International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2584
Volume 3, Issue 05, May-2017

PARAMETRIC STUDY OF CLOSED GRID FLOOR SYSTEM

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***Abstract*— Generally for grid slab analysis, it is assumed that although slab is directly supported on beam-grid, bending of beam-grid has no effect on slab. An attempt has been made to consider the effect of same by considering actual behavior. Different parameters like slab depth, depth of grid-beam and spacing of grid-beam are consider for study. Charts are prepared for slab stresses and grid-beam stresses at top surface and bottom surface. The parametric study is done by ABAQUS 6.14 software.**

***Keywords*— Stresses at top surface and bottom surfaces of slab and grid beams.**

I. INTRODUCTION

The floor resting on the beams, which are running in two perpendicular directions is known as Grid Floor. Grid floors are used to cover a large column free area. The Grid structure is monolithic in nature and is stiffer. Grid structure used to cover column free large area. A.J. Mehetre and Navale B. R. [2] presented analysis of grid floor by sequential and immediate pre-stressing of grid. Anant. R. Kukreti and Yatendra Rajapaksa[3] had developed energy based procedure for analysis of grid slab. Stijn Matthys and Luc Taerwe[4] used FRP to increase strength of the grid slab. Jianguo Nie, Xiaowei Ma, A. M. ASCE, and Lingyan Wen[5] had shown that steel-concrete composite waffle slab exhibits excellent ductility and load-bearing capacity. Muhammed Yoosaf. K. T., Ramadass S and Jayasree Ramanujan[6] had derived relationship for the mid span deflection and bending moments and spacing of the transverse beams in grid floor.

II. ANALYTICAL MODEL STUDY

From the references, it can be observed that most of the analysis is performed by considering the neutral plane of the slab and neutral axis of the beam are always coincide. To take the advantage of eccentricity between neutral axis of the grid-beam and neutral plane of slab a study is done. For the study of slab-beam grid floor, a model is analyzed in ABAQUS-6.14 Software. The dimensions for the plan of the grid slab floor is as shown in the figure.1.

Beam size=0.4m*1.0m*12.4m, slab size=12.4*12.4m*0.1m, bay size=4.0m, M-20 grade concrete, $E_{concrete}$= 22360.67977 N/mm^2, µ=0.2, $\rho_{concrete}$=25KN/m^3, Total load=1.5(DL+LL) and LL= 5 KN/m^2 on slab and boundary condition is fixed.

In the 1st case as shown in fig-2, the neutral axis of beam-grid & neutral plane of slab are made coinciding. The structure was then analyzed & results obtained are shown in chart.

In the 2nd case as shown in fig-3, the slab is made to rest on the beam-grid, which will produce actual site condition. The structure was then analyzed & results obtained are shown in chart.

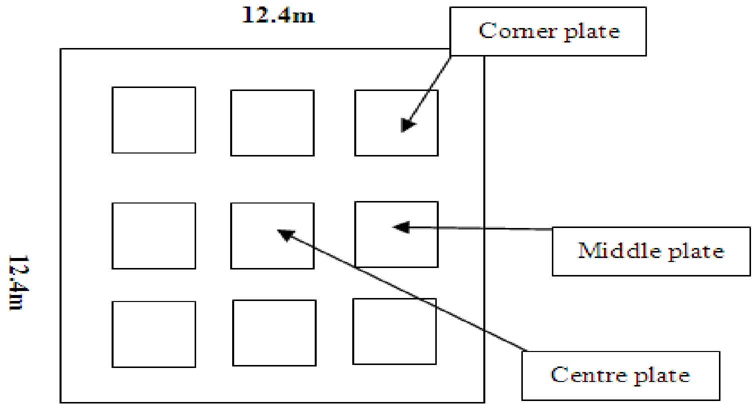

Fig-1: Grid floor layout

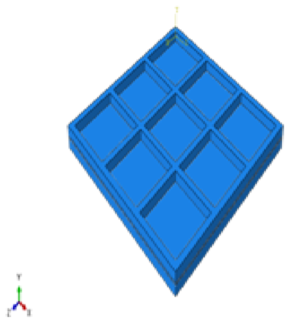

Fig-2: Slab and grid coincide

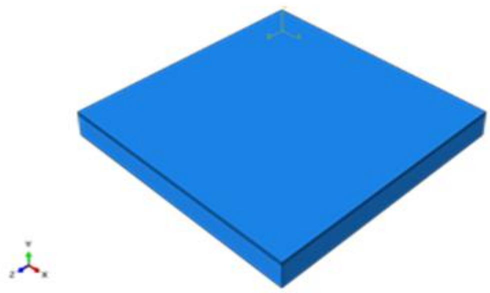

Fig-3: Slab over grid

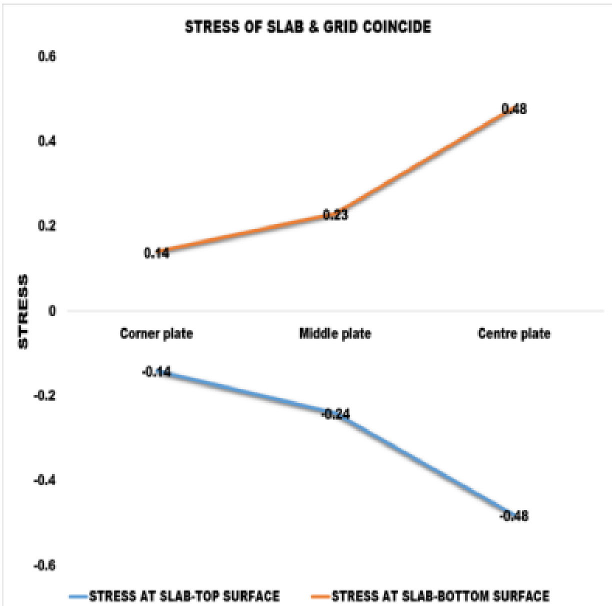

CHART-1: - STRESS OF SLAB & GRID COINCIDE MODEL

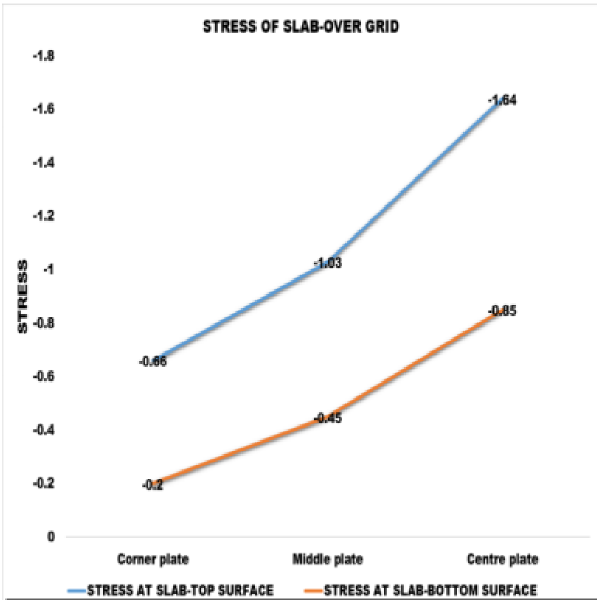

CHART-2: - STRESS OF SLAB OVER GRID MODEL

Based on result of chart-1, it can be seen that compressive stress at slab top surface, whereas tensile stress at slab bottom surface and they are almost same, which indicate that neutral plane of slab and neutral axis of beam-grid are not eccentric. Based on result of chart-2, it can be seen that compressive stresses in slab at slab top and bottom surfaces but they are not same, which is based on actual site condition i.e. neutral plane of slab and neutral axis of beam-grid are eccentric. That shows that bending of beam-grid has no effect on slab.

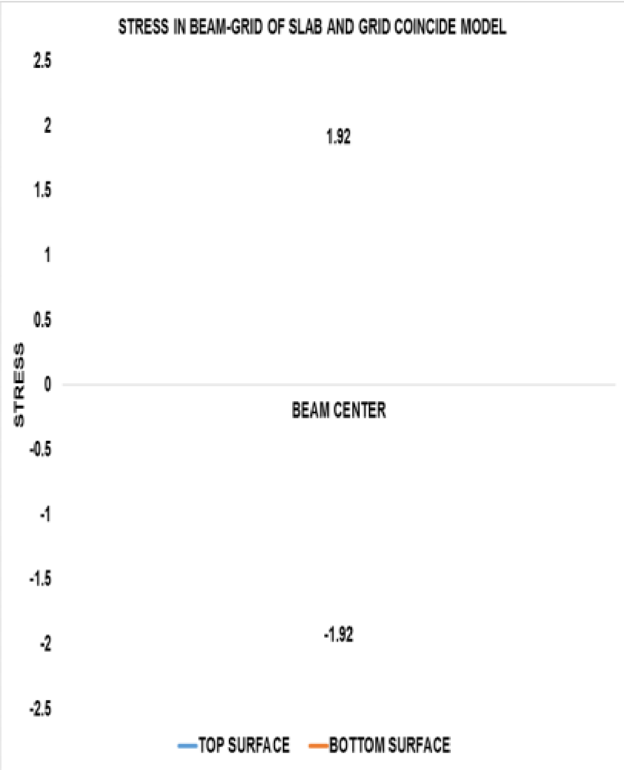

CHART-3: - STRESSES IN BEAM-GRID OF SLAB AND GRID COINCIDE OMDEL

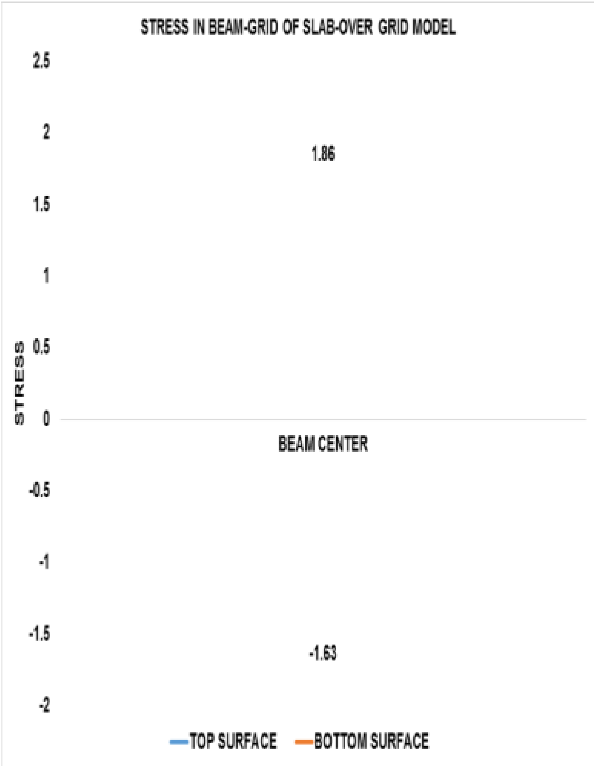

CHART-4: - STRESSES IN BEAM-GRID OF SLAB OVER GRID MODEL

Base on result of chart-3, it can be seen that compressive stress at beam top surface and tensile stress at beam bottom surface are exactly same, which indicate that in slab and grid coincide model beam-grid is subjected to bending only.
Based on result of chart-4, it can be seen that compressive stress at beam top surface and tensile stress at beam bottom surface are not same. The tensile stress is more than compressive stress which indicate that in slab-over grid model beam-grid is subjected to bending as well as axial tension.
Based on the result of slab-over grid model, I further spanned my study on different models which are described as below.

III. MODEL DESCRIPTION

1) 3X3 beam-grid: -
Slab length- 20.8m
Slab depth- 0.180m, 0.190m, 0.200m
Grid beam depth- 1.5m, 1.6m, 1.7m
C/C distance between beam- 6.8m
2) 4X4 beam-grid: -
Slab length- 21.2m
Slab depth- 0.140m, 0.150m, 0.160m
Grid beam depth- 1.3m, 1.4m 1.5m, 1.6m
C/C distance between beam- 5.2m
3) 5X5 beam-grid: -
Slab length- 20.4m
Slab depth- 0.115m, 0.125m, 0.135m

Grid beam depth- 1.1m, 1.2m, 1.3m, 1.4m, 1.5m
C/C distance between beam- 4.0m

4) 6X6 beam-grid: -

Slab length- 22.0m
Slab depth- 0.08m, 0.09m, 0.100m
Grid beam depth- 0.9m,1.0m, 1.1m, 1.2m, 1.3m, 1.4m
C/C distance between beam- 3.6m

5) 7X7 beam-grid: -

Slab length- 22.8m
Slab depth- 0.08m, 0.09m, 0.100m
Grid beam depth- 0.7m, 0.8m, 0.9m, 1.1m, 1.2m, 1.3m
C/C distance between beam- 3.2m

- Beam width is 0.4m, M-20 grade concrete, $E_{concrete}$= 22360.67977 N/mm^2, μ=0.2, $\rho_{concrete}$=25KN/m^3 for all model.
- Total Load = 1.5(D. L+L.L)
- L.L is 5KN/m^2
- Results of stresses at top surface and bottom surface of slab and beam-grid are shown by charts.

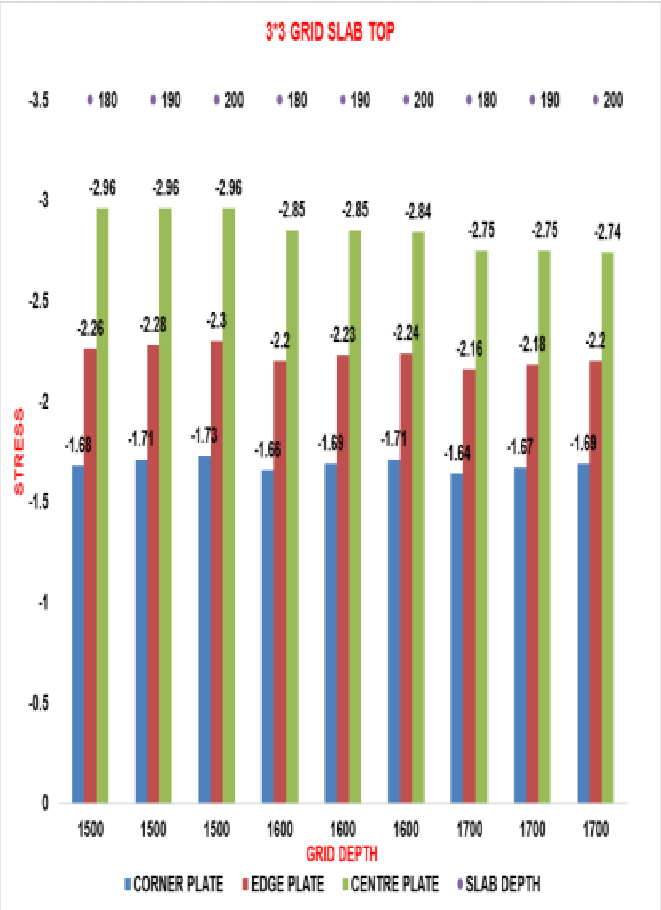

CHART-5: - STRESSES OF 3X3 GRID SLAB TOP SURFACE

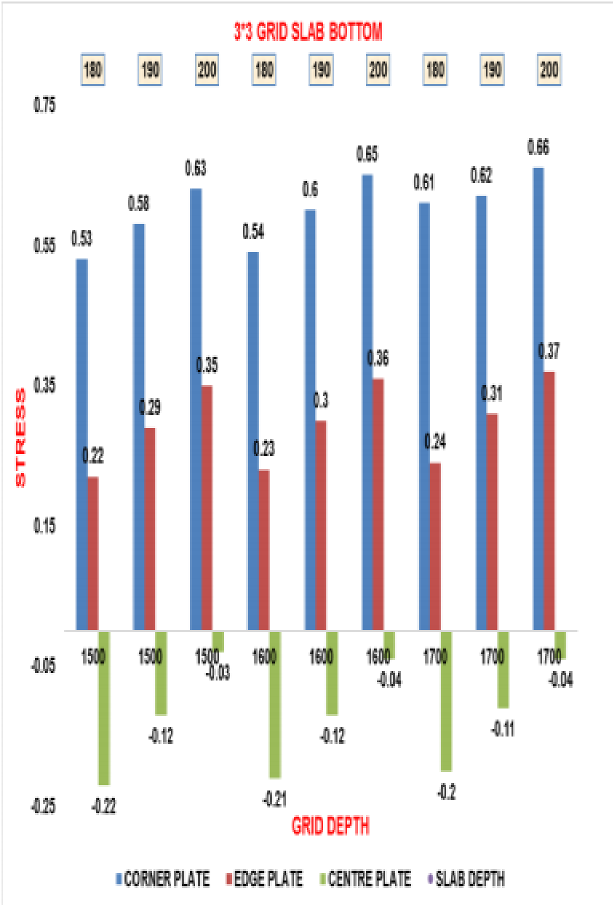

CHART-6: - STRESSES OF 3X3 GRID SLAB BOTTOM SURFACE

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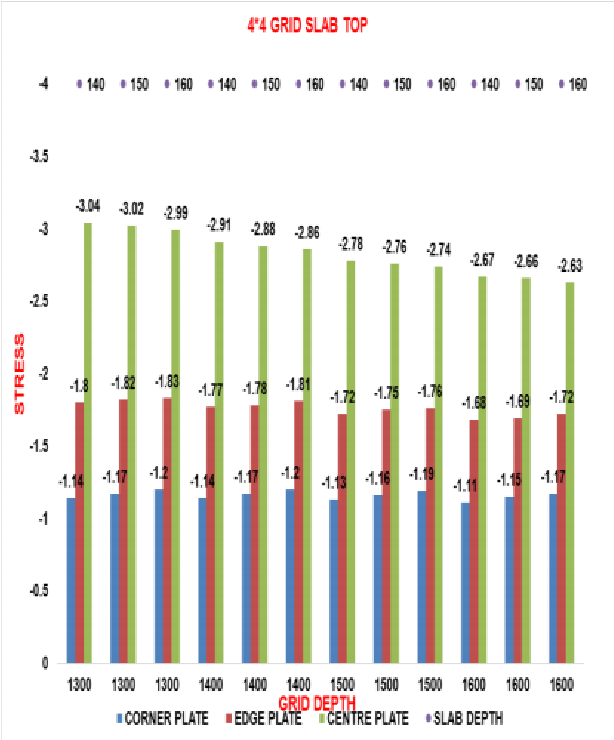

CHART-7: - STRESSES OF 4X4 GRID SLAB TOP SURFACE

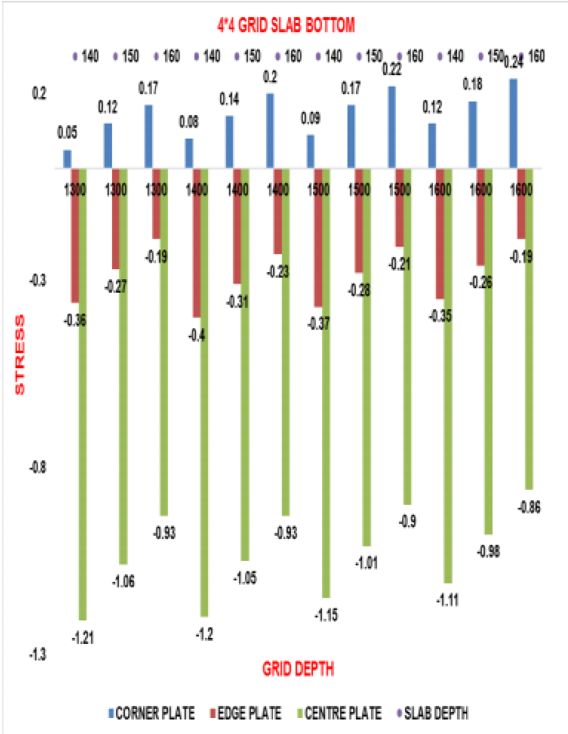

CHART-8: - STRESSES OF 4X4 GRID SLAB BOTTOM SURFACE

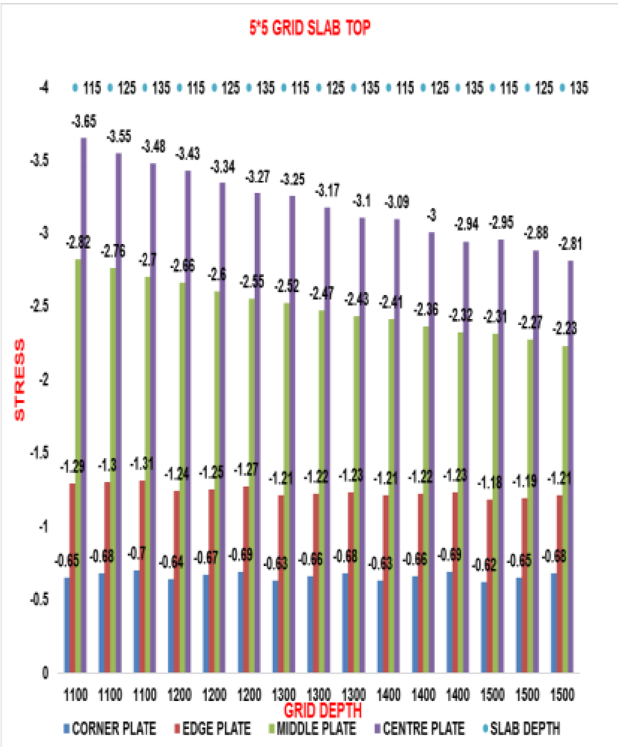

CHART-9: - STRESSES OF 5X5 GRID SLAB TOP SURFACE

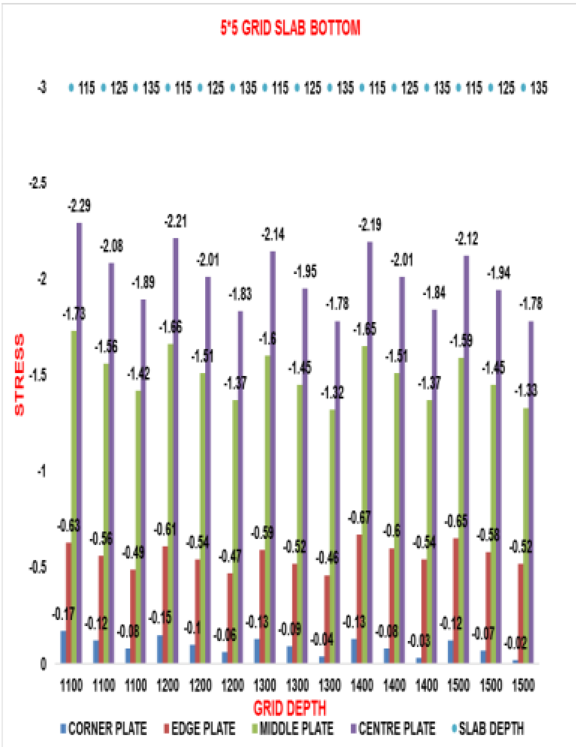

CHART-10: - STRESSES OF 5X5 GRID SLAB BOTTOM SURFACE

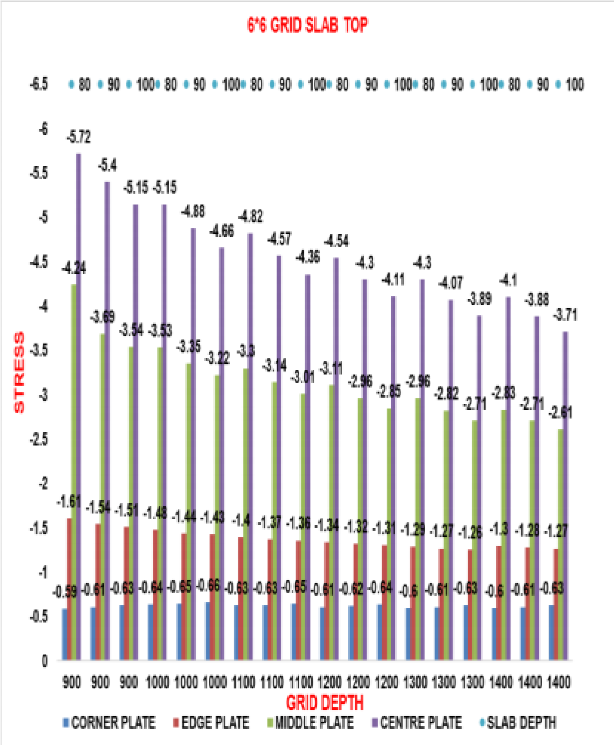

CHART-11: - STRESSES OF 6X6 GRID SLAB TOP SURFACE

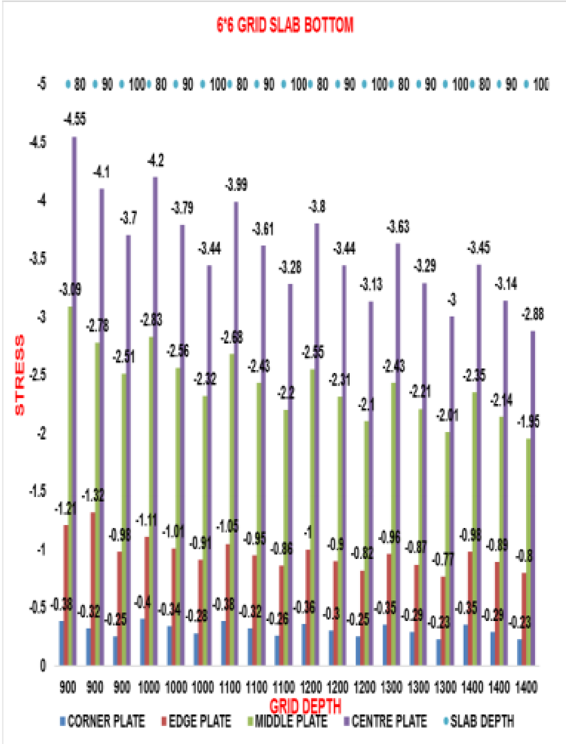

CHART-12: - STRESSES OF 6X6 GRID SLAB BOTTOM SURFACE

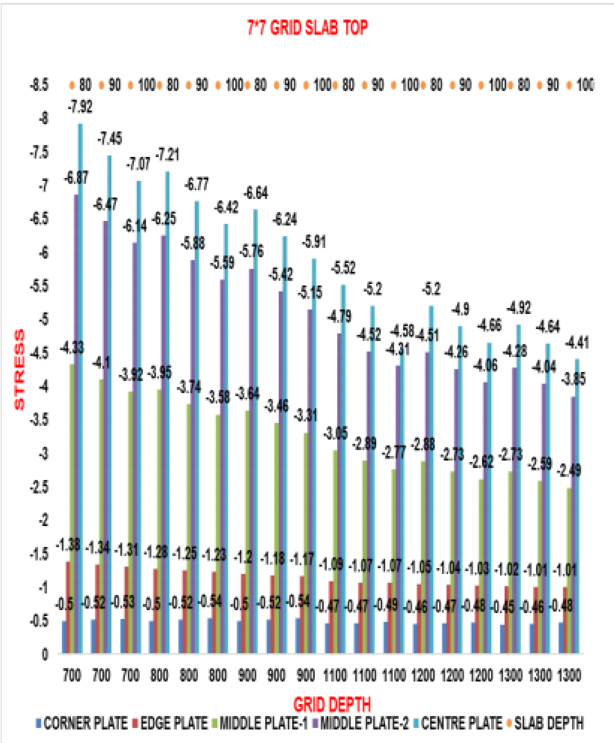

CHART-13: - STRESSES OF 7X7 GRID SLAB TOP SURFACE

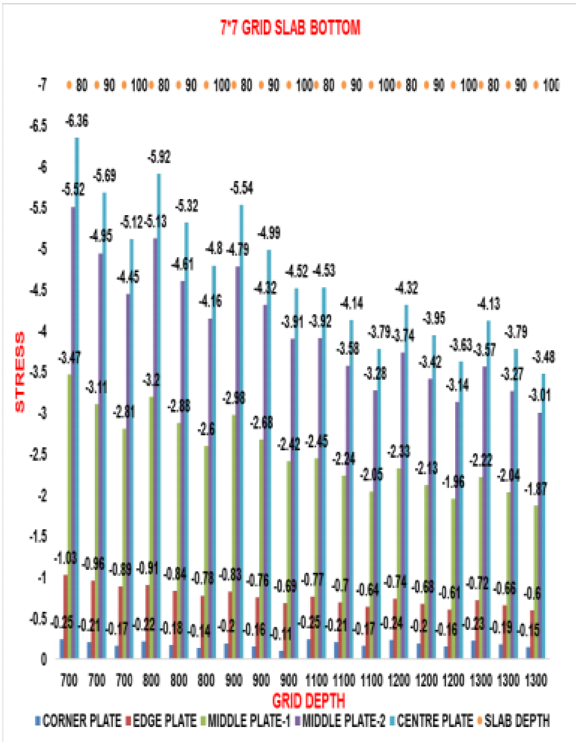

CHART-14: - STRESSES OF 7X7 GRID SLAB BOTTOM SURFACE

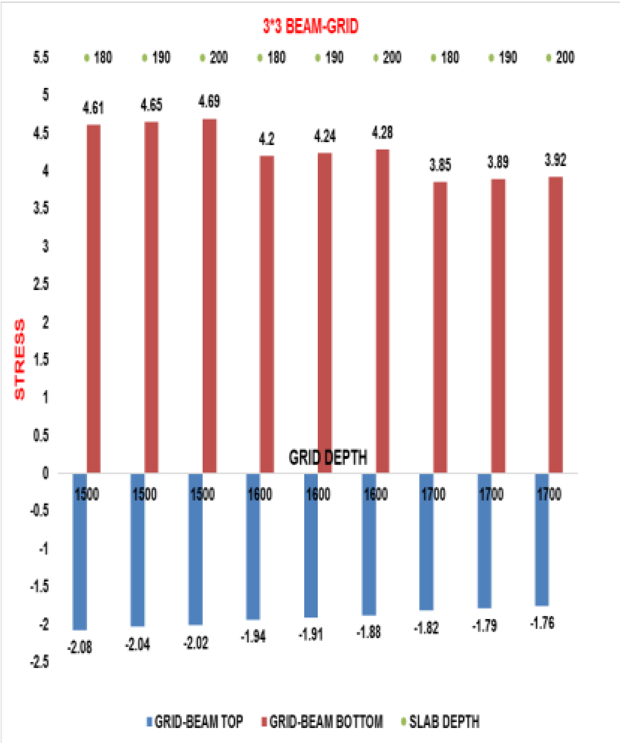

CHART-15: - STRESSES OF 3X3 BEAM-GRID

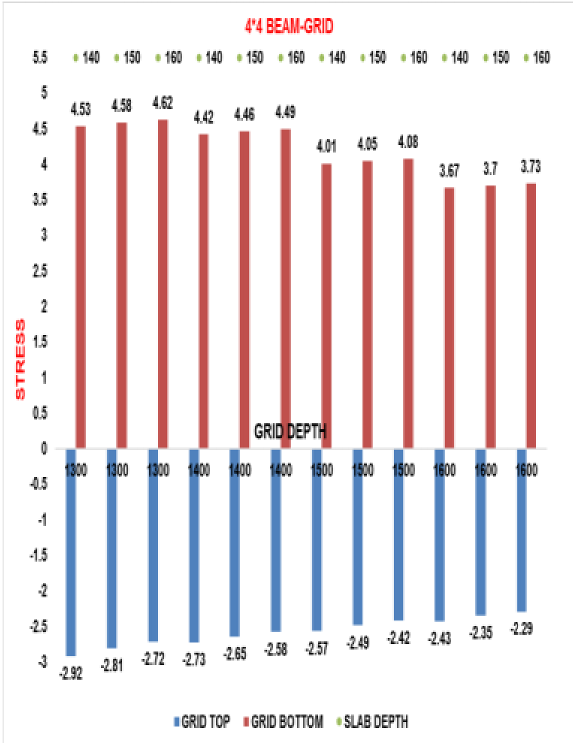

CHART-16: - STRESSES OF 4X4 BEAM-GRID

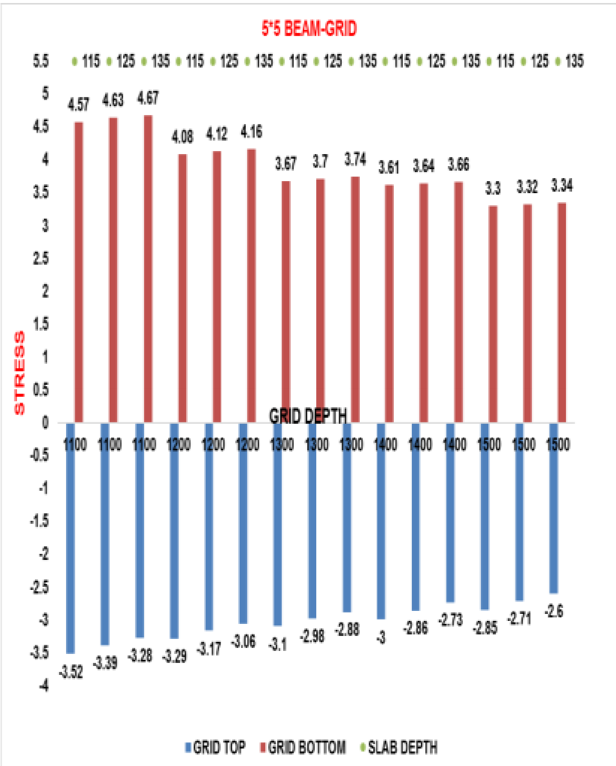

CHART-17: - STRESSES OF 5X5 BEAM-GRID

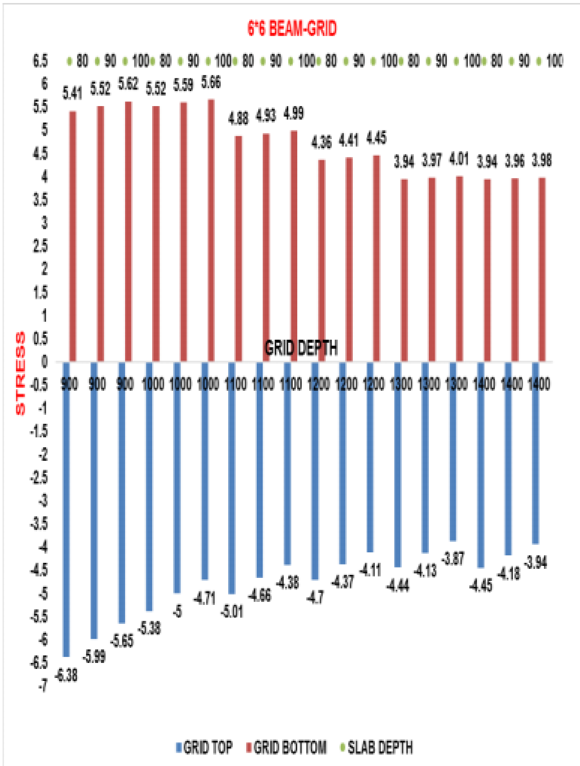

CHART-18: - STRESSES OF 6X6 BEAM-GRID

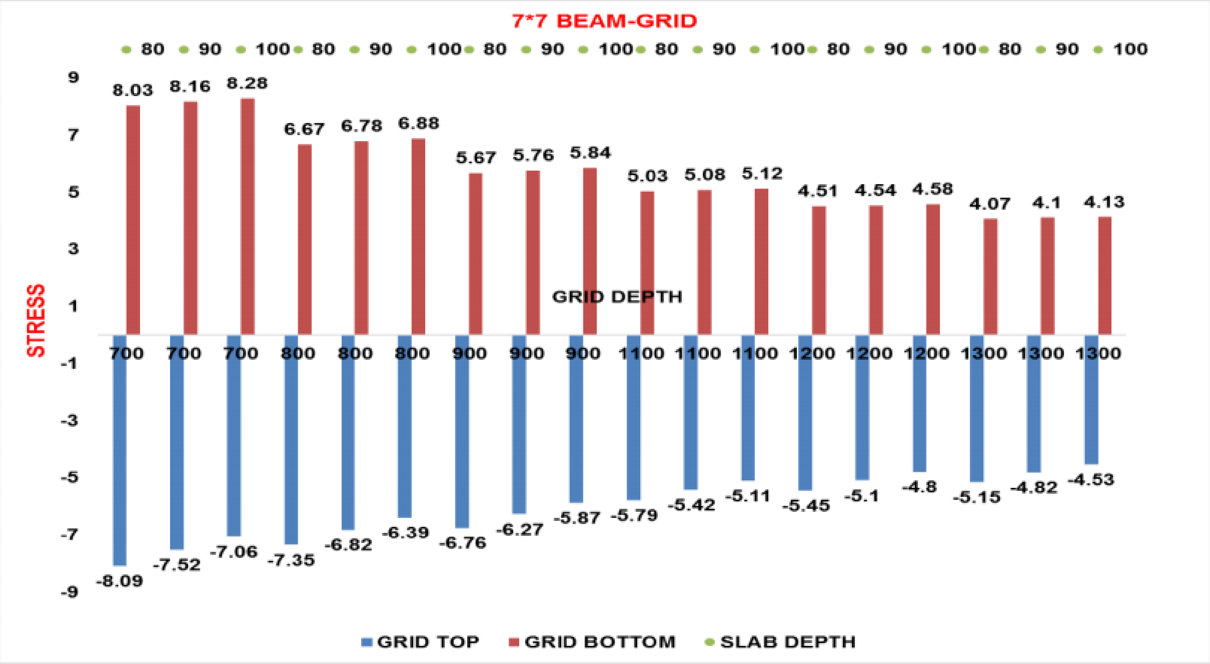

CHART-19: - STRESSES OF 7X7 BEAM-GRID

IV. CONCLUSION

Looking at the scenario following conclusions are reached;

- For 3 X 3 grids, it can be seen that when neutral axis of beam and neutral plane of slab are coinciding the stresses in slab are compressive at top and tensile at bottom surfaces and they are almost same indicating that the slabs are in pure bending and planar actions (in plane stresses) are not present in the slabs.
- For 3 X 3 grids, it can be observed that when neutral axis of beam and neutral plane of slab are not coinciding the compressive stresses in slab at top and tensile stresses at bottom surfaces for all the slabs except central panel. But they are not equal. The compressive stress at top is more than tensile stress at bottom indicating that the slab exhibits bending as well as planar compression.
- For higher no of panels except 4 X 4 model, it can be observed that the slabs are exhibiting only compressive stresses at top and bottom surfaces. As well as in 4 X 4 model, the central and mid-edge panels exhibit the same behavior, while for the corner panels bottom surface under goes tension. Hence, for higher grid model that is 5 X 5 and above tension is not present in the slab, there is no need of design for the tension reinforcement in the slab.
- For all grid beams, stresses in beam are compressive at top and tensile at bottom surfaces. The compressive stress is less than the tensile stress indicating that the beams are in bending as well as axial tension state.

V. REFERENCES

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