Dynamic Analysis of Grid and Flat Slab for Long Span Building

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Abstract— Design needs to have good hand on numerical problem, to counter different challenges while getting twisted in a design. After complete knowledge of analysis and design one can design any structure but it is not possible for a single person to go through all fields. It is necessary to get a full knowledge in a particular field. Building analysis and design needs complete knowledge of IS Codes and numerical analysis. One must be well versed about loading which are considered in a building. Building can be of various types and can be residential, commercial, industrial and institutional. So, while performing a design we need to go through different design codes. Some of the codes are given below with their description of loading.
IS- 875 (Part 1) – Design Code for Dead Load.
IS- 875 (Part 2) – Design Code for Live Loads.
IS- 875 (Part 3) – Wind Load Design Code.
IS- 1893 – Earthquake Design Code.

In addition to above codes we have other codes too to take proper loading and to follow the steps as per standard code recommendation. Engineers which are dealing with Analysis and Design of Structures are known as Structural Design Engineers. They are professional in design both by manual process and by software means. But there is a question that which method we must choose while designing nowadays. It is not as easy as it looks to design a problem it needs mathematical calculation and practice in that field. With this specialization one must have good hand on numerical calculation and must have good experience as well.
Keywords: Flat Slab, Long Span Building

I. INTRODUCTION

With this research I am now familiar with various Software, which can be now added to my technical skills. Now onwards I can be able to perform various projects whether it may be building or any other structure. Things were very tough for me till date as I have solved various problems in my college level but while going through this, I found it don't need much efforts to design or analyse a structure. Models can be quickly built with artifacts, and when editing and constructing complex models they can understand the concepts.

II. OBJECTIVE OF THE RESEARCH

The key technique for this examination is to check the key speculations that others have utilized in the field. It is very workable for a hypothesis to become built up reality basically on the grounds that a similar idea was referenced or cited by numerous creators, in spite of the fact that it was rarely deliberately checked or affirmed. I have could find such an untested hypothesis and can think about a method of checking it, so my examination can be of extraordinary advantage to the field (if it's progressed nicely)

Advancement is building up nowadays with an upsetting rate. It is imperative for every individual to get consider latest advancements they make life less complex once in a while. Mind blowing specialist's and creative work power are related with the path toward making changes in progresses and to make complex things straightforward anyway much as could sensibly be normal.

With this exploration I will become acquainted with about most recent advancements and will look at certain outcomes how much distinction is being obtained and how much exact is the outcome given by innovations utilized in our field. The focuses which will be contemplated while experiencing the examination are recorded beneath:

- Modeling: How to deal with objects based on the physical member and thus take less time to construct the model and interpret the effects.
- Concrete Frame Design & Detailing with Flat and Grid Slab: Applicable to line artifacts and when the process is performed, the system decides the correct design method.
- To determine resistance of grid slab in place of flat in a long span building.
- To assign a suitable cross section which will resist load as well as fulfill some design requirements such as economy and serviceability.
- Learning the value of emerging technology with less effort and time to get the necessary results. G+14 R.C. Modeling and analysis; Framed structure using ETABS and describing the mechanism using different algorithms of design code for concrete member selection, stress testing and drift optimisation.
- Designing of regular and irregular building plans as per Indian standard codes IS-456 & IS-1893:2002
- Computation of stresses and deflection in the portion of building with flat slab and the portion of building with grid slab and finally verifying the results.
- Comparison of results obtained from flat and grid slab design with revised design result values.

To observe how much accurate result is given by software and does it come under range given in design codes. What changes are necessary to pass the members which are getting failed under given conditions and to what extent I can make structure economical.

III. OVERVIEW OF THE METHODOLOGY

The exploration comprises of different qualities which are considered to know the reality which I was looking for. The approach must be notable and ought to be of for all intents and purposes pertinent. Along these lines, in this exploration I thought that it was reasonable to choose ETABS for my reality discovering process as they are generally utilized these days. Specialists are accessible on the off chance that there is

any need of help while having some specialized issue. The short history of these two Software is given underneath:

In structural design and analysis are various types of software uses like: -

- STAAD PRO
- ETABS
- SAP
- SAFE
- ANSYS
- STAAD PRO FOUNDATION
- STAAD PRO RCDC

Many interface alternatives run in tandem with STAAD PRO's cloud services and see the results through simple side-by - side graphical comparisons. Plan for high seismic regions or daily environments, using an analysis of the Finite Elements. Optimize the BIM concrete and steel workflows with complete incorporation of physical and air.

IV. STRUCTURAL DESIGNING

Structural engineers have sufficient technical skills for describing systems and evaluating them. Therefore they are more experienced in building systems. The structural design procedures carried out by the structural engineers include measuring the loads and stresses acting on the building, evaluating results for the loading applied, designing parts of structures to support the loads, so that the built structure can withstand the expected loads in a safe manner.

Even the structural engineers are interested in choosing materials that are ideally suited for the structure. This will also require good knowledge of the various materials used in the construction under the current conditions

A structural engineer may evaluate the quality factors of various building materials to finalize their suitability in the construction of the beams , columns, or foundations.

Another of a structural designer's expertise is structure analysis. The program such as ETABS, STAAD PRO, SAP etc. actually does this. New software is being developed to evaluate structures at various conditions of loads such as wind, earthquake etc. as years pass.

Many structural engineers have to research and work with this software, understanding both the technical details and the specifics of the programming. In some organizations, the analysis is conducted by a programmer who may not have the diploma in civil engineering but is assisted by a structural engineer.

Whatever the mode of analysis performed, the structural engineer must be able to understand and interpret the results of the software in order to know the validity of the values provided as output. Some company is not going to depend solely on the results of the machine, they are doing a separate man-made calculation for assurance.

Since the structural engineers are the ones who carry and create the design ideas and details, only if the structure is designed as desired can he see this happening on the site. The other representatives of the projects have to express ideas and perceptions for this.

The structural engineer will collaborate and communicate with other stakeholders such as the site engineers, other construction engineers, geotechnical engineers, landscape architects, architects, project managers etc. Proper awareness allows the community to distribute accurate information preventing misunderstanding and error.

V. RESULTS AND DISCUSSIONS

A. Introduction

The model comprises of RCC outline with concrete as a base material. This undertaking for the most part comprises of Grid Slab and Flat piece in working at each level. Level section is being utilized at front bit of working to make beamless zone for tasteful reason while internal side of building is having matrix piece to oppose stacks effectively and to expand inflexibility of the structure. This thought of both level chunk and matrix piece encourages us to limit utilization of firmly separated segments. The different boundaries taken for examination and configuration process are referenced beneath:

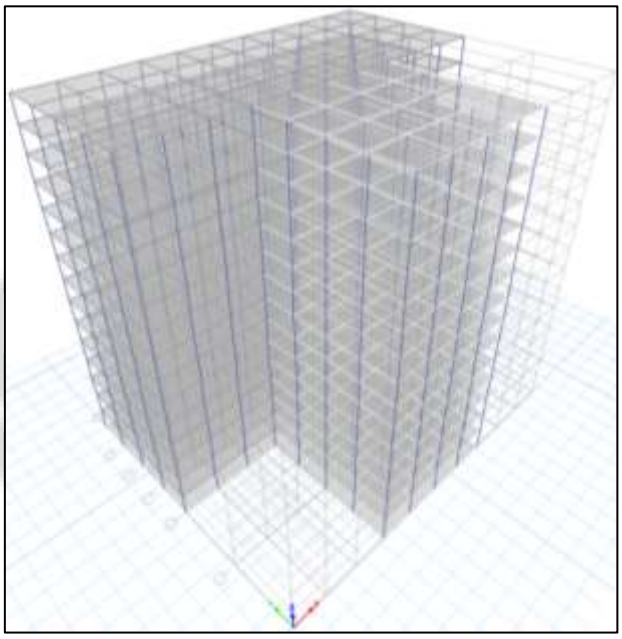

Fig. 1: Isometric view of structure.

No of Floors = G+14
Height of each Floor = 3m
Beam Size = 300 mm X 250 mm
Column Size's taken = 500mm X 400mm, 350mmX300mm, 450mmX350mm and 550mmX500mm.
Flat Slab Thickness = 150 mm
Grid Slab Thickness (Waffle Slab) = 450 (Overall)
Live load on each floor = 3 Kn/m2
Floor Finish = 0.75 Kn/m2
Type of Soil = Medium
Zone = III
Mix used = M 25
Steel Grade taken = Fe 415

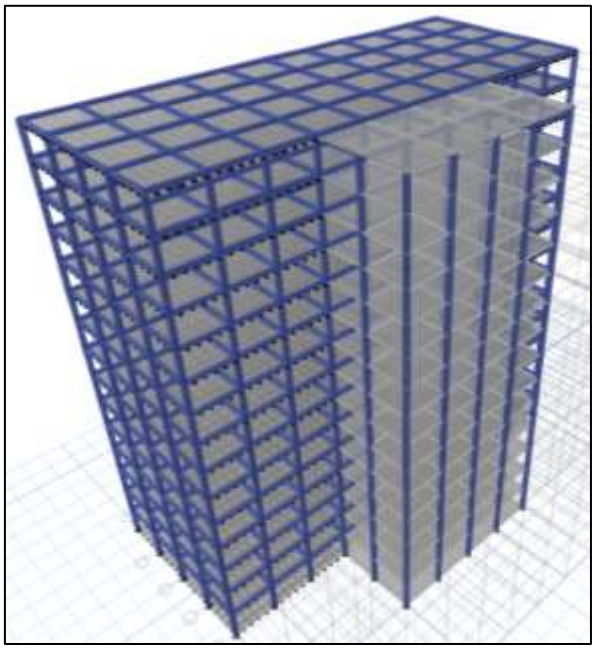

Fig. 2: 3D Rendered view of building.

The structure composes of both flat and grid slabs. Above diagram makes it clear by showing rendered view of structure. When slabs are used without beams, they are called flat slabs. That means load coming on slab is resisted by slabs itself but not transferred to beams. In case of flat slab load is directly transferred from slab to columns. In this configuration of slabs, load is not distributed in one way or two-way phenomenon. Drop panels were used to prevent the structure from punching failure.

B. Displacement

Displacement is due to external loads in this project maximum displacement takes place in the area where there are flat slabs. Some pictorial representation showing displacement due to dead load in slabs are shown below:

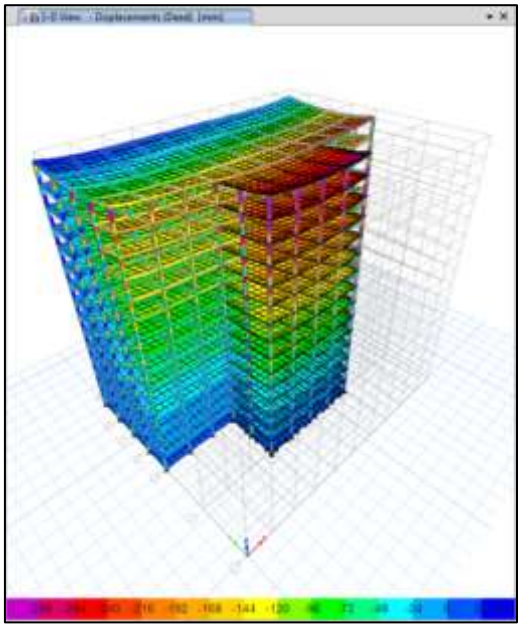

Fig. 3:

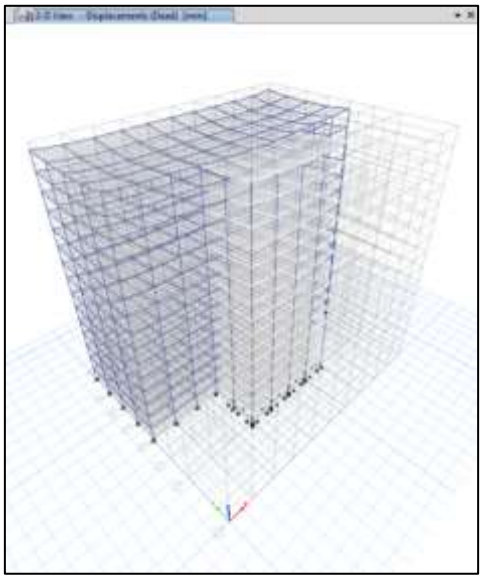

Fig. 4: Deformation in Building.

Some green spots can be seen near columns showing less stress in slabs near columns. Stress analysis in slabs was broadly checked to know the different nature of flat and grid slabs. Above pictures show stress at top storey.

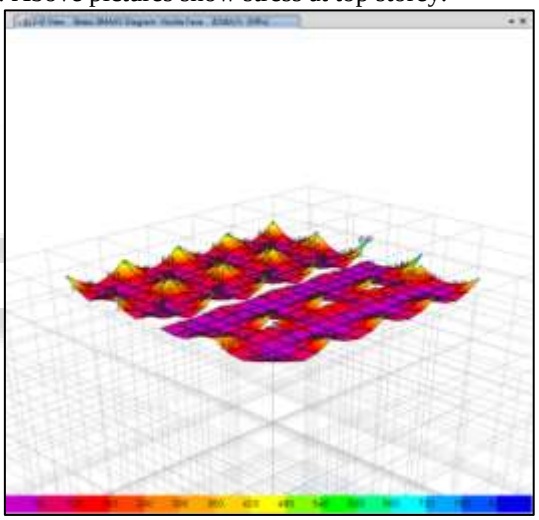

Fig. 5: Stress Diagram

Picture showing Stress levels in each zone of slab. Slabs are shown apart to make it clear. This is the stress diagram of visible face.

C. Storey Displacement.

Displacement is calculated for each member of building including beams, columns and slabs. The results are taken to know effect at each load combination. It is necessary to check storey displacement to know if it found under limit. Below graph shows the storey displacement. Here maximum displacement occurs on top storey with magnitude of less than $13.5X10^{-3}$mm and displacement on base is zero. Red line shows displacement along Y-axes whereas blue line shows displacement along x-axes. As there is large span along X-axis that is why stiffness of building is greater in this direction. And it clear that displacement along Y direction will be maximum because of small span.

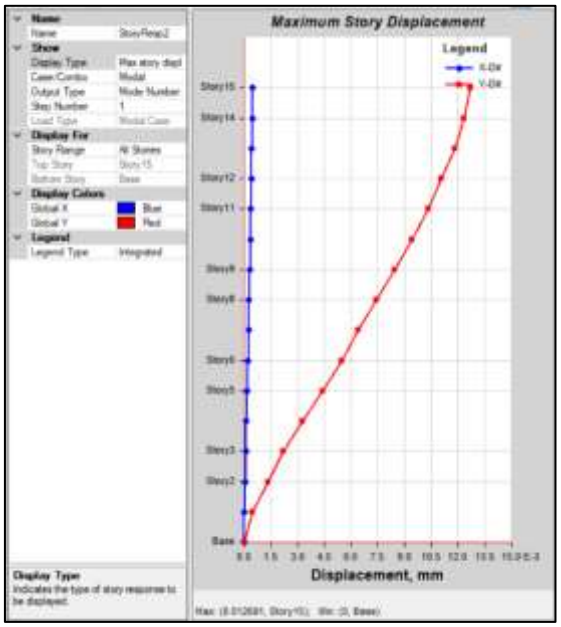

Fig. 6: Storey Displacement.

D. Maximum story displacement

This is the story answer production for a given range of stories and a specified load case or combination of loads.

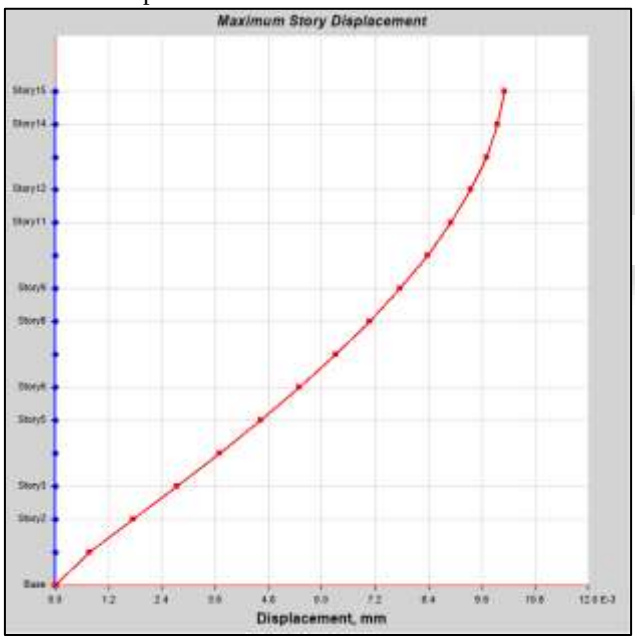

Fig. 7: Storey Displacement (Response Spectrum)

1) Tabulated Plot Coordinates

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	45	Top	2.65E-07	0.01
Story14	42	Top	4.657E-07	0.01
Story13	39	Top	3.924E-07	0.01
Story12	36	Top	3.824E-07	0.009
Story11	33	Top	3.716E-07	0.009
Story10	30	Top	3.588E-07	0.008
Story9	27	Top	3.444E-07	0.008
Story8	24	Top	3.285E-07	0.007
Story7	21	Top	3.112E-07	0.006
Story6	18	Top	2.926E-07	0.005
Story5	15	Top	2.728E-07	0.005
Story4	12	Top	2.532E-07	0.004
Story3	9	Top	2.25E-07	0.003
Story2	6	Top	2.893E-07	0.002
Story1	3	Top	2.083E-06	0.001
Base	0	Top	0	0

Table 2.4: Story Response Values

E. Storey Drift:

The resultant drift in two adjacent storey define storey drift. Below graph makes it clear to know the condition of the building for storey drift due to external loading.

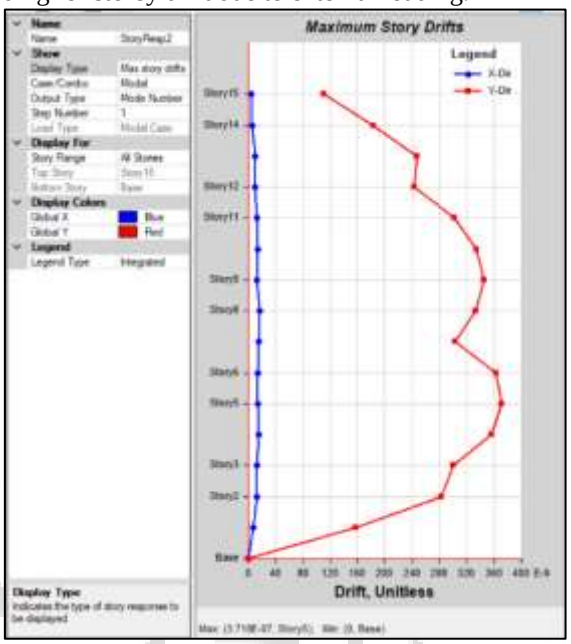

Fig. 8: Maximum Storey Drift.

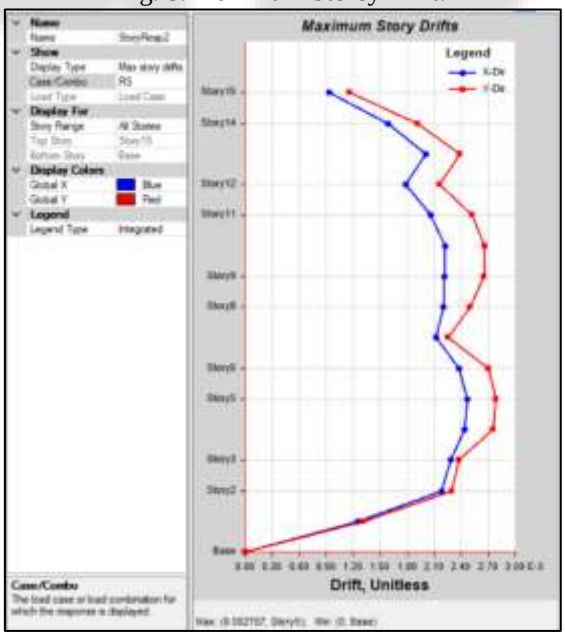

Fig. 9: Storey drift due to Response Spectrum.

It is found that Storey drift along X-axis is minimum as compared to Y -axis because displacement along y axis is greater than the displacement along x-axis. It mainly depends on orientation of building. If building is symmetrical along both the axes then there will be same drift along both the axes.

VI. CONCLUSION

Despite the fact that the ways to deal with check different consequences of various sections in a solitary structure is distinctive yet principle center is same, which is to check the adequacy on their auxiliary perspective. Static and dynamic investigation is being completed to know the aggregate response of section and bars to outer stacking. Conservative area is being checked by numerous investigates at various burden conditions. Story float is limited by arrangement of network sections. By experiencing every one of these papers, I came to know whether we consider prudent perspective then framework chunk isn't vital. Be that as it may, on the off chance that we are planning a significant structure where there is need of huge spaces Grid chunks assumes a fundamental job at that place. Some basic Engineers prescribe to give gliding segments in parking areas, open spaces and so on however consequently that needs additional fortification for close by shafts and segments which sidestep the stacking which is moved by that section.

To know the between connection between lattice piece and level chunk and their reliance on neighboring bars and to check the impact on support, area itemizing. By experiencing a portion of the explores done beforehand I arrived at resolution by this examination that:

1) Flat slab makes it best for design purpose instead of grid slab if we take economic point of view.
2) Reinforcement provided for flat slabs is minimum as compared to grid slabs.
3) Grid slabs help to minimize provision of number of columns as they are rigid and can be used for longer spans. But flat slabs cannot resist that much amount of load as they are not supported by beams.
4) Stress is found to be maximum on flat slab as compared to grid slab. So, chances of cracks will be more in flat slabs.
5) As found in analysis result stress is minimum at column joints in both the cases but in case of flat slab drop panels are used to minimize stress on columns. Drop panels transfer loading uniformly from all sides.
6) Deflection is always found more in case of flat slabs as they are not supported by beams whereas grid slabs show good resistance for deflection.
7) By this research work I came to conclusion that if it is any important building like public building then it is necessary to use grid slabs to make frame as rigid as possible. On the other hand, it will cost more but will be durable and safe as compared to flat slabs. Flat slabs are mostly used in the cases where we prioritize aesthetic look of building and where we want to provide any different Architectural look in building.
8) Designing the building with Flat Slab and Grid slab for long span building on ETABS, it is clear that ETAB gives best result for reinforcement data. This is the main reason which I found while going through this research. Secondly ETABS gives the reinforcement detailing with drawing in the form of distinct tables.
9) In case of ETABS failed members can be checked simply after design step. "Check failed members" in design section directly select those members and Design Engineer can change the section of those members by taking them in "view selected objects only". And then section is changed to those members to make them pass for the given loading. ETABS consists of multiple steps to complete a design by assigning each parameter of design that is why results were taken by use of this software.

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