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Comparison Of Steel Girder And RC Girder As Peripheral Beam To Study The Effect Of Spacing Of Grid Beams And Its Depth On Peripheral Beams In Grid Floor Frame

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Abstract:
The terms "Grid slab" and "Waffle slab" refer to an arrangement of intersecting beams that are spaced regularly and joined to form a slab of nominal thickness. For buildings like hotels, porches, airport terminals, banquet halls and parking garages, grid slabs are a fairly common structural form. In contrast to a conventional concrete slab, the Grid construction is monolithic in nature, stronger, and capable of supporting heavier weights. This study suggests a brand-new type of composite Grid slab made of flat RC slabs and orthogonal steel peripheral girders. Because it fully utilizes both the compressive resistance of concrete slabs and the tensile resistance of steel, composite slab structures have a strong load-bearing capacity. In this study, a non-linear static analysis is conducted using the E-Tabs 2016 program to examine the impact of grid beam spacing and depth in the grid floor frame. The findings are tabulated using MS Excel. The comparison of such results with the available results obtained from the study carried out by Prof.Dr.S.A.Halkude and S.V.Mahamuni for halls with reinforced concrete peripheral beams is done by plotting graphs.

Conclusion: *For a fixed depth of steel Peripheral beams, the maximum bending moment can be reduced by decreasing the depth of Grid beams. For L /B ratios less than 1.2, the maximum bending moment in peripheral beams may be attained. The maximum bending moment in RC peripheral beams in halls grows with increasing L/B ratio for the specified depth of peripheral beams.*

Key Word**:**Grid slab, Waffle slab, steel peripheral girders, RC slabs, E-Tabs 2016.

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I. Introduction

A grid slab system comprises of beams or ribs that are monolithic with the slab and spaced at regular intervals in a perpendicular direction. These sorts of slabs have a nominal thickness and are supported by a grid or mesh of beams that run in both directions. It has been discovered that grids (beams) are particularly effective in transferring weight. Grids that run in perpendicular directions often maintain the same size. For architectural reasons, grid slabs are typically used in big rooms like auditoriums, vestibules, theatre halls, and retail display rooms where column free space is frequently the primary need. As a result of their greater rigidity and reduced deflection, they are employed for heavy loads and long span constructions. The ceiling void that is created reduces dead load and is useful for architectural lighting that is hidden. Although they are most frequently utilised in commercial or industrial buildings, these slabs are also employed as the foundation for many various kinds of buildings and structures. Grid foundations can support a lot more weight than conventional concrete slabs and are resistant to cracking and drooping.

The classic RC grid slab comprises of a plate (concrete slab), grillage of beams (ribbed), and shell behavior (diaphragm stiff and ribbed). It benefits from two-way load-bearing capacity, and the demand for engineering remains high.In case of composite grid slab,the RC ribs are swapped out for steel girders which are attached to the flat slab by shear studs. The compressive strength of concrete slabs and the tensile strength of steel girders may both be used in the design of composite slabs. By employing the right studs to stop slide between the RC slab and steel girders, a nice composite action may be achieved.

II. Literature review

Prof.Dr.S.A.Halkude et al., (2014) carried out study on grid slab and stated, the main goal of their work was to use STAAD-PRO to conduct a parametric inquiry on flexural actions and an analytical analysis on the modification of grid beam spacing with different (L /B) ratios. By maintaining a ratio of hall dimensions lesser and a minimal ratio of grid beam spacing, the bending moments in RC peripheral beams may be reduced to a minimum. Grid beams spacing (l /b) may be maximized for greater hall sizes ratios (L /B), resulting in the least amount of bending moments in periphery beams.The study also took grid beam depth into account, and it was found that the bending moments of grid beams and periphery beams differed noticeably.By making Grid beams shallower than Peripheral beams, the maximum bending moment in Peripheral beams may be maximized.

RisnaRasheed et al.,(2017) stated that, in order to investigate the effects of grid beam spacing in a waffle slab with a central opening and the effects of opening size, a non-linear static analysis was carried out using FEM software ANSYS 2015.Based on the construction of RC waffle slabs, this study offers a unique composite waffle slab comprised of orthogonal steel grillages and flat RC slab. It was found that lower grid beam spacing results in greater performance after studying various grid beam spacings.By comparing various opening sizes, it was shown that smaller openings should be used for better performance and larger load bearing ability.

ChinthaSanthosh et al.,(2016) stated**,** the G+5 building is taken into account, and both gravity and lateral (earthquake and wind) stresses are analyzed and designed for. And the flat slab is contrasted with this.In both zones, the grid slab with and without infills had less displacement than the flat slab with drop, but zone IV had more deflection than zone III. In zone IV, the flat slab with and without dips, with and without infills had a longer maximum time period than the grid slab, which had a shorter maximum time period. Structures without infills endure far longer than those with infills.Grid slab structures, as compared to flat slab with and without drop, have the largest base shear in both zones.

AnithuDev et al.,(2017) carried out study on methods of analysis. In the current study, Rankine'sGrashoff's technique, Timoshenko's plate theory and stiffness method are explored for their ability to analyze grid slab systems. The findings are compared.The foundation for the comparison is flexural properties, such as bending moments, shear forces, and deflection measured using various techniques. Additionally, they consist of the span-to-depth ratio, transverse beam spacing, thickness of the web, and thickness of the flange.The bending moment, shear force, and mid-span deflection produced in grid floor beams have been calculated using both traditional and numerical methods. The findings have been compared, and the software E-Tabs 2015 has been verified using the results. MS-EXCEL is used to do the cost analysis and determine the most cost-effective design.

Anitha. K et al.,(2017) examines how several characteristics affect the grid floor's economical transverse beam spacing. The mid span deflection produced in grid beams has been predicted using traditional and numerical methods, and the outcomes are compared.The ANSYS 12.0 software model is used to conduct the parametric investigation. The study's findings provide insight into the magnitude range of many characteristics that should be taken into account for grid floors to work at their best.

ShivnarayanMalviya et al.,(2020)demonstrates how a flat slab may be utilized successfully for a multistory construction. Due to the higher resisting moment capability of the slabs, waffle and ribbed may also be employed in high rise and tall structure construction.Compared to other slab types, the waffle slab construction has a higher load bearing ability, saves weight and materials, and has outstanding vibration control capabilities.

III. Objectives and Methodology

Research Objectives: The objectives of this study includes,

- To analyze waffle slab with RC peripheral beams and steel peripheral beams using ETABS 2016 and comparing the outcomes for factors such as grid beam spacing and depth.

Methodology:

1. To study the literature on effective spacing of grid beams in a grid floor frame.
2. Creating frame layouts by retaining the hall's width at 10 meters while extending the length suitably to raise the (L /B) ratio at intervals of 0.05 meters.
3. To determine the proper grid beam spacing (l/b), the width of the hall's grid beam spacing is held constant at 1.00 m, and the length of the hall's grid spacing is changed by splitting the length into equal segments. As a result, different Grid beam spacing ratios are achieved.
4. Models for various L/B ratios and l/b ratios are prepared using E-Tabs software by assigning material specification and gravity loads.
5. Analysis is performed using multiple grids with varied l/b ratios, and the fluctuation of the maximum bending moments in peripheral beams is examined in a variety of scenarios.

6. The depth of grid beams is the additional factor considered. The depth of grid beams is raised for halls with different L /B ratios, as stated in the table below, and the fluctuation of bending moment is analyzed.

Spacing of grid beams:

TableNo1: Halls having various L /B ratios and l /b ratios

Case No.	Hall sizes (in m)	L/B ratio	Spacing of grid beams considered (l/b) ratios
1	10.00x10.00	1	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
2	10.00x10.50	1.05	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
3	10.00x11.00	1.1	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
4	10.00x11.50	1.15	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
5	10.00x12.00	1.2	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
6	10.00x12.50	1.25	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
7	10.00x13.00	1.3	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
8	10.00x13.50	1.35	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
9	10.00x14.00	1.4	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
10	10.00x14.50	1.45	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
11	10.00x15.00	1.5	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0
12	10.00x16.00	1.6	1.0, 1.1, 1.2,1.3,1.4, 1.5,1.6,1.7,1.8,1.9,2.0

The study is done for multiple grids with varied l/b ratios, with the grid beam measuring 230x550mm and the periphery beam measuring 300x750mm. For such circumstances, the fluctuation of the maximum bending moment is examined.

Depth of grid beams:
The second component is the grid beam depth. The depth of the grid beams is modified by 0.05m while keeping the depth of the peripheral beams 300x750mm, fixed in order to examine the variation of the grid beams. This is done for the various L /B ratios of the halls.

Description of Composite Grid slab:

TableNo2: Material properties

Sl. No.	MATERIAL SPECIFICATIONS	
1	Grade of concrete	F_{ck} = 30 N/mm^2
2	Grade of steel (rebar)	F_y = 500 N/mm^2
3	Grade of steel (peripheral beam)	F_y = 250 N/mm^2
4	Density of concrete	Y= 25KN/m^2

TableNo3: Structural details and sectional properties

Sl. No.	SPECIFICATIONS	
1	Story Height	3 m
2	No. Of Stories	2

3	Plinth Level	1.5 m
4	Slab Thickness	100 mm
5	Size Of Steel Peripheral Beam	300x750mm
6	Size Of RC Grid Beam	230x550mm
7	Size Of RC Column	450x750mm

TableNo4: Gravity Load condition

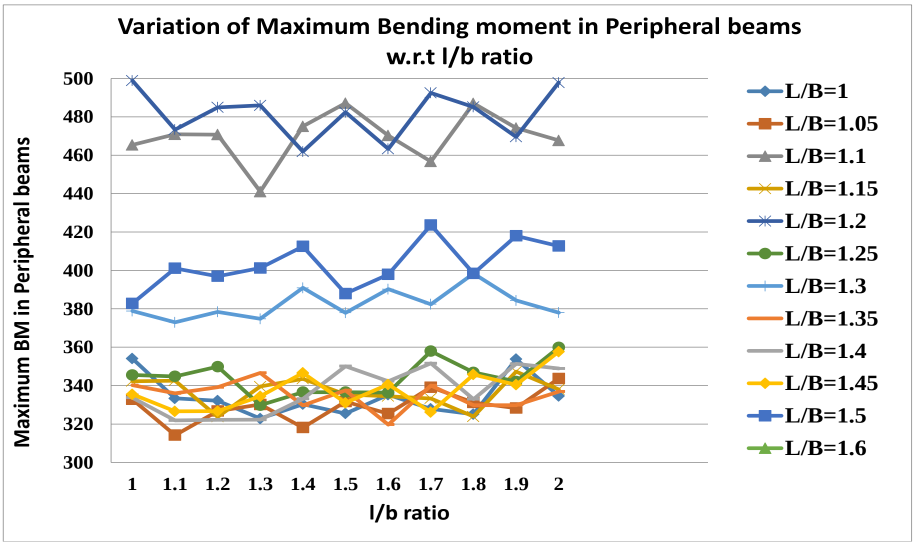
GRAVITY LOADS	
Dead Load	Default Values Taken By E-Tabs
Live Load	3 kN/ m^2
Wall Load	9.7 kN/ m^2
Partition Wall Load	4.5 kN/ m^2
Floor Finish	1 kN/ m^2
Parapet Wall Load	4.5 kN/ m^2

IV. Results

Spacing of grid beams:

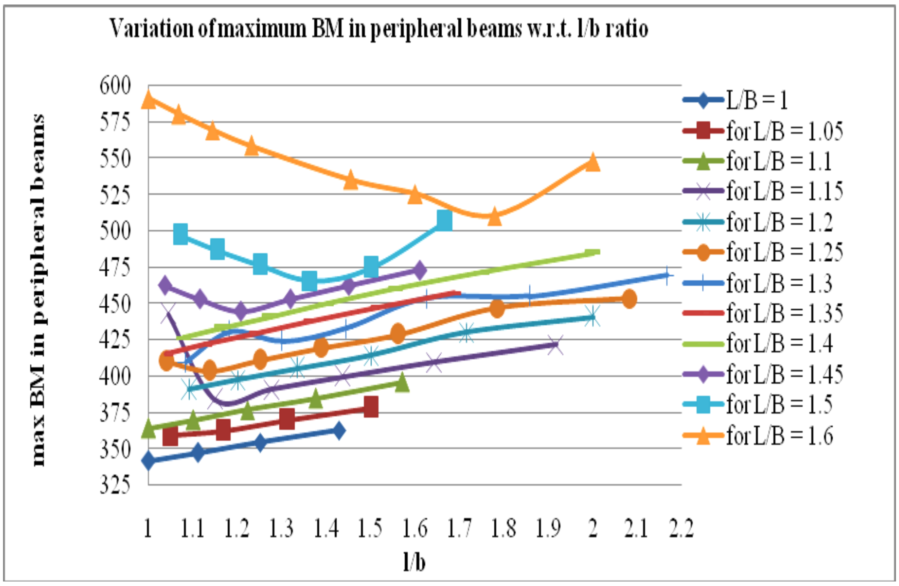
Following analysis of sample Grids, it is shown that the bending moments in steel Peripheral Beams are not significantly impacted by the spacing of Grid beams. For a given L /B ratio, it is discovered that the maximum bending moment in the peripheral beams varies nonlinearly with increasing grid beam spacing. The outcomes are listed as follows, and they are contrasted with the outcomes for RC grid beams.

The maximum bending moment in steel periphery beams varies as the l/b ratio of grid beam spacing increases in Graph No. 1. From the graph it is observed that, for a given hall size with different l/b ratios the variation in bending moment slightly increases. When compared to other ratios, the maximum bending moment in peripheral beams increases at a faster pace for L/B ratios of 1.1, 1.2, 1.3, and 1.5.



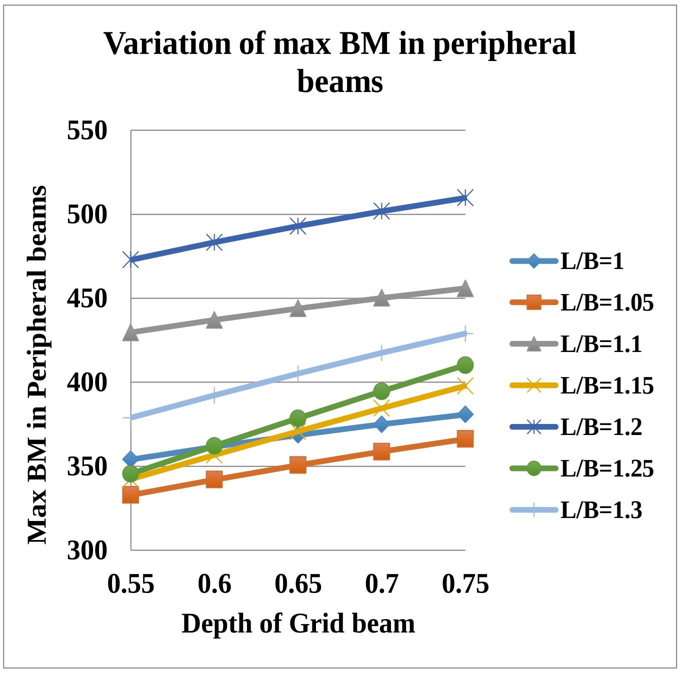
GraphNo.1 MaximumBendingMomentsin Steel Peripheralbeamsv/sl/b

Graph No. 2 shows the fluctuation of the maximum bending moment in RC peripheral beams with respect to increasing l/b ratio of grid beam spacing for a given ratio of the hall dimensions L/B. For a given L/B ratio, it is demonstrated that the maximum bending moment in the peripheral beams increases with increasing grid beam spacing. For lower values of L/B ratio up to 1.1, initial rates of increase in maximum bending moment in peripheral beams are essentially identical. The linearity of the maximum bending moment in peripheral beams varies when the L/B ratio rises more than 1.1. For L/B ratios larger than 1.2, it is demonstrated that the maximum bending moment fluctuations in peripheral beams are non-linear. For L/B>1.45, it is observed that the maximum bending moment in beams first decreases up to a certain point, then increases as the L/B ratio rises beyond that point. It suggests that for L/B > 1.45, the bending moments can be reduced.



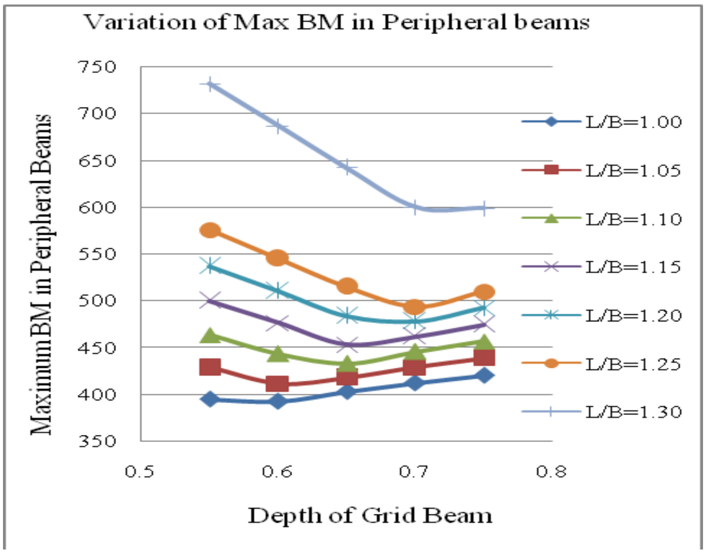
GraphNo.2 MaximumBendingMomentsin RC Peripheralbeamsv/sl/b(fromEffect of Spacing of Grid Beam and its Depth onPeripheralbeamsin Grid FloorFrame by Prof.Dr.S.A.Halkude and S.V.Mahamuni)

Depth of grid beams:
Graph no 3 shows the values of bending moment obtained from varying depths of grid beams for halls with different L/B ratios.



GraphNo.3 MaximumBendingMomentsin Steel Peripheralbeamsv/sDepth of grid beams

The maximum bending moment in a steel peripheral beam for a particular depth of grid beams continues to increase, as can be shown in graph no. 3, according to the observation. The maximum bending moment is lower in halls with L/B ratios under 1.05 than it is for halls with L/B ratios over 1.2.



GraphNo.4 MaximumBendingMomentsin RC Peripheralbeamsv/sDepth of grid beams (fromEffect of Spacing of Grid Beam and its Depth onPeripheralbeamsin Grid Floor Frame by Prof.Dr.S.A.Halkude and S.V.Mahamuni)

According to graph no 4 as the depth of the grid beams rises, the maximum bending moment in the perimeter beam gradually decreases up to a particular depth. After reaching a minimal value, it continues to rise with increasing Grid beam depth. Similar fluctuation is seen in halls with different L/B ratios.

V. Conclusion

a. A hall size with an L/B ratio of 1.3 and the smallest grid beam spacing shows the best bending moment in steel periphery beams.
b. The most cost-effective grids are square ones.
c. For halls with RC peripheral beams, bending moments can be reduced by limiting the ratio of hall dimensions to grid beam spacing at a minimum of 1.4.
d. For a fixed depth of steel Peripheral beams, the maximum bending moment can be reduced by decreasing the depth of Grid beams. For L /B ratios less than 1.2, the maximum bending moment in peripheral beams may be attained.
e. The maximum bending moment in RC peripheral beams in halls grows with increasing L/B ratio for the specified depth of peripheral beams.

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