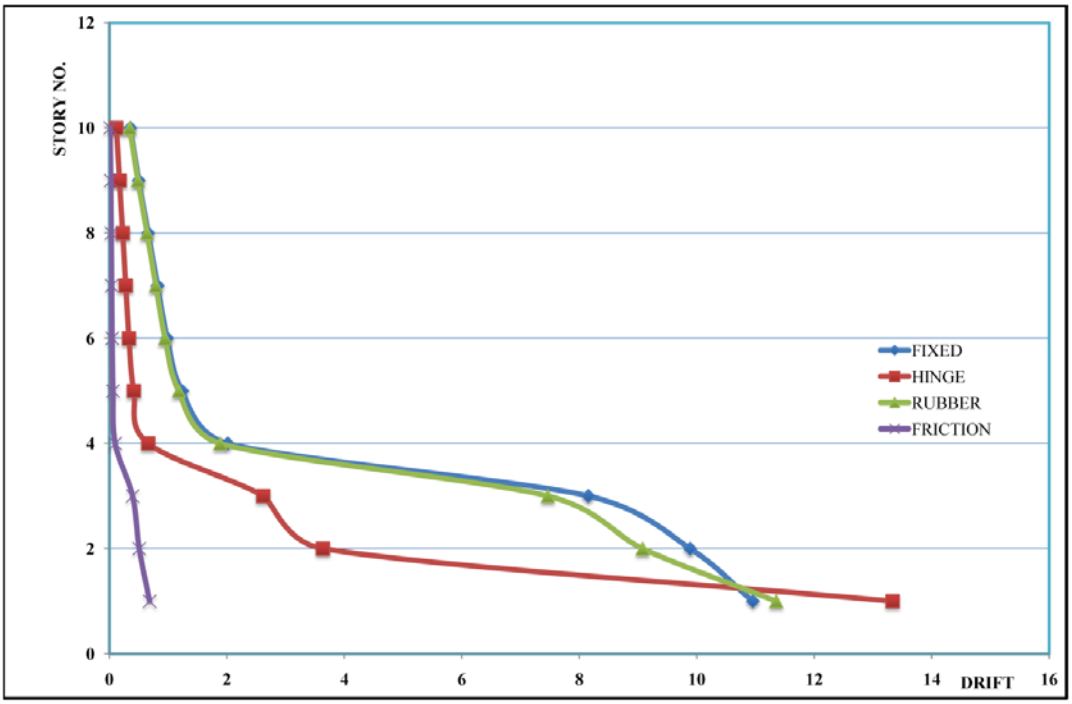


Fig.(16) Hybrid's drift

4.2 Response spectrum of Hybird building system

The purpose is to calculate the maximum dynamic response experienced by the two masses during the newest earthquake in Iraqi regions. The maximum response such as displacement, velocity, and acceleration for the examples may be obtained by considering the earthquake effects as a series of impulsive loads, and then integrating the effect of individual impulses over the duration of the earthquake. This procedure, non-linear finite element analysis, requires considerable numerical effort. The spectral acceleration response for the north–south component of the Halabjha earthquake is shown in figures (17)-(19) for various supporting systems.

The response of acceleration of friction is sharp decrease but the collimate at increase to reach constant decrease, and the velocity it has four parts of collimate then sharp decrease after that constant decrease while distance response little three parts of collimate before reach to peak then sharp decrease and constant increase.

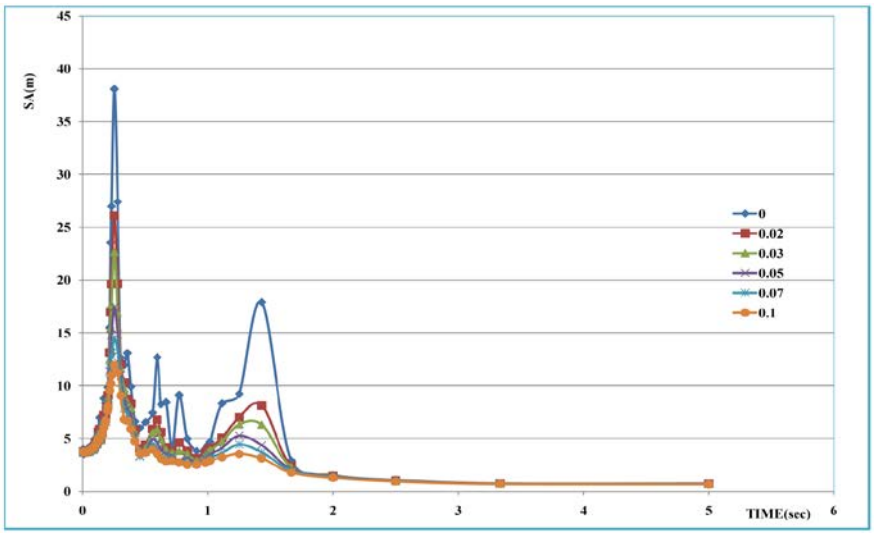


Fig.(17) Response spectra of friction

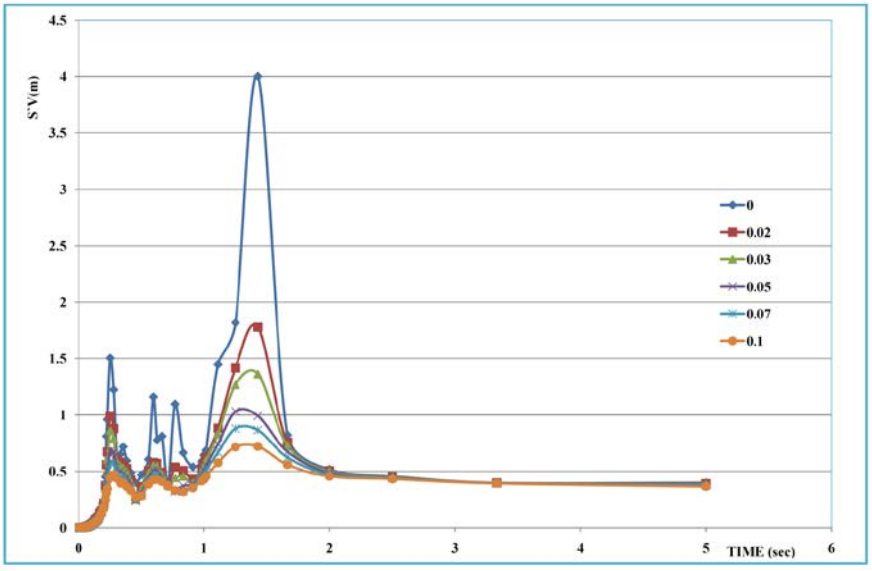


Fig.(18) Response spectra of friction

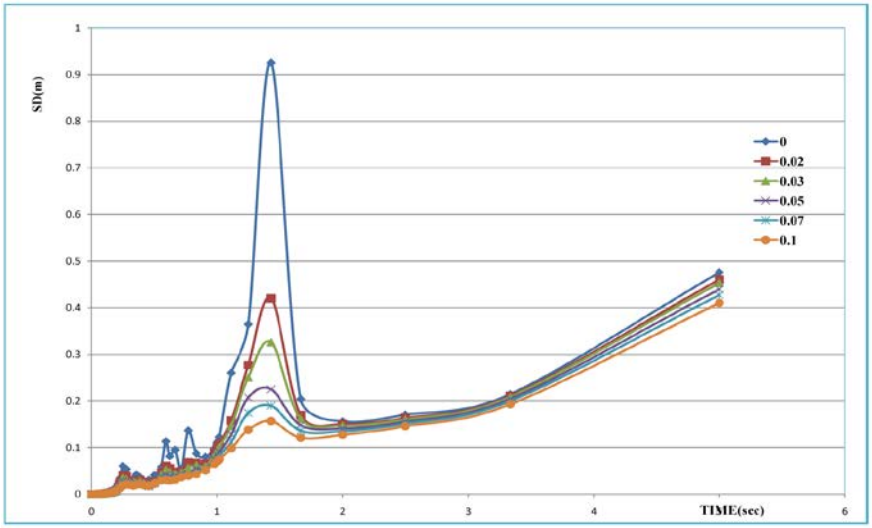


Fig.(19) Response spectra of friction

5. Conclusions

This study deals with the dynamic response of multistory building having hybrid system of construction.A nonlinear ,time history analysis has been done using finit element method ,by using SAP2000 software.

Many calculations were resulted from this study, can be briefed by:

1. Finite element method analysis can be done for dynamic response of formed building with various support systems using SAP2000 software.
2. The formed building system having many support systems such as fixed, pinned ,rubber isolator and friction pendulum isolator whichever ,the friction pendulum support has been preferred type due to the lowest drift story of building when it compared with other support system.
3. The redistribution of moment in fixed support building has been the biggest value because the drift of story was increased when the earthquake forced applied, especially at first &end story.
4. The response spectrum of formed building can be conducted for all systems within the damping ratio effect ,the maximum value of response spectrum occurred friction pendulum due to the posid time increased because the deformation and stories remark small force formed members.
5. Fixed support system is not preferred for seismic loadings and increased the stiffness of members load to reduced the ductility of structures, due to increased the moment of inertia of all members.
6. The hybrid system is very recommend system of multi-story building against static & seismic loading because increased the ductility and reduce the weight of structure.
7. The response spectra of Ramadi city has been conducted using Halabjha-earthquake time history because the center of earth quake near to Ramadi city, it can be used for design for structure within many frequencies.

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