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 bending moment, planar forces and grid-beam bending moment, axial forces. The parametric study is done by ABAQUS 6.14 software.*

Key Words: Grid floor, waffle slab, Stress values

1. 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.

Akash R. Patel and Atul N. Desai[7] analysed grid floor using abaqus in which a slab was divided into number of panels and change in stress values was studied.

2. RESEARCH GAP

Past researches have focused on stress values and have compared various methods of analysis. Akash R. Patel and Atul N. Desai tried to analyze floor considering floor and to be different part and then providing boundary conditions and interaction properties. This paper will try to analyse floor as a monolithic structure and compare various results. This paper will aim to compare moment as well as axial load.

3. MODEL DESCRIPTION

Different panel sizes of 3600x3600, 4000x4000, 4400x4400 and 4800x4800 having beam size of 400 mm have been considered for analysis. 3 beam depths have been considered to be varying from L/17 to L/15. Also 3 different slab size of 80 mm, 90 mm and 100 mm have been considered.

Data mentioned below have been considered for parametric study of models:

Beam width=0.4m , M -20 grade concrete,
E concrete= 22360.67977 N/mm^2, μ=0.2, ρ concrete=25KN/m^3,

Total load=1.5(DL+LL) and LL= 5 KN/m^2 on slab and

Boundary condition is considered to be fixed on all edges.

Results for 4800x4800 mm bay have been discussed in this paper. Similar trend was observed for 3600x3600 mm , 4000x4000 mm and 4400x4400 mm bay size.

Number of models prepared as listed below and then their results were plotted on chart to facilitate result comparisons:

Panel size (mm)	Bay arrangement	Beam size (mm)	Slab thickness (mm)
3600x3600	3x3	730,780,830	80,90,100
	4x4	970,1030,1090	80,90,100
	5x5	1200,1280,1360	80,90,100
	6x6	1440,1530,1620	80,90,100
4000x4000	3x3	800,850,900	80,90,100
	4x4	1060,1130,1200	80,90,100
	5x5	1320,1400,1490	80,90,100
	6x6	1580,1680,1780	80,90,100
4400x4400	3x3	880,930,980	80,90,100
	4x4	1160,1230,1300	80,90,100
	5x5	1440,1530,1620	80,90,100
	6x6	1720,1830,1940	80,90,100
4800x4800	3x3	950,1000,1050	80,90,100
	4x4	1250,1330,1410	80,90,100
	5x5	1560,1660,1760	80,90,100
	6x6	1860,1980,2100	80,90,100

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4. RESEARCH METHODOLOGY

For obtaining results, stress values of slab and grid on top and bottom faces were noted down. Then moments were calculated using formula obtained from theory of plates:

$$F = \frac{\sigma_{top} + \sigma_{bottom}}{2} \times t$$

$$M = \sigma_{diff} . \frac{t^2}{6}$$

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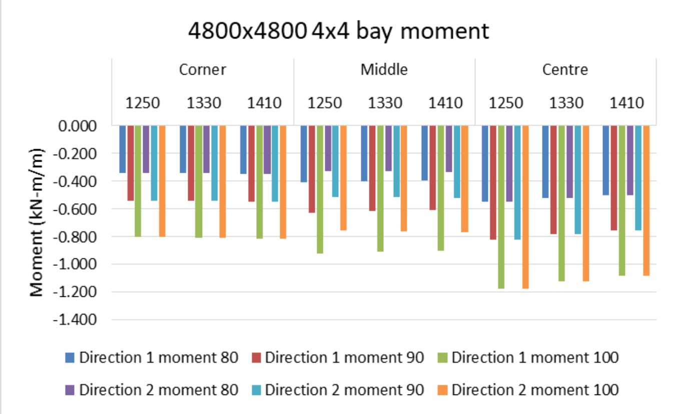
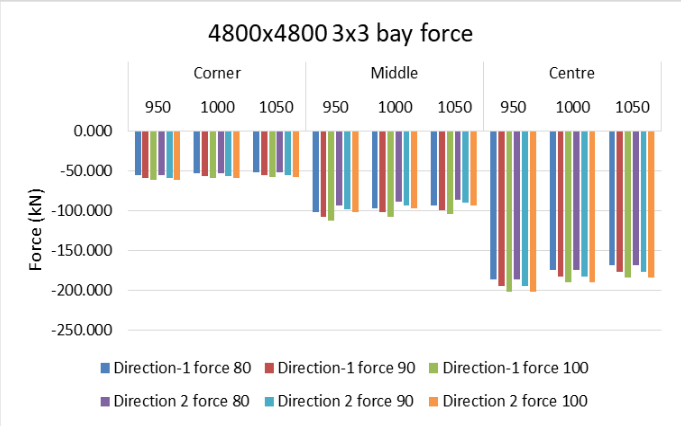
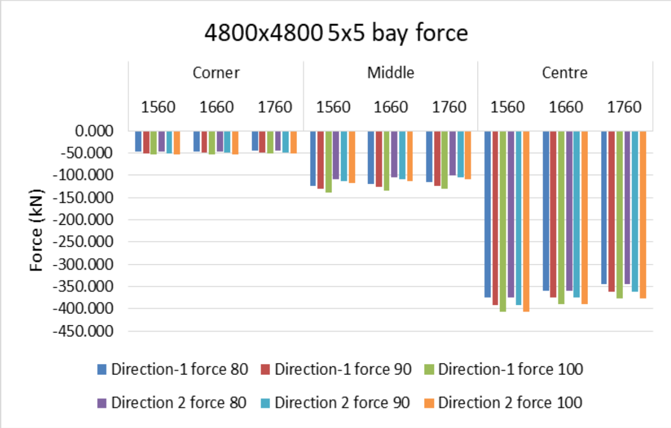
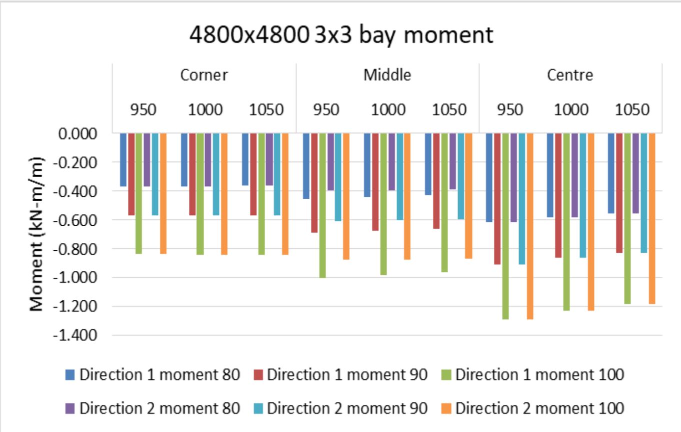
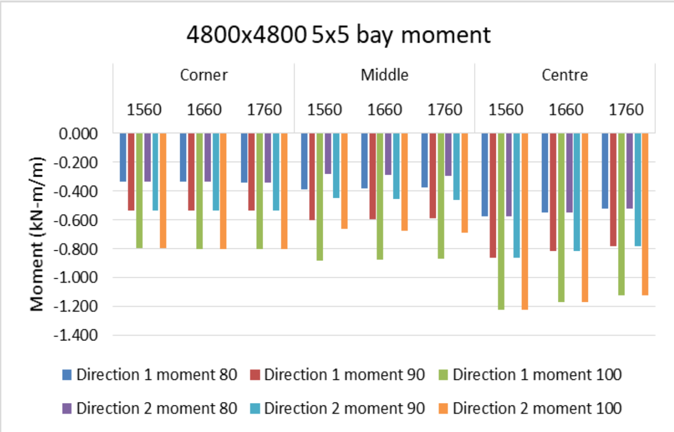
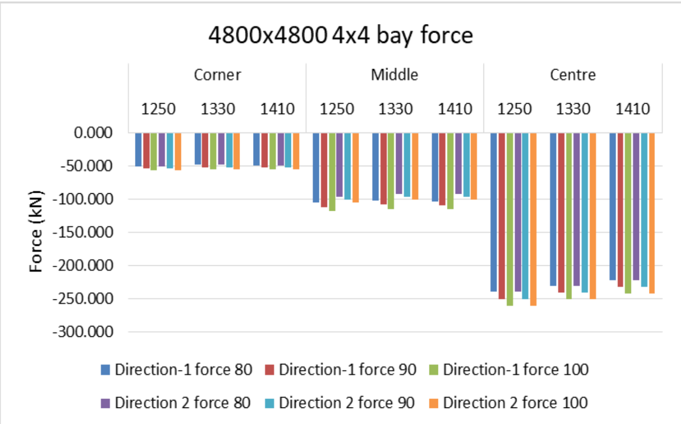


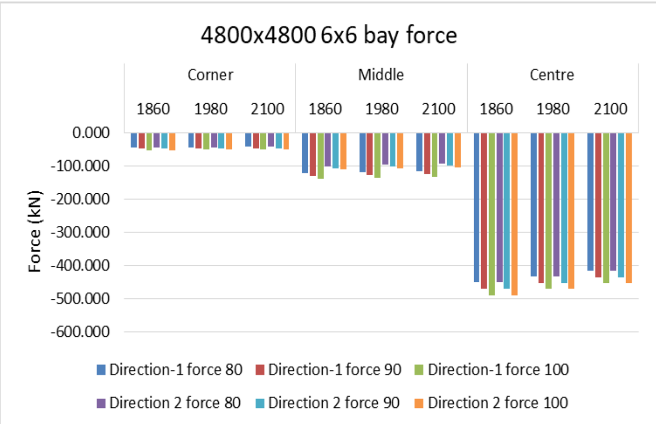


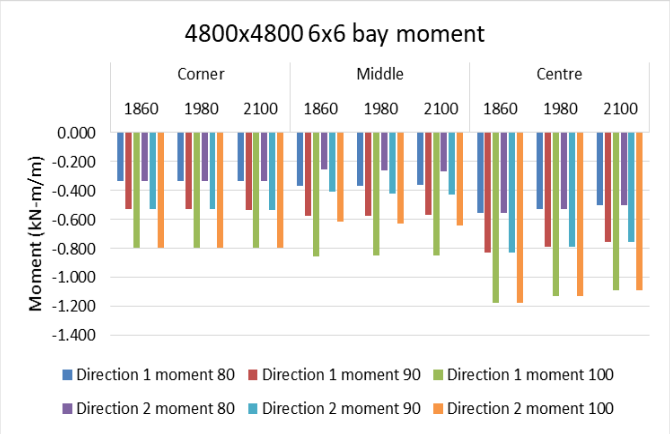


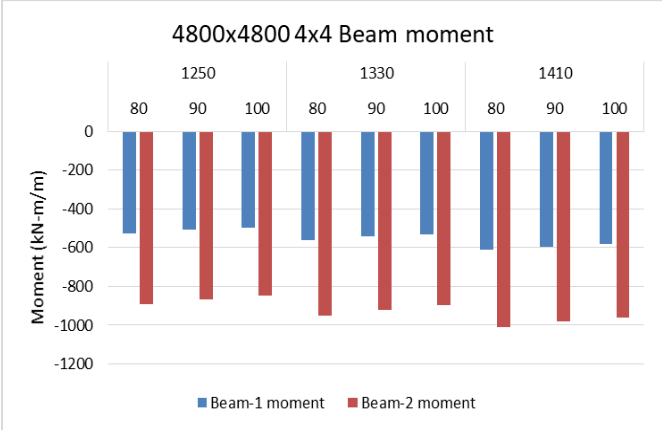


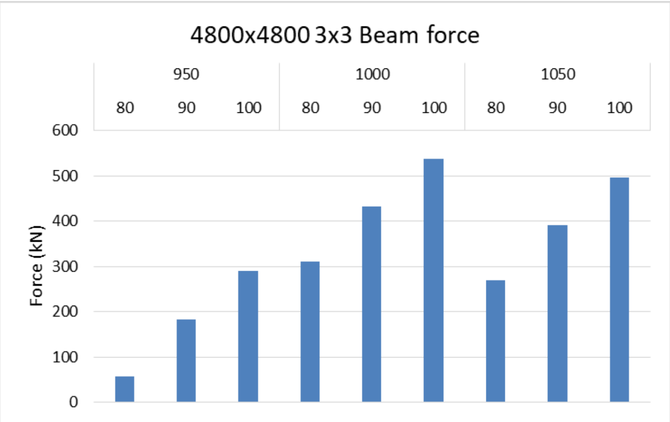


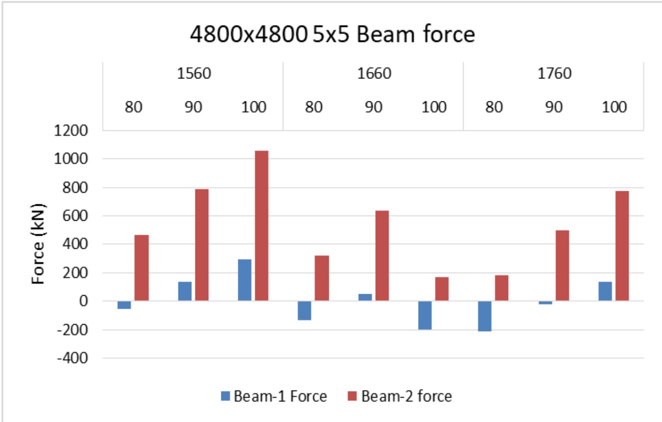


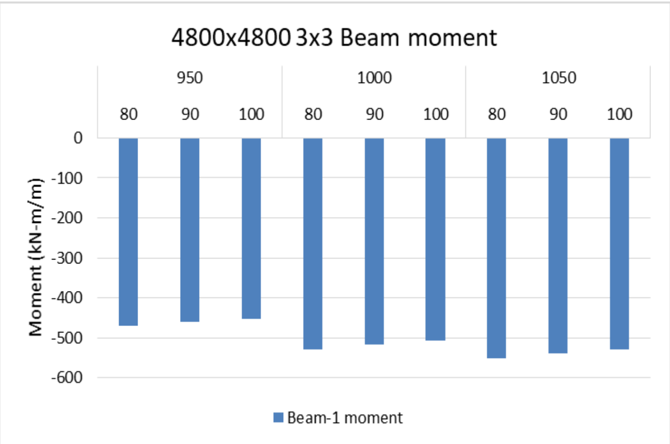


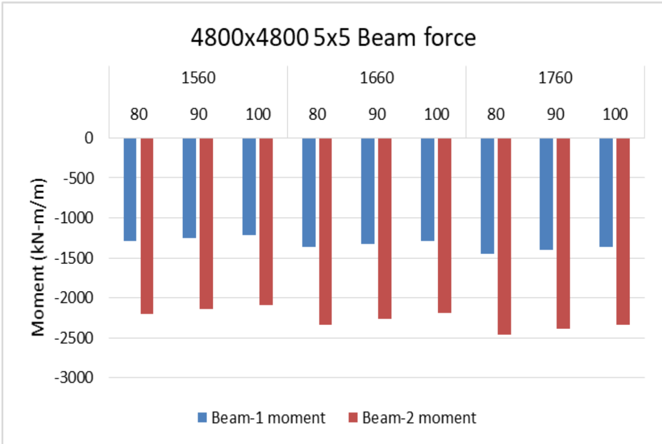

4800x4800 6x6 bay moment
Corner
Middle
Centre
1860
1980
2100
Moment (kN-m/m)
0.000
-0.200
-0.400
-0.600
-0.800
-1.000
-1.200
-1.400
Direction 1 moment 80
Direction 1 moment 90
Direction 1 moment 100
Direction 2 moment 80
Direction 2 moment 90
Direction 2 moment 100

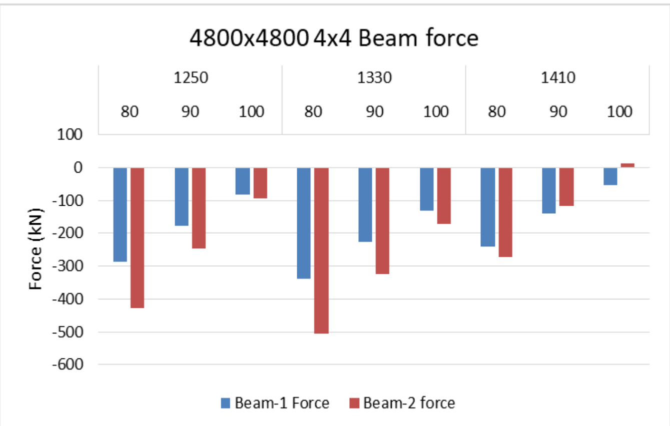

4800x4800 4x4 Beam moment
1250
1330
1410
80
90
100
Moment (kN-m/m)
0
-200
-400
-600
-800
-1000
-1200
Beam-1 moment
Beam-2 moment

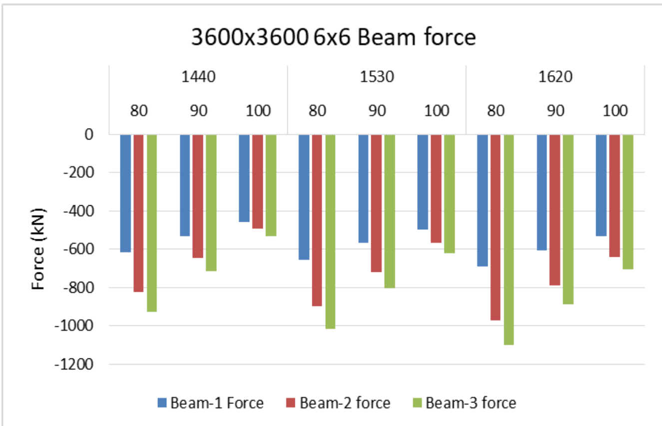

4800x4800 3x3 Beam force
950
1000
1050
80
90
100
Force (kN)
600
500
400
300
200
100
0

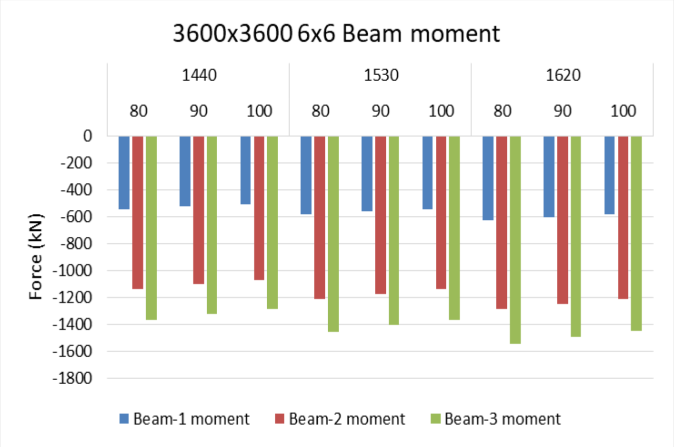

4800x4800 5x5 Beam force
1560
1660
1760
80
90
100
Force (kN)
1200
1000
800
600
400
200
0
-200
-400
Beam-1 Force
Beam-2 force


4800x4800 3x3 Beam moment
950
1000
1050
80
90
100
Moment (kN-m/m)
0
-100
-200
-300
-400
-500
-600
Beam-1 moment


4800x4800 5x5 Beam force
1560
1660
1760
80
90
100
Moment (kN-m/m)
0
-500
-1000
-1500
-2000
-2500
-3000
Beam-1 moment
Beam-2 moment


4800x4800 4x4 Beam force
1250
1330
1410
80
90
100
Force (kN)
100
0
-100
-200
-300
-400
-500
-600
Beam-1 Force
Beam-2 force


3600x3600 6x6 Beam force
1440
1530
1620
80
90
100
Force (kN)
0
-200
-400
-600
-800
-1000
-1200
Beam-1 Force
Beam-2 force
Beam-3 force



CONCLUSIONS

1. Axial force and bending moment values in slab increase with increase in slab thickness.
2. Gradual decrease in axial force and moment is observed in slab with increase in beam depth.
3. In slab, axial forces and moment in corner panel decreases with increase in number of bays
4. In slab, axial forces and moment, in central plate increases with increase in number of bays.
5. Non-linear change in moment is observed with increase in number of bays for a central plate
6. Beam goes from compression to tension with increase in slab thickness.
7. For studied number of bays, it was observed that beam was found to remain in compression even with increase in slab thickness.
8. Due to boundary conditions considered to be rigid on edge of slab, beam was found to remain compression.
9. On considering simply supported slab i.e. one edge simply supported, it was found that same beam undergoes tension with change in boundary conditions.

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BIOGRAPHIES

ViveK B. Kothari is a student of structural engineering department in BVM engineering college.

Atul N. Desai is Associate professor in BVM Engineering college having vast experience of more than 30 years in teaching field and guided more than 40+ master thesis

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