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"SEISMIC ANALYSIS OF MULTISTORIED BUILDING WITH RIGID AND SEMI RIGID DIAPHRAGM"

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***Abstract*— Seismic analysis plays a crucial role in assessing the structural performance of multistoried buildings subjected to earthquake forces. This abstract presents an overview of a study conducted on the seismic behavior of a multistoried building with both rigid and semi-rigid diaphragms. The objective of the analysis is to evaluate the structural response and identify the influence of diaphragm flexibility on the building's seismic performance. The study employs a numerical modeling approach, utilizing finite element analysis (FEA) software to simulate the building's behavior under seismic loading conditions. A three-dimensional (3D) model of the multistoried building, considering different heights and configurations, is developed. Two distinct diaphragm types, namely rigid and semi-rigid, are incorporated into the model to investigate their effects. The rigid diaphragm represents a traditional assumption in structural analysis, assuming perfect rigidity and full transfer of lateral forces across the building's floors. On the other hand, the semi-rigid diaphragm incorporates flexibility by considering the rotational and translational stiffness of the floor slabs. Through the seismic analysis, various key performance indicators are evaluated, including displacement, Time period, and column forces.**

***Keywords*— Seismic analysis, Multistoried building, Rigid diaphragm, Semi-rigid diaphragm**

I. INTRODUCTION

A reinforced concrete slab is a structural element commonly found in modern buildings. It is supported by columns and beams and is typically a flat, two-dimensional, planar element with a thickness that is small compared to its other two dimensions. The primary function of a slab is to support transverse loads and transfer them to the supporting structure primarily through bending, similar to a beam. A diaphragm, on the other hand, refers to a horizontal or nearly horizontal structural system that transmits lateral forces to the vertical elements connected to it. In the context of building construction, a diaphragm can be a floor, roof, or a horizontal bracing system. According to the given information, a reinforced concrete monolithic slab-beam floor or a floor consisting of prefabricated or precast elements with a reasonable reinforced screed concrete thickness of at least 75 mm, with 6mm bar spacing and 150mm centre-to-centre spacing as topping, can be considered a rigid diaphragm. A diaphragm is considered rigid if its plan aspect ratio is less than 3. On the other hand, a floor diaphragm is considered flexible if it deforms in such a way that the maximum lateral displacement measured from the chord (reference line) of the deformed shape at any point of the diaphragm is more than 1.2 times the average displacement of the entire diaphragm.

AIM & OBJECTIVE

The proper selection of rigid or semi rigid in multistore building for seismic analysis.

- The analysis of multistorey building with various percentages of openings in the slab.
- The analysis of multistorey buildings with different percentage of shear wall in the structural system.
- This objective focuses on studying the behaviour of multistorey buildings that have a combination of normal (vertical) columns and inclined columns. The analysis involves understanding how the presence of inclined columns affects the overall structural response and load distribution within the building.

II. LITERATURE REVIEW

Reinforced concrete buildings are typically analysed and designed on the assumption that floor serve as rigid diaphragm spanning between vertical resisting elements. Current literature survey includes analysis of basic rigid & flexible rigid diaphragm in terms of in plane forces, behaviour of structure, displacement, time period, shear wall, tall structure, static and dynamic analysis, masonry structure steel frame work etc…Some of the literatures emphasized on seismic design and performance of RC buildings in seismic prone regions, urban region.

Contributions of researchers are presented as follows,

Ankan Kumar Nandi [1]Described the seismic analysis of structural systems with floor diaphragms has been a requisite in the recent past. The duty of a structural engineer was to be prudent about the behaviour of every structural system adopted. Amongst the structural systems that are adopted world over, diaphragm with rigid and semi-rigid floor plate are adopted widely in the analysis. This research focuses on the backstay effect i.e. podium structural interaction with the tower area and consideration of retaining wall as increment of lateral stiffness as specified in latest tall building code IS6700:2016 for low and high rise structures. In the current study models were prepared with low to high rise storeys with rigid and flexible diaphragms considering backstay diaphragm placing tower at centre and corner. The models were subjected to seismic forces; response spectrum along with the combination of the gravity loads. The structural responses like natural periods, base shear, displacement and inter storey drift were also studied.

Jacob A. Kollerathu [2] described that the numerical modelling considering inelastic response often becomes essential for seismic analysis and assessment of existing masonry structures. Post-earthquake surveys and past experimental studies have demonstrated that flexible diaphragms significantly alter the seismic behaviour of masonry structures. The absence of a rigid diaphragm alters the seismic performance of a structure due to local mechanisms or out-of-plane actions that could compromise the global in-plane capacity. Consistent inferences from different numerical modelling approaches for masonry structures with flexible diaphragms have however been elusive in previous research. Post earthquake surveys and past experimental studies have demonstrated that flexible diaphragms significantly alter the seismic behaviour of masonry structures. Consistent inferences from different numerical modelling approaches for masonry structures with flexible diaphragms have however been elusive as pointed out in the review of past research (§ 2). Macro-element modelling and non-linear finite element modelling approaches can represent flexible diaphragms in different ways.

U.S. Ansari [3] The author discussed that, the methods of analysis of slabs as floor diaphragms. First, a framed building with &without considering shear walls is being modelled and analysed using Staad-Pro Software. There are three types of Floor Diaphragm: a) Flexible Diaphragm, b) Rigid Diaphragm, c) Semi-Rigid Diaphragm. All the types of Floor Diaphragms are being analysed with increase in floor rise as 7-storey, 15-storey, and 25-storey. All Floor diaphragms results being obtained and compared with them, to get the idea of floor diaphragm suitable for a particular type of structure, here only a 3x3 bay structure with equal distances of 5m is being used. For the buildings with shear walls, the rigid floor models differ greatly with the flexible floor & semi – rigid floor models due to the very large lateral stiffness of the shear wall system. It was being observed that the results of flexible & semi-rigid diaphragm are identical in the cases mention, but might differ with geometry non – linearity. It was clear that base shear is greater at the centre of rigidity of the structure compared to end columns.

C.G. Chiorean [4] A research study that examined the behaviour of different floor systems in Mexico as diaphragms under lateral loading. The study evaluated the effect of two variables: the plan aspect ratio of buildings and the stiffness of the floor system. The models were analysed using finite element software, and force and displacement criteria were used to assess the diaphragm condition. The study concluded that floor systems designed according to building codes and recommendations, along with the expertise of engineers, can behave as rigid diaphragms for smaller floor spans. However, other design practices may result in semi-rigid, semi-flexible, or flexible diaphragms for larger floor spans typically found in office buildings.

Abhilash.E. P [5] The Author have discussed the general building structures were composed of several vertical systems bounded by horizontal diaphragm. If the diaphragms are assumed to be rigid, then the analysis of the building structure is fast. Flexibility ratio decreases with increase in number of stories we can say that as number of storey increases the effect of flexibility of diaphragm decreases. Flexibility ratio increases with increase in aspect ratio of building said that flexibility of diaphragm increases with increase in aspect ratio building with 1:4 aspect ratio has flexibility ratio greater than 1.5. So it’s important to analyse it with flexible floor assumption as there was much difference with rigid floor assumption.

Dr. S.N. Tande and S.A. Devarshi. [6] The Author have discussed “Reinforced concrete buildings are typically analysed and designed on the assumption that floor serve as rigid diaphragm spanning between vertical resisting elements R.C frame without shear wall shows more top storey displacement compared to that of a frame with shear wall, in both cases where the in plane flexibility of slabs is ignored and considered. In R.C frames with and without shear wall, the top storey displacement, as well as all the storey level displacements is more when the in plane flexibility of the slabs is included compared to that where it is not included.”

MortezaMoeini and BehzadRafezy [7] The Author have discussed “All the seismic codes generally accept that in most cases the floor diaphragms may be modelled as fully rigid without in-plane deformability. Even though a rigid floor diaphragm is a good assumption for seismic analysis of the most buildings, several building configurations may exhibit significant flexibility in floor diaphragms. In these configurations, some codes like (EC8, NZS4203, GSC-2000) set certain qualitative criteria related to the shape of the diaphragm, while some others (2800, UBC-97, SEAOC-90, FEMA-273) set quantitative criteria relating the in-plane deformation of the diaphragm with the average drift of the associated story.”

Saeed Ahmad, AsimGulzar, and HumavPervaiz [8] The Author have discussed significance of diaphragms in transmitting lateral forces in a structure. The study evaluates the behaviour of reinforced concrete floor slabs acting as diaphragms in two regular building models. The analysis considers the effect of slabs on storey displacements, storey shears, support reactions, column reinforcement, torsional forces, and modal time period. The results suggest that including the slabs in the structural analysis leads to smaller displacements and shears, higher support reactions and column reinforcement, mixed behaviour in modal time period, and the transfer of torsional forces to beams.

C.G. Chiorean [9] **an** efficient computer method for analysing steel space frames with non-linear flexible joint connections. The method uses plastic zone analysis and models structures with one element per member to reduce computational time. It incorporates gradual yielding of cross-sections and includes connection flexibility. The method is implemented in an object-oriented computer program and has been proven to be robust, accurate, and time-saving in studying the ultimate response of steel frames. It accounts for key factors influencing frame behaviour and provides a reliable approach for analysing semi-rigid space frames.

Dr. Basu D [10] The Author have discussed “This technical note presents a convenient modelling/design procedure for a class horizontal setback building to minimize the adverse effect of in-plane floor flexibility. Existence of such a class requires proportional eigenvalue problems of all the constituting frames regardless of the floor properties. For L, T, + etc. shape of buildings, the eigenvalue problem (of the frames) along two orthogonal directions need not be proportional. Moreover, the presence of a nonrectangular joint region theoretically precludes the existence of such a class. A step-by-step proportioning procedure, in the presence of a nonrectangular joint region, is outlined such that (1) "nearly" rigid floor modes exist, and (2) participation of the flexible floor modes under spatially uniform ground motion is close to zero.

III. THEORETICAL FORMULATION

The literature review discussed in pervious chapter considering the same, I have combined rigid diaphragm and semi rigid diaphragm which include the parameter of the various percentage of opening in the slab, various percentage of the shear wall and the normal and incline column with respect to different parameter like displacement, time period and column forces for the different story height.

Seismic Analysis Method:

Seismic Analysis is a major tool in earthquake engineering which is used to understand the response of buildings due to seismic excitations in a simpler manner. In the past the buildings were designed just for gravity loads and seismic analysis is a recent development. It is a part of structural analysis and a part of structural design where earthquake is prevalent

There are different types of earthquake analysis methods:

1. Equivalent Static Analysis
2. Response Spectrum Analysis
3. Time History Analysis
4. Pushover Analysis

From above mentioned seismic analysis method, the work has been done by Equivalent Static analysis.

Equivalent Static Analysis:

The equivalent static analysis procedure is essentially an elastic design technique. It is, however, simple to apply than the multi-model response method, with the absolute simplifying assumptions being arguably more consistent with other assumptions absolute elsewhere in the design procedure.

The equivalent static analysis procedure consists of the following steps:

a) Estimate the first mode response period of the building from the design response spectra.
b) Use the specific design response spectra to determine that the lateral base shear of the complete building is consistent with the level of post-elastic (ductility) response assumed.
c) Distribute the base shear between the various lumped mass levels usually based on an inverted triangular shear distribution of 90% of the base shear commonly, with 10% of the base shear being imposed at the top level to allow for higher mode effects

Distribution of Design Force:

The design base shear, Vb computed above shall be distributed along the height of the building as per the following expression,

$$Q_i = \frac{W_i h_i^2}{\sum_{i=1}^{n} W_i h_i^2}$$

Where,

Qi = design lateral force at ith floor

Wi = seismic weight of ith floor

hi = height of ith floor measured from base, and

n = numbers of storey in the building is the number of the levels at which the masses are located.

In case of buildings whose floors are capable of providing rigid horizontal diaphragm action, the total shear in any horizontal plane shall be distributed to the various vertical elements of lateral force resisting system, assuming the floors to be infinitely rigid in the horizontal plane.

In case of building whose floor diaphragms cannot be treated infinitely rigid in their own plane, the lateral shear at each floor shall be distributed to the vertical elements resisting the lateral forces, considering the in plane flexibility of the diaphragms.

Rigid Diaphragm Analysis Method for Seismic Load:

Rigid diaphragm behavior is well known and it is extensively used in analysis of buildings. Briefly, its salient characteristics are summarized as follows:

1. It is assumed that the diaphragm is rigid enough so that no axial, bending and shear deformations are expected in the plane of the diaphragm. Thus, the diaphragm is displaced as one rigid component under applied lateral loads.
2. Story shears are distributed to supporting lateral members based on their relative rigidities. Thus, stiffer members attract more story shears.
3. Diaphragm deformation characteristics can be uniquely defined with three degrees of freedom: two lateral displacements in the plane of the diaphragm (i.e., one along global X-direction, and one along global Y-direction) and one rotation perpendicular to the diaphragm (i.e., rotation around global Z-axis).
4. Diaphragm mass is lumped at diaphragm's mass center and it has three components: mass in X and Y direction and around Z-axis (i.e., rotational inertia of diaphragm mass).
5. An analysis is carried out based on the assumption that applied loads are imposed through the center of mass of the diaphragm but they are resisted through diaphragm' center of rigidity. Thus, if diaphragm's center of rigidity and center of mass are not coincident, an inherit torsional moment is imposed on the diaphragm and it is further transmitted to the lateral members through the infinitely stiff in- plane action of the diaphragm.

Semi Rigid Diaphragm Analysis Method for Seismic Load:

Distribution of horizontally applied loads through diaphragms to lateral load-resisting elements depends on relative rigidity of diaphragms and the resisting lateral elements. For the cases where diaphragm deflections and resisting members' deflections are in the same order of magnitude, then such diaphragms cannot be categorized as Rigid or Flexible\None. Instead, it is referred to as a Semi rigid diaphragm, which basically represents a diaphragm condition between Rigid and Flexible\None. Analysis with semi rigid diaphragms considers diaphragms stiffness and thus, it reflects real diaphragm deflections and provides a more involved load distribution among the resisting members. Note that diaphragm properties (such as thickness, E, etc…) and its dimensions do not alone reflect whether diaphragm is categorized as rigid, none-rigid or semi rigid. Rather, its interaction with the resisting members and relative stiffness of diaphragms as well as of the resisting members plays a major role in this decision. Many building codes provide some guidelines for determination of diaphragm types.

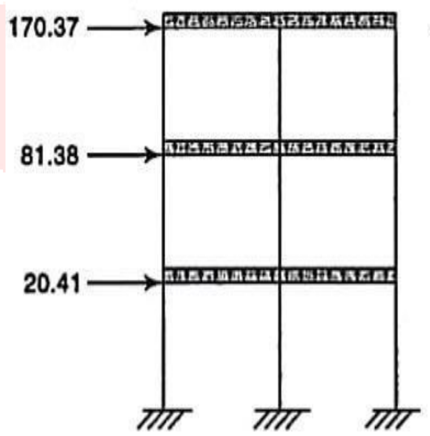
IV. PROBLEM FORMULATION

The problem is defined in the previous chapters along with loading conditions prescribed in chapter three. The flow and methodology of the research work related to different cases i.e. various percentage of opening in the slab, various percentage of the shear wall and the normal and the incline column with respect to different parameter like displacement, Time period and column forces are discussed in the current chapter

Flow of the Research

Parameter Considered:

The Current problem formulation includes rigid and semi rigid diaphragm analysis, using lateral load that is earthquake. Factors influence the inclusion of the normal and incline columns, shear wall and various percentage of opening in slab with different height of structure that is



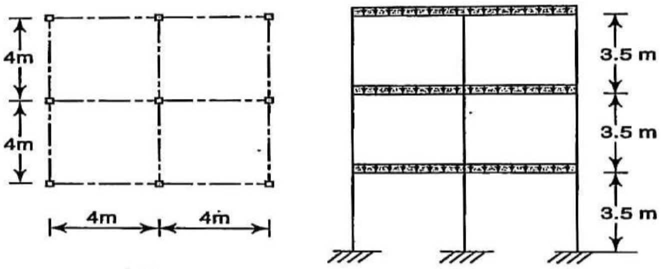
G+15, G+20, Gr+25 for displacement, Time period and column forces. Design of earthquake resident structure based on codal provision, design criteria, general provisions of earthquake analysis and modal analysis. The structural modelling analysis procedure by finite element software is also included in this chapter.

Loading on building:

Dead load: The dead load depends upon the unit weight of the material. Dead loads include the self-weight of walls, floors, beams, column etc. The unit weight of commonly used building materials are given in the code IS 875(Part 1):1997. Dead load=volume x unit weight of material self-weight of slab, beam, vertical structural element (column and shear wall), floor finishes and the partition wall load etc….

Live Load: The live load also known as imposed loads. Various types of imposed loads coming on the structure are given in IS 875(Part 2): 1997.The imposed loads depend upon the use of building. In our case it is the residential building.

Seismic load: Seismic loading is one of the basic concepts of earthquake engineering which means application of an earthquake-generated inertia to a structure. It happens at contact surfaces of a structure either with the ground or with adjacent structures. It includes the seismic weight of the building.



(a) Plan (b) Elevation

Validation of Results:

For validation of result the numerical is taken from a reference book by S K Duggal (Second Edition) and the same numerical is analyzed by using finite element analysis software. The result from the book and software are compared which is as follows. A plan elevation of three storey RCC school building is shown in fig.4.1 The building is located in seismic zone V. the type of soil encountered is medium stiff and itis proposed to design the building with special moment resisting frame. The intensity of dead load is 10 KN/$m2$and the floor is to cater to imposed load of 3 KN/$m2$. Determine the design seismic loads on the structure by static analysis. (Problem no.5.1 &PageNo.229)

Fig.4.1: Validation Problem Plan and Elevation

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Solution: -

Design Parameter: -

For seismic zone V, zone factor, Z=0.36Importance factor, I = 1.5ResponsereductionfactorR=5Floorarea=8 x8=64$m2$

For live load up to and including3KN/$m2$ percentage of live load to be considered=25%

Seismic weight contribution from one floor = 64 x (10+ 0.25 x 3) = 688KNLoad from roof = 64 x 10 =640 KN

Hence, the total seismic weight of the structure=2 x688 +640 =2016 KN

Result: -As per Earthquake resistance design of structure (S.k. Duggal)

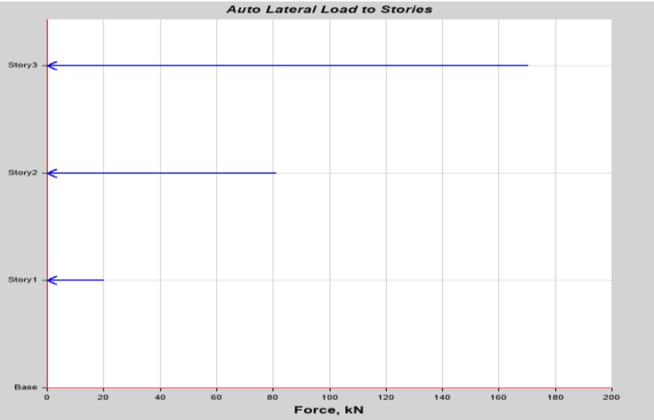
Fig.4.2: Problem Validation Lateral Forces

Storey	elevation(m)	Location	Software result(kN)	Reference book result(kN)
Storey3	10.5	Top	170.39	170.37
Storey2	7	Top	81.41	81.38
Storey1	3.5	Top	20.35	20.41
Base	0	**BaseShear**	**∑272.1599**	**∑272.16**

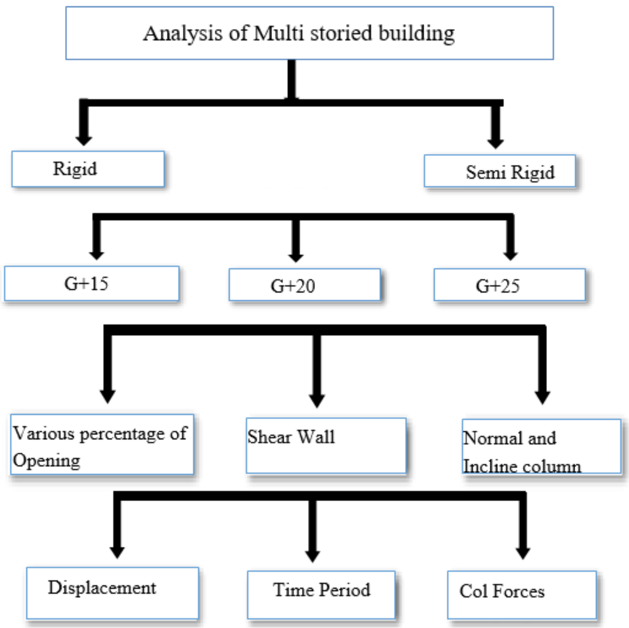
Table4.1: Validation of result

Lateral forces plot:

Graph4.1: Lateral Forces Plot



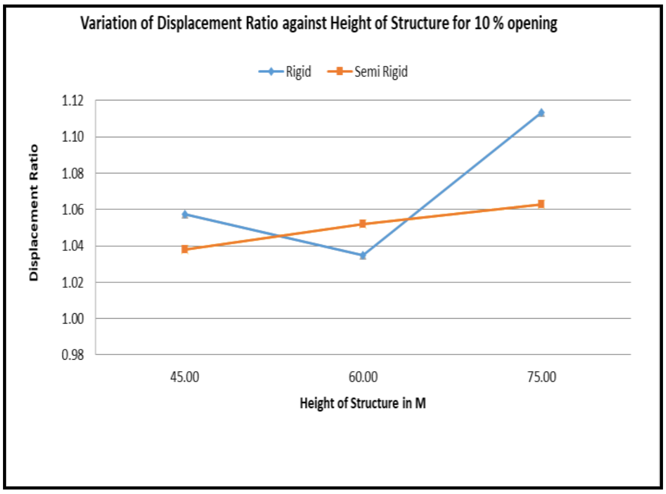
Cases considered for analysis in current project:



V. RESULTS

The current project work is about the selection of rigid and the semi rigid diaphragm in multi storied building. The different building height consider for the same i.e. G+15, G+20, G+25.The various parameter like Displacement, Time period, Shear wall, various percentage of opening in slab and in plane forces.

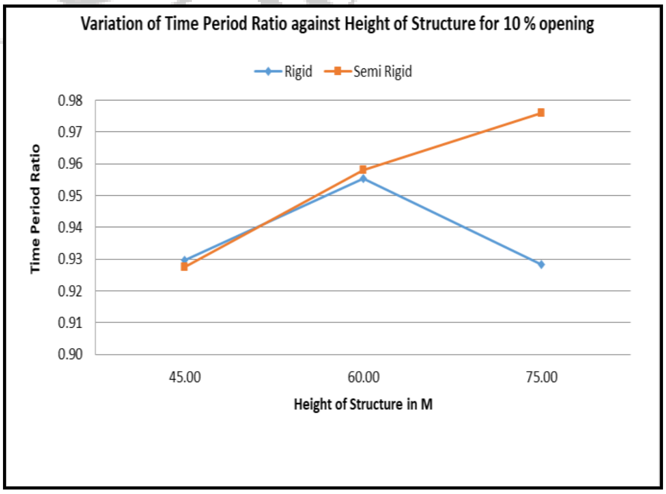
Effect of various percentage Opening in the slab



G1 Variation of displacement against different story height for rigid and semi rigid diaphragm in 10% Opening

Observation:

- For 45m height of structure the displacement ratio of without opening w.r.t. 10% opening in rigid diaphragm is increase by 6%.
- For 45m height of structure the displacement ratio of without opening w.r.t. 10% opening in semi rigid diaphragm is increase by 4%.
- For 60m height of structure the displacement ratio of without opening w.r.t. 10% opening in rigid diaphragm is increase by 4%.
- For 60m height of structure the displacement ratio of without opening w.r.t. 10% opening in semi rigid diaphragm is increase by 5%.
- For 75m height of structure the displacement ratio of without opening w.r.t. 10% opening in rigid diaphragm is increase by 11%.
- For 60m height of structure the displacement ratio of without opening w.r.t. 10% opening in rigid diaphragm is increase by 6%.

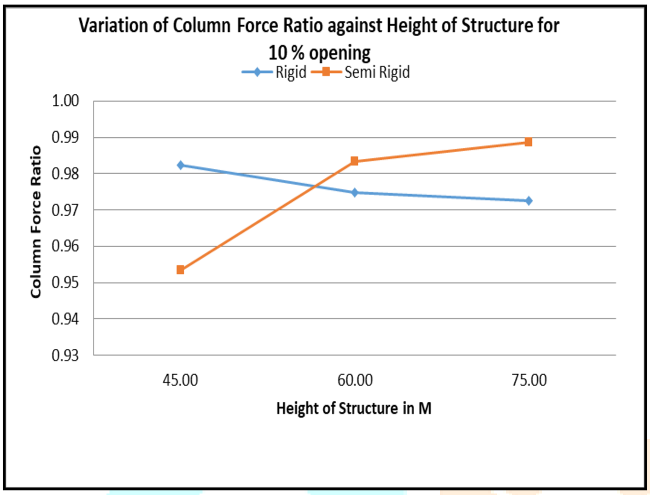


G2 Variation of Time Period ratio against height of structure for rigid and semi rigid diaphragm in 10% Opening

Observation:

- For 45m height of structure the Time period ratio of without opening w.r.t. 10% opening is reducing by 7% in rigid diaphragm.
- For 60m height of structure the Time period ratio of without opening w.r.t. 10% opening is reducing by 4% in rigid diaphragm.

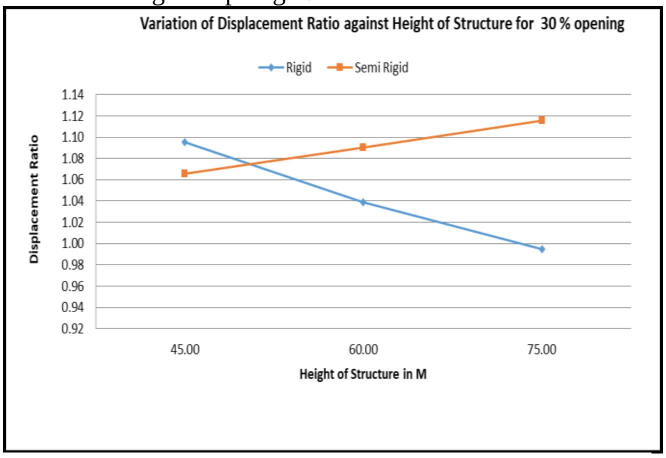
- For 75m height of structure the Time period ratio of without opening w.r.t. 10% opening is reducing by 7% in rigid diaphragm.
- For 45m height of structure the Time period ratio of without opening w.r.t. 10% opening is reducing by 7% in semi rigid diaphragm.
- For 60m height of structure the Time period ratio of without opening w.r.t. 10% opening is reducing by 4% in semi rigid diaphragm.
- For 75m height of structure the Time period ratio of without opening w.r.t. 10% opening is reducing by 2% in semi rigid diaphragm.



G3 Variation of Column forces ratio against height of structure for rigid and semi rigid diaphragm in 10% Opening

Observation:

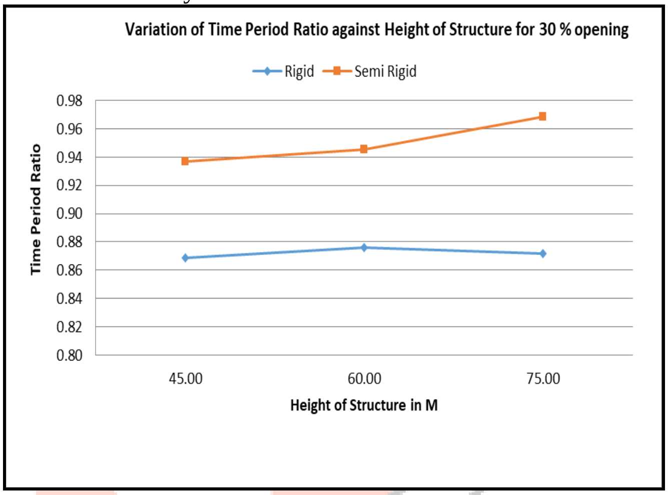
- For 45m height of structure the column forces ratio of without opening w.r.t. 10% opening is reducing by 2% in rigid diaphragm.
- For 60m height of structure the column forces ratio of without opening w.r.t. 10% opening is reducing by 3% in rigid diaphragm.
- For 75m height of structure the column forces ratio of without opening w.r.t. 10% opening is reducing by 3% in rigid diaphragm.
- For 45m height of structure the column forces ratio of without opening w.r.t. 10% opening is reducing by 5% in semi rigid diaphragm.
- For 60m height of structure the column forces ratio of without opening w.r.t. 10% opening is reducing by 2% in semi rigid diaphragm.
- For 75m height of structure the column forces ratio of without opening w.r.t. 10% opening is reducing by 1% in semi rigid diaphragm.



G4 Variation of displacement ratio against height of structure for rigid and semi rigid diaphragm in 30% Opening

Observation:

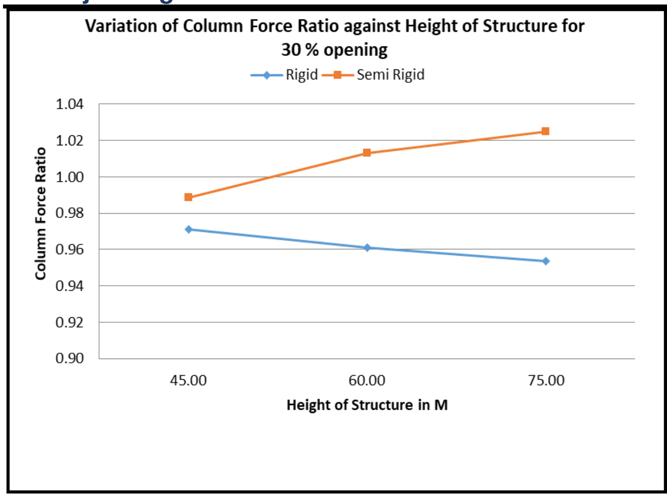
- For 45m height of structure the displacement ratio of without opening w.r.t. 30% opening in rigid diaphragm is increase 10%.
- For 45m height of structure the displacement ratio of without opening w.r.t. 10% opening in semi rigid diaphragm is increase 7%.
- For 60m height of structure the displacement ratio of without opening w.r.t. 10% opening in rigid diaphragm is increase by 4%.
- For 60m height of structure the displacement ratio of without opening w.r.t. 10% opening in semi rigid diaphragm is increase by 9%.
- For 75m height of structure the displacement ratio of without opening w.r.t. 10% opening in rigid diaphragm is reduce by 1%.
- For 60m height of structure the displacement ratio of without opening w.r.t. 10% opening in rigid diaphragm is increase by 12%.



G5 Variation of Time period ratio against height of structure for rigid and semi rigid diaphragm in 30% Opening

Observation:

- For 45m height of structure the Time period ratio of without opening w.r.t. 30% opening in rigid diaphragm is reduce by 13%.
- For 60m height of structure the Time period ratio of without opening w.r.t. 30% opening in rigid diaphragm is reduce by 12%.
- For 75m height of structure the Time period ratio of without opening w.r.t. 30% opening in rigid diaphragm is reduce by 13%.
- For 45m height of structure the Time period ratio of without opening w.r.t. 30% opening in semi rigid diaphragm is reduce by 6%.
- For 60m height of structure the Time period ratio of without opening w.r.t. 30% opening in semi rigid diaphragm is reduce by 5%.
- For 75m height of structure the Time period ratio of without opening w.r.t. 30% opening in semi rigid diaphragm is reduce by 3%.

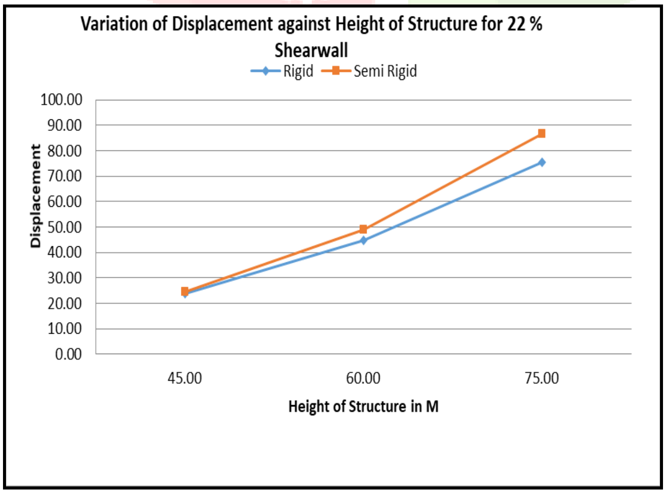


G6 Variation of Column forces ratio against height of structure for rigid and semi rigid diaphragm in 30% Opening

Observation:

- For 45m height of structure the column forces ratio of without opening w.r.t. 30% opening in rigid diaphragm is reduce by 3%.
- For 60m height of structure the column forces ratio of without opening w.r.t. 30% opening in rigid diaphragm is reduce by 4%.
- For 75m height of structure the column forces ratio of without opening w.r.t. 30% opening in rigid diaphragm is reduce by 5%.
- For 45m height of structure the column forces ratio of without opening w.r.t. 30% opening in semi rigid diaphragm is reduce by 1%.
- For 60m height of structure the column forces ratio of without opening w.r.t. 30% opening in semi rigid diaphragm is increase by 1%.
- For 75m height of structure the column forces ratio of without opening w.r.t. 30% opening in semi rigid diaphragm is increase by 2%.

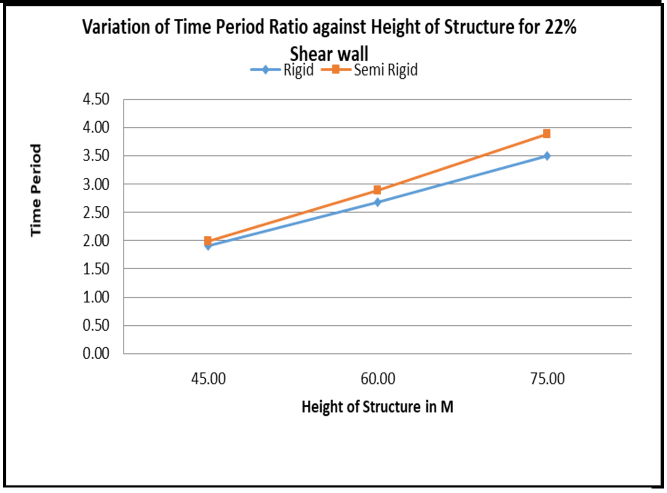
Effect of various percentage Shear wall in the structural system



G7 Variation of displacement ratio against height of structure for rigid and semi rigid diaphragm in 22% Shear wall

Observation:

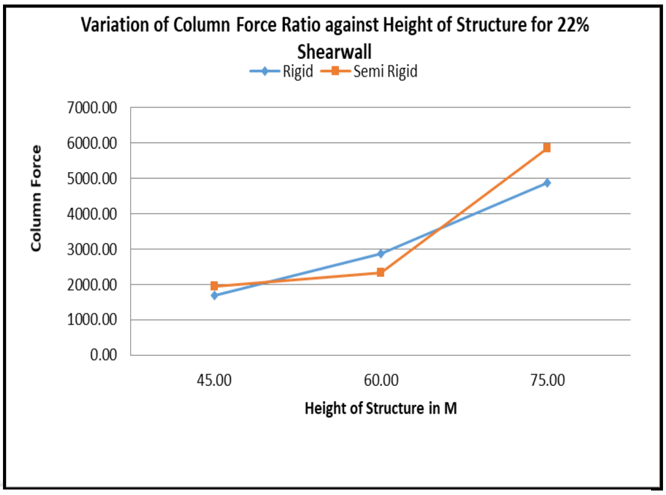
- For 45m height of structure the displacement ratio of rigid w.r.t semi rigid diaphragm is increase by 2%.
- For 60m height of structure the displacement ratio of rigid w.r.t semi rigid diaphragm is increase by 10%.
- For 75m height of structure the displacement ratio of rigid w.r.t semi rigid diaphragm is increase by 15%.



G8 Variation of Time Period ratio against height of structure for rigid and semi rigid diaphragm in 22% Shear wall

Observation:

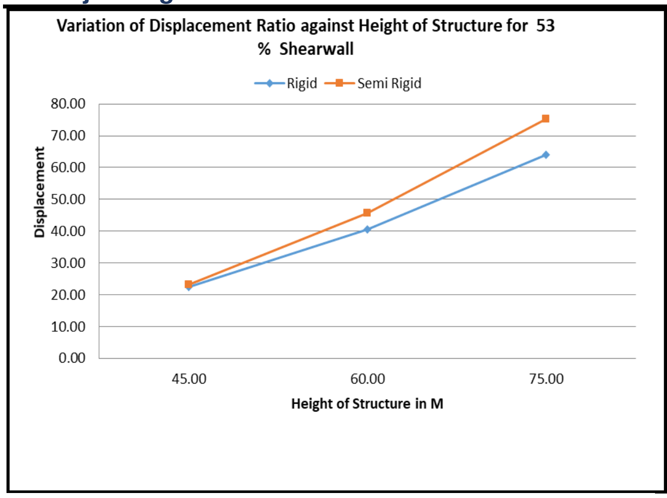
- For 45m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is increase by 4%.
- For 60m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is increase by 7%.
- For 75m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is increase by 11%.



G9 Variation of Column force ratio against height of structure for rigid and semi rigid diaphragm in 22% Shear wall

Observation:

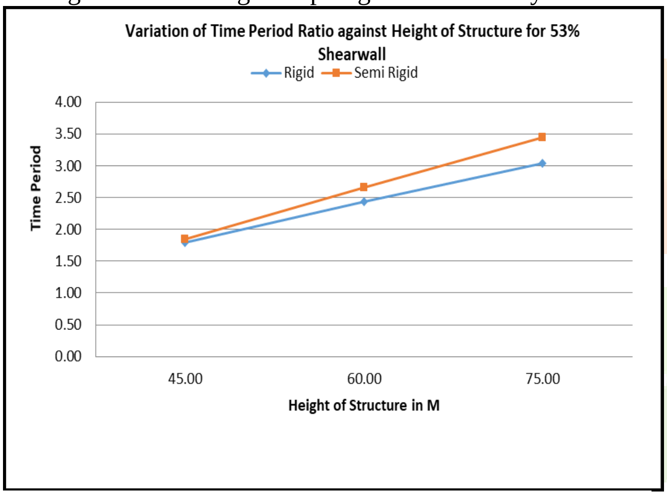
- For 45m height of structure the column forces ratio of rigid w.r.t semi rigid diaphragm is increase by 15%.
- For 60m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is reducing by 19 %.
- For 75m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is increase by 20%.



G10 Variation of displacement ratio against height of structure for rigid and semi rigid diaphragm in 53% Shear wall

Observation:

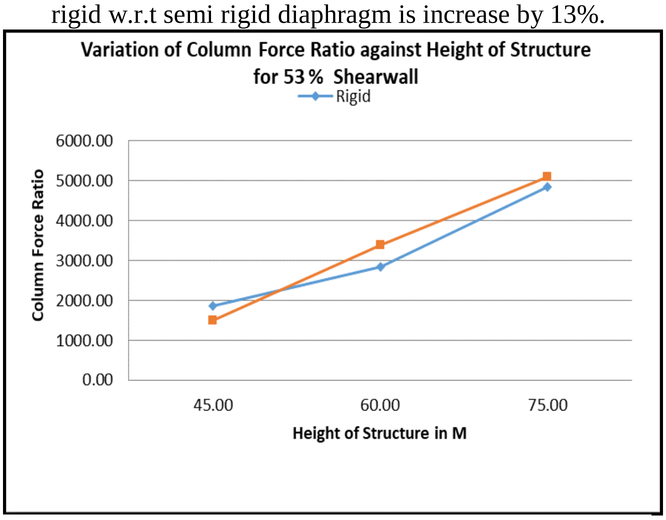
- For 45m height of structure the displacement ratio of rigid w.r.t semi rigid diaphragm is increase by 3%.
- For 60m height of structure the displacement ratio of rigid w.r.t semi rigid diaphragm is increase by 12%.
- For 75m height of structure the displacement ratio of rigid w.r.t semi rigid diaphragm is increase by 18%.



G11 Variation of Time Period ratio against height of structure for rigid and semi rigid diaphragm in 53% Shear wall

Observation:

- For 45m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is increase by 3%.
- For 60m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is increase by 9%.
- For 75m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is increase by 13%.



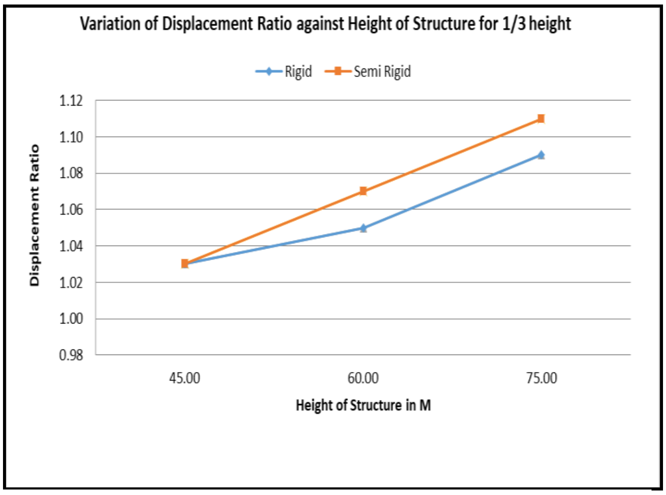
G12 Variation of Column forces ratio against height of structure for rigid and semi rigid diaphragm in 53% Shear wall

Observation:

- For 45m height of structure the column forces ratio of rigid w.r.t semi rigid diaphragm is reducing by 19%.
- For 60m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is increase by 19 %.

For 75m height of structure the time period ratio of rigid w.r.t semi rigid diaphragm is increase by 5%

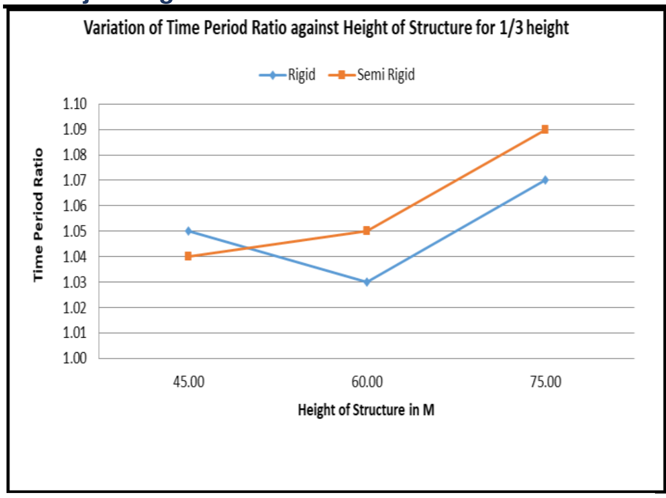
Effect of the Normal and the Incline column



G13 Variation of displacement ratio against height of structure for rigid and semi rigid diaphragm in the incline column at 1/3 height of the structure

Observation:

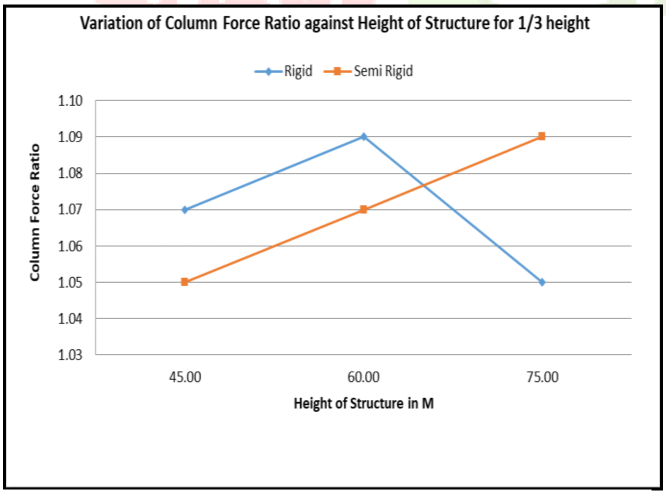
- For 45m height of structure the displacement ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the rigid diaphragm is increase by 3%.
- For 60m height of structure the displacement ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the rigid diaphragm is increase by 5%.
- For 75m height of structure the displacement ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the rigid diaphragm is increase by 5%.
- For 45m height of structure the displacement ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the semi rigid diaphragm is increase by 3%.
- For 60m height of structure the displacement ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the semi rigid diaphragm is increase by 7%.
- For 75m height of structure the displacement ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in semi rigid diaphragm is increase by 11%.



G14 Variation of time period ratio against height of structure for rigid and semi rigid diaphragm in the incline column at 1/3 height of the structure

Observation:

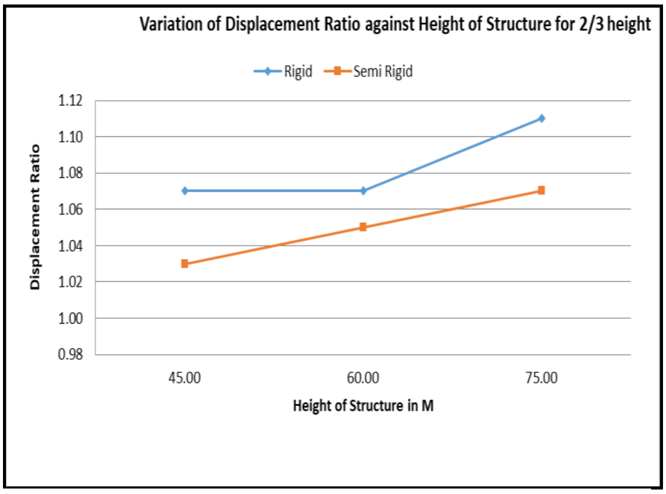
- For 45m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the rigid diaphragm is increase by 5%.
- For 60m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the rigid diaphragm is increase by 3%.
- For 75m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the rigid diaphragm is increase by 7%.
- For 45m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the semi rigid diaphragm is increase by 4%.
- For 60m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the semi rigid diaphragm is increase by 5%.
- For 75m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the semi rigid diaphragm is increase by 9%.



G15 Variation of column forces ratio against height of structure for rigid and semi rigid diaphragm in the incline column at 1/3 height of the structure

Observation:

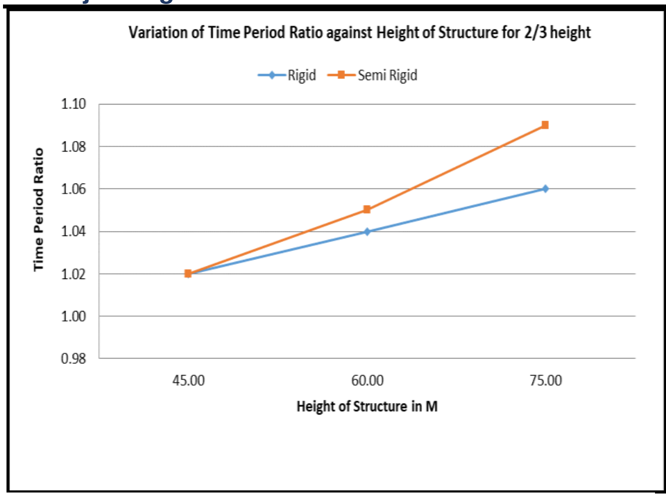
- For 45m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the rigid diaphragm is increase by 5%.
- For 60m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the rigid diaphragm is increase by 3%.
- For 75m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the rigid diaphragm is increase by 7%.
- For 45m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the semi rigid diaphragm is increase by 4%.
- For 60m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the semi rigid diaphragm is increase by 5%.
- For 75m height of structure the time period ratio of the normal column w.r.t. the incline column at 1/3 height of the structure in the semi rigid diaphragm is increase by 9%.



G16 Variation of displacement ratio against height of structure for rigid and semi rigid diaphragm in the incline column at 2/3 height of the structure

Observation:

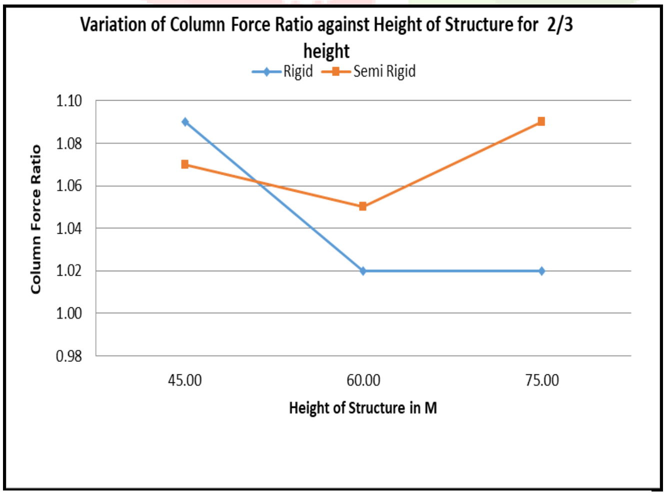
- For 45m height of structure the displacement ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the rigid diaphragm is increase by 7%.
- For 60m height of structure the displacement ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the rigid diaphragm is increase by 7%.
- For 75m height of structure the displacement ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the rigid diaphragm is increase by 11%.
- For 45m height of structure the displacement ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the semi rigid diaphragm is increase by 3%.
- For 60m height of structure the displacement ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the semi rigid diaphragm is increase by 5%.
- For 75m height of structure the displacement ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the semi rigid diaphragm is increase by 7%.



G17 Variation of time period ratio against height of structure for rigid and semi rigid diaphragm in the incline column at 2/3 height of the structure

Observation:

- For 45m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the rigid diaphragm is increase by 2%.
- For 60m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the rigid diaphragm is increase by 4%.
- For 75m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the rigid diaphragm is increase by 6%.
- For 45m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the semi rigid diaphragm is increase by 2%.
- For 60m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the semi rigid diaphragm is increase by 5%.
- For 75m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the semi rigid diaphragm is increase by 9%.



G18 Variation of column forces ratio against height of structure for rigid and semi rigid diaphragm in the incline column at 2/3 height of the structure

Observation:

- For 45m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the rigid diaphragm is increase by 9%.
- For 60m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the rigid diaphragm is increase by 2%.
- For 75m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the rigid diaphragm is increase by 2%.
- For 45m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the semi rigid diaphragm is increase by 7%.
- For 60m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the semi rigid diaphragm is increase by 5%.
- For 75m height of structure the time period ratio of the normal column w.r.t. the incline column at 2/3 height of the structure in the semi rigid diaphragm is increase by 9%.

VI. CONCLUSIONS

The effect of rigid and semi rigid diaphragm on various stories height gives significant results for normal column, incline column, shear wall and various percentage of opening from different structural parameter like displacement, time period and column forces. The effect various storey height on performance of rigid and semi rigid diaphragm is observed through displacement, time period and column forces. Variation from different point of view plotted in the previous chapter observations are noted with the variations. From these variations following conclusions are drawn.

1. As the percentage of opening increases the result accuracy decreases in the rigid diaphragm for displacement, time period and column forces (vertical elements).
2. The more or less percentage of opening doesn't affect the result accuracy in the semi the rigid diaphragm for displacement, time period and column forces (vertical elements).
3. As the percentage of shear wall increase the displacement, time period and column forces contribution in seismic decrease in both rigid and semi rigid diaphragm.
4. The seismic result displacement, time period, column force distribution and in plane forces in slab and beam due to incline column in the semi rigid are more accurate.
5. The seismic result displacement, time period, column force distribution and in plane forces in slab and beam due to incline column accuracy in the rigid are less accurate.

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