Comparative Analysis of Grid Slab and Flat Slab for Buildings with Column Free Spaces

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Abstract— Structural Engineering is tied in with planning Structures and make them ready to oppose the outer stacking under basic conditions. Auxiliary planning is the fundamental field with which structural designers arrangement to satisfy a few states of the structure which incorporate sturdiness and workableness of the structure. To satisfy such conditions innovation has reached at significant level to get best outcomes however much as could reasonably be expected. In structural Engineering STAAD Pro and ETABS are assuming a significant job to make best approach for complex plans and make complex issues simple to illuminate inside specified timeframe. This review paper is the short conclusion of projects being as research to check various results. Various structures have been analysed and designed with grid slab Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement. The rectangular or square void formed in the ceiling is advantageously utilized for concealed architectural lighting. The sizes of the beams running in perpendicular directions are generally kept the same. Instead of rectangular beam grid a diagonal. This paper presents work of numerous specialists which discover point by point report to impact different boundaries on the practical dividing of the transverse shafts in framework floor. The boundaries considered in this examination are range to profundity proportion, dispersing of transverse shafts, thickness of web and thickness of spine. The size of length to profundity proportion considered is 16 to 60. The dispersing of transverse pillars is fluctuated from 0.5m to 2.0 m. Thickness of piece and the rib are made steady and are equivalent to 0.1m and 0.15m separately. The twisting second, the shear power and the mid range redirection created in network floor shafts have been anticipated by traditional and numerical techniques and the outcomes are looked at.

Keywords: Grid Slab, Flat Slab, Buildings with Column Free Spaces

I. INTRODUCTION

This paper presents a survey of the past work done on the seismic presentation of tall structures with various strengthened solid section frameworks. It centers around level chunk and network section framework. These two frameworks include the most alluring and normally utilized floor frameworks, particularly in tall structure development. The Flat section working in which piece is straightforwardly bolstered by segments, have been embraced in numerous structures built as of late, because of the benefit of decreased floor to floor tallness. Lattice chunk framework comprises of flimsy pillars separated at customary spans in opposite ways, solid with piece. The seismic presentation of structures having lattice section and level chunk is practically identical however the distinctions exist. Tall structures with level chunk framework are more vulnerable in shear while those with matrix/regular floor framework are strong yet taller and practically less well disposed.

Grid slab system consists of beams spaced at regular intervals in perpendicular direction, monolithic with slab. The rectangular or square void formed in the ceiling is advantageously utilized for concealed architectural lighting. The sizes of beams running in perpendicular directions are generally kept the same. Grid slab system is robust & inherently strong. Grid slabs are those structures in which beams are provided at square or rectangular intervals, in perpendicular direction with slabs, in recent days grid slabs are more used by the construction companies and designers, they are using grid slab for making auditoriums, theater, vestibules, show rooms, where column free space are required.

Framework floors comprise of firmly dispersed crossing pillars two way with solid section on the top. It is commonly received when huge section free space is required and diminishes the range to profundity proportion of rectangular lattices. Network discovered extremely productive in load moving. The rectangular or square void shaped in the roof is beneficially used for covered design lighting. Various examples of lattice are in particular Rectangular, square and slanting.

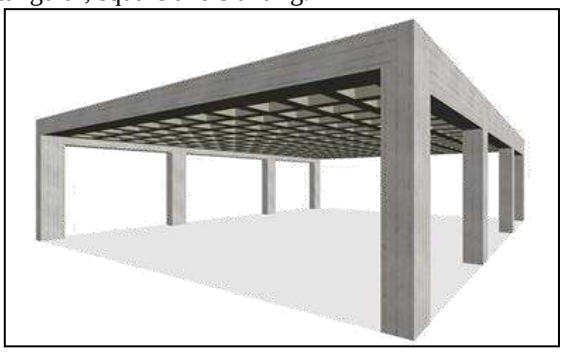

Fig 1: Typical Grid Slab.

II. LITERATURE REVIEW

Different writing has introduced as specialized papers on lattice chunk. Different issues and focuses are shrouded in the audit paper like seismic investigation of framework chunk working according to seismic zones, story dislodging, story float and proportional static and reaction range strategy according to various May be codes. A portion of those are talked about beneath:

A. Ashwini Waghule, Patil Harshal S, Waghmare Ratnakumar B., Kadam Shubham V., Biradar Ballav S., and Udatewar Diksha B.

- Concrete usage is reduced as 33.02 kg as recycled plastic replaces concrete. This avoids the cement production and allows reduction in global CO2 emissions. Hence this technology is environmentally green and sustainable.
- Reducing material consumption made it possible to make the construction time faster, to reduce the overall costs. Besides that, it has led to reduce dead weight up to 18%, which allow creating foundation sizes smaller.
- The Bubble Deck configuration gives much improved flexural capacity, stiffness and shear capacity when the same amount of concrete and the same reinforcement is used as in the solid slab.
- Advantage of Bubble Deck system is the significant cost saving, because of the Possibility of obtaining great spans with less support elements

B. Ch. Rajkumar and Dr. D. Venkateswaru (2017)

Seen that the outcomes are increasingly traditionalist in Static examination when contrasted with the dynamic strategy coming about uneconomical structure. As a result of the Box impact of secluded sort plot, it is expanding by and large solidness of the structure accordingly, decreasing the influence issue in the structure. As building is in sporadic the conduct in the two bearings isn't comparative. Further, the examination among customary and particular sort demonstrates the general possibility of the plan without influencing its dependability in gravity just as horizontal burdens. Some perception is referenced beneath:

1) The story float esteems in x and y bearing is higher for seismic tremor load than the breeze load.
2) The breeze load estimations of zero force for float Y.
3) In the popular narratives' area, the story shear is most extreme for range loads.
4) The turning second increments through and through stories for popular narratives area.
5) For the base stories' area, the story shear increments from popular narrative to base story and will be most extreme for base story.
6) The turn (T) is increments additionally increment from popular narrative to base story in base story area.
7) The help response esteems are most extreme for Fz.
8) The segment powers are most extreme for M3.
9) Designing by Software resembles ETABS decreases ton of your time in configuration work.
10) Accuracy is improved by utilizing programming.

C. Anitha.K , R.J Rinu Isah (2017)

This paper manages the impact of different boundaries on the practical separating of the transverse shafts in lattice floor. The boundaries considered in this examination are range to profundity proportion, dividing of transverse shafts, thickness of web and thickness of spine. The extent of range to profundity proportion considered is 16 to 60. The separating of transverse bars is changed from 0.5m to 2.0 m. Thickness of chunk and the rib are made steady and are equivalent to 0.1m and 0.15m individually. The bowing second, the shear power and the mid range redirection created in framework floor shafts have been anticipated by traditional and numerical strategies and the outcomes are looked at. The parametric investigation is done utilizing the model proposed by ANSYS 12.0 programming. The aftereffects of the examination give a knowledge to the range for the extent of the different boundaries to be considered for the ideal execution of framework floors.

D. Avinash Patel and Seema Padamwar (2017)

performed dynamic analysis of multistoried RCC buildings with Flat slab & Grid slab (10 Storey) having Square geometry, using Response Spectrum Analysis, considering earthquake Zone II as per the Indian Standard code of practice IS 1893-2002 part-I: Criteria for Earthquake resistant structure. And modeled different structures with aforementioned configuration and compare them using design aids like STAAD.Pro. They also compared seismic behaviour of multistoried RCC building with Flat slab & Grid slab for different earthquake intensities in terms of various responses such as, base shear, Story displacements, Story Drift, Axial Force, Time Period. They also found the relationship between earthquake intensities and responses.

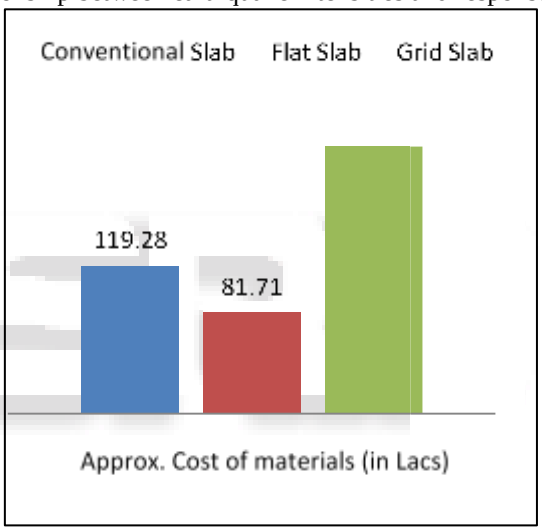

Fig 2: Observation's made on three types of slabs.

From this research it is clear to all that the seismic hazard has to be carefully evaluated before the construction of important and high-rise structures. Based on the above analytical study carried out on 3 structures, the following were made:

- The frame with flat slabs clearly provides more safety to the designers and it proves to be extremely cost effective.
- In all the systems, the storey drift is within the permissible limits as per IS:1893 (Part 1). However, grid floors showed better results when compared to other models.
- There is an increase of 45.97 % in the cost of Conventional slabs and an increase of 163.57 % in the cost of Grid Slabs when compared to Flat Slabs. This also results in a deduction of 66.12 % in the amount of storey drift in Flat Slabs.
- There is a huge increase in the quantity of concrete and steel in case of Grid Slabs when compared to Flat Slabs or Conventional Slabs. This is because number of beams in the model of the higher

- The lateral loading is most effectively resisted in Flat Slabs. Thus, the service life will be largest for this framing configuration.
- Due to the falling of the zone, the earthquake hazard will also increase. In such cases, Flat slabs with shear walls are applicable.
- The Response Reduction Factor plays an important role on the variation of cost.
- To further increase the effectiveness of the structure, earthquake resisting techniques such as shear walls & base isolation can be used.

E. Salman I Khan and Ashok R Mundhada

This paper presents a review of the seismic performance of multi-storied buildings for different floor heights and having different floor systems like Flat slabs, Grid slabs and conventional solid slab-beam systems. It seems that the seismic performance of buildings having grid slab and flat slab is comparable but the differences exist. For e.g. the base shear of a multi-storey structure with flat slab is less as compared to Grid slab, whereas the axial force in the intermediate columns are more in case of flat slabs than grid slabs. Buildings having the flat slab system are weaker in shear as compared to those with conventional or even grid slab systems. The storey drift in building with flat slab construction was significantly more as compared to conventional RCC building. As a result, additional moments were developed. Therefore, the columns of such buildings should be designed by considering additional moments caused by the drift. Base shear of flat slab building would be less than the base shear in grid slab building. To draw definitive conclusions, more research is required.

F. Dr. S. A. Halkude, S. V. Mahamuni gives the following result in their research:

- Rankine-Grashoff method is an approximate method. Rankine-Grashoff method does not give the values of torsion moments. Rankine-Grashoff method underestimates critical bending moment (Mx) and shear force (Qx).
- Plate theory and Rankine-Grashoff method are used for simple support conditions. On the contrary the stiffness method can be used for rigid supports as well.
- In Plate theory and Rankine-Grashoff method, design moments and shear force in Peripheral beams cannot be obtained. In fact, in monolithic framed construction, design moments and shears in peripheral beams will be the maximum.
- Initially, up to L/B=1.2, Plate theory shows higher value of bending moment (Mx) with respect to stiffness method. With increasing L/B, beyond L/B=1.3 Plate theory shows lower value of bending moment (Mx) as compared to stiffness method.
- Stiffness method shows higher value of shear force as compared to other methods discussed. Plate theory shows less values than that of stiffness method.
- Stiffness method is accurate & more suitable to arrive at design moments and shear force. Also, Stiffness method takes less time for analysis.

G. Mayuri S. Sethia, Prof. R.S Deotale and P.S. Patankar discovered that contrasted with various kinds of Flat chunk, Concrete and steel required is less in Flat with Drop board. Drops are significant standards in expanding the shear quality of section.

For elevated structure, so as to build unbending nature of chunk, segment heads are consolidated. Drop board increment negative second limit of piece. It solidifies the section and consequently diminish diversion.

Contrasted with various networks of matrix Slab, Concrete and steel required is less in (1.5*2.0 m) lattice board.

Concrete required in bubble section is less. The Bubble Deck has numerous favorable circumstances as contrast with customary solid piece, for example, lower absolute cost, diminished material use, improved auxiliary effectiveness and diminished development time.

Pace of covering of lattice section is practically twofold the pace of Flat chunk. Lattice section requires extraordinary or exclusive formwork, because of which level piece with drop is liked.

SAFE outcomes are more efficient than the hypothetical qualities.

H. Lalit Balhar, Dr. J.N. Vyas completed the exploration on multi-celebrated RC chunk structures are displayed in STAAD.PRO programming.

The structures comprise of stories G+10 is one of a kind second opposing edge thought to be arranged in seismic zone V. Structures are displayed in STAAD.PRO programming, are exposed to gravity and dynamic burdens are broke down by equal static examination, reaction range investigation, time history investigation is completed taking information. Pillars and segment individuals have been characterized as solid zone components. Traditional Slabs are characterized as zone components having the properties of solid territory components and plate components, Flat pieces having the properties of plate component, likewise shear dividers are characterized as surface components. Structures having evaluation of cement for pillar, section, piece is M40 with unit weight of cement being 25kN/m3. Segment size for working up to tenth floor is 1.5mx1.5m, while the bar size is 0.40mx0.60m, The Building models having every story tallness of 3m.

I. Amit A. Sathawane & R.S.Deotale (2012)

- Drops are important criteria in increasing the shear strength of the slab.
- Enhance resistance to punching failure at the junction of concrete slab & column.
- By incorporating heads in slab, we are increasing rigidity of slab.
- The negative moment's section shall be designed to resist the larger of the two interior negative design moments for the span framing into common supports.
- Concrete required in Grid slab is more as compared to Flat slab with Drop and Flat slab without Drop.
- Steel required in Flat slab without Drop is more as compared to Flat slab with Drop and Grid slab.

- Flat slab with drop is more economical than Flat slab without Drop and Grid slab.
- Rate per square meter of flat slab with drop (3524) was found to be more economical than flat slab without drop (3855) and grid slab (4005).
- Rate per square feet of flat slab with drop (327) was found to be more economical than flat slab without drop (358) and grid slab (372).

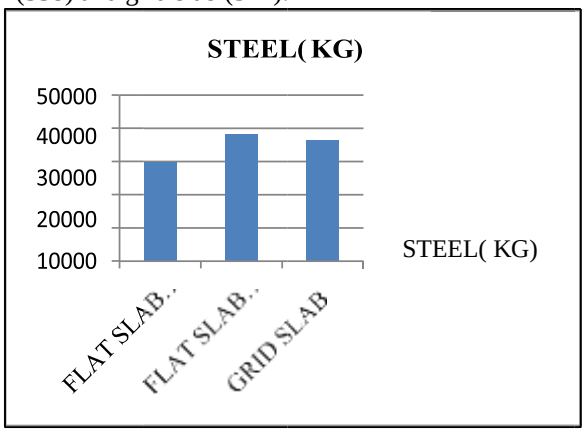

Fig. 3: Amount of Steel in various cases.

J. Sumit Sharma,Ashish Yadav and Mukesh Dubey (2018)

According to the above audit paper its been seen that thickness of the structure having level piece with shear divider changes with the story stature. Indian code use for stoop level section propose greater support and firmness as contrast with European code. level piece gives greater adaptability to the structure as contrast with regular section. we can structure level piece by post tensioning and just as by customary fortified cement however we favor strengthen solid more as cost of post tensioning is higher. Level section likewise gives greater security and tasteful view to the structure. If there should be an occurrence of modern structures built in a square and rectangular format the uprooting is more is instance of level piece as contrast with waffle framework and removal is increments with the increments in the tallness of the structure. Anyway Indian code for level chunk has numerous inadequacies, which must be re-examined soon.

K. R.Arvind, P.C.Balamurugan, R.Aravind, and C.S.Aslam Basha

A voided section where voids are created to decrease the measure of cement. This paper manages voided pieces utilizing U-boot beton innovation made by reused polypropylene, the innovation is plans for lightweight chunks in RCC. It is answer for fabricate chunks of huge ranges with all the more bearing limit. It resembles a state of formwork like a pyramid and for the most part size estimation 52 X 52 centimeters. It is an easy to utilize. Introductory, a plain surface has been set up with deck of wooden or other comparable equipment's. At that point, steel fortification must be presented in the two including right edges or perpendiculars bearings, as structured in the undertaking. In this manner, steel dunk into throwing of the solid. A framework of symmetrical shafts, almost shut by chunks of different statures'- Boot its lightweight, soundness, particularity, can be utilized to make structures without mechanical aides of hardware and it's likewise establishment rafters can be made with a low measure of cement with huge thickness. By utilizing U-boot beton, it is anything but difficult to manufacture pontoon establishments with a low amount of cement. It is utilized in tall structures to decrease the heaviness of the structure. It decreases the development time and furthermore requires less works. It has high imperviousness to fire and it's prudent. Higher number of floors can be manufactured.

After the examination, we reason that the u-boot beton is so conservative, productive, Fire obstruction, and Eco inviting. Subsequently, the outcome gives an away from of u-boot beton that is exceptionally helpful for development reason.

L. Amit A. Sathawane, R.S. Deotale carried out the research and found the following results:

- Drops are important criteria in increasing the shear strength of the slab.
- Enhance resistance to punching failure at the junction of concrete slab & column.
- By incorporating heads in slab, we are increasing rigidity of slab.
- The negative moment's section shall be designed to resist the larger of the two interior negative design moments for the span.
- Framing into common supports.
- Concrete required in Grid slab is more as compared to Flat slab with Drop and Flat slab without Drop.
- Steel required in Flat slab without Drop is more as compared to Flat slab with Drop and Grid slab.
- Flat slab with drop is more economical than flat slab without drop and grid slab.
- Rate per square meter of flat slab with drop (3524) was found to be more economical than flat slab without drop (3855) and grid slab (4005).
- Rate per square feet of flat slab with drop (327) was found.

M. Avinash Patel And Seema Padamwar (2017)

The conduct of all the surrounding frameworks is taken as an essential report on the displayed structure. The parallel float/diversion proportion is checked against the condition 7.11.1 of IS-1893:2002 for example under transient seismic burdens. The accompanying boundaries were considered to introduce a correlation between the various edges. Celebrated structures are demonstrated utilizing ordinary sections, level chunks and matrix pieces separately. These structures were given square geometry. These are then examined utilizing reaction range technique for seismic tremor zone II of India. The subtleties of the displayed fabricating are recorded beneath. Modular damping of 5% is considered with SMRF and Importance Factor (I) =1. The accompanying suppositions were made before the beginning of the demonstrating technique to keep up comparative conditions for all the three models:

Only the fundamental square of the structure is thought of. The flights of stairs are not considered in the structure technique.

The building is to be utilized for shows thus no inside dividers are given.

- Only outer dividers 230 mm thick with 12 mm mortar on each side will be given. In any case, in the current examination, just the casing is thought of and thus, dividers are not given.
- At ground floor, chunks are not given and the plinth is resting 2m over the ground.
- The bar shafts are laying halfway on the sections in order to dodge the states of erraticism.
- For every auxiliary component, M25 and Fe415 are utilized.
- The footings are not planned. Supports are allocated as fixed backings.
- Seismic loads are considered in the flat heading just and the vertical course are thought to be inconsequential.
- Sizes of the individuals are as per the following: (All measurements are in mm).

III. Conclusion

In spite of the fact that the ways to deal with check different practices of various sections utilized by Researchers is unique yet the principle center is by all accounts same, which is to check the adequacy of their auxiliary perspective. Static and dynamic investigation is being completed to know the aggregate response of piece and shafts to outside stacking. Conservative segment is being checked by numerous investigates at various burden conditions. Story float is limited by arrangement of matrix sections. By experiencing every one of these papers, I came to know whether we consider prudent perspective then matrix chunk isn't essential. In any case, on the off chance that we are planning a significant structure where there is need of huge spaces Grid pieces assumes a crucial job at that place. Some auxiliary Engineers prescribe to give coasting segments in parking garages, open spaces and so forth however consequently that needs additional fortification for close by shafts and sections which sidestep the stacking which is moved by that segment.

To know the between connection between matrix chunk and level piece and their reliance on contiguous pillars and to check the impact on fortification, area itemizing. By experiencing a portion of the explores done already I arrived at decision to do an examination which will be founded on following trials:

1) To check whether level piece makes it best for configuration reason or network chunk ought to be given by mulling over their economy.
2) Decrease in shaft fortification by arrangement of matrix piece and increment in support by utilization of level chunk.
3) Effect on number of sections in the two cases. Area of section and variety in measure of support in discrete cases.
4) Change in second and impact on unbending nature of an edge because of matrix chunk rather than level section.
5) To check Punching disappointment and offer disappointment at section joints.
6) To watch the measure of avoidance in both the cases.
7) To check expository consequences of level chunk and framework piece structured in a multi-storeyed structure.

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