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Effect of Differential settlement of foundation on RCC Building using Staad- Pro

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Abstract – *Differential settlement is primary aspect of any building design. It is well known that settlement may occur in the area where soil having low BC. Foundation gets settled due to load acting on structure, calamity, consolidation, nature of soil ground water table fluctuation, forces. Even small amount of differential settlement can cause redistribution of forces in superstructure. In this paper effect of differential settlement on9 storied RCC frame structure using Staad pro software considered. A differential settlement of 25mm, 50mm, 75mm, and 100mm is applied to two rows with fixed support and also spring support is considered and results are compared. DL, LL, WL, SL are considered as per IS code. Mainly corner, center columns.*

Key Words: **Differential settlement, comparison of forces, modulus of subgrade reaction, staad pro software, building code…**

1. INTRODUCTION

It is noted that many times while designing RCC building / Superstructure structural designer do not considered the amount of differential settlement which results in changing shear forces & bending moments in the building/ superstructure and gives design by applying maximum factor of safety. This study will give approximate idea to them about amount of shear forces, bending moments, Stress & displacement changes. In this project we have considered G+9 building and DL,LL,WL,SL applied. Firstly analysis done by considering fixed support to all supports and results are seen. Then settlement of 25mm,50mm,75mm & 100mm accordingly are applied to two rows along X-axis as shown in figure 1.to see effect of differential settlement and results seen. After comparing results of fixed support & differential settlement it is concluded that forces & moments are changed when building undergoes differential settlement which sometimes results in failure of members & even some time building may collapse. From this study one can be concluded that it is very important to take note of differential settlement during design of any RCC superstructure / Building for safe & economical design.

1.1 Literature Review

(Skempton and Macdonald, 1956, Burland and Wroth, 1975). stated that Differential settlement is a general term used to describe the differences in vertical displacement of foundations. However differential settlement on its own does not give any indication of the spatial variation. It is the magnitude of differential settlement combined with the spatial variation that influences the behavior of the structure **Polshin and Tokar (1957)** defined a slope, equivalent to angular distortion; and relative deflection as the ratio of deflection to the length of the deflected part. Subsequently similar definitions have been defined by a number of authors (Fjeld, 1963, Grant *et al.*, 1974, Burland and Wroth, 1975, Wahls, 1981, Burland *et al.*, 2001a). Burland and Wroth (1975) proposed a consistent set of definitions based on the displacement of a number of discrete points on the foundation of a building.

Meyerhof 1947 analyzed that the building frames subjected to unequal settlement by Studying the field observations and theoretical investigation. It was concluded that settlement of 1 inch to 2 inch is inevitable and does not usually harm the buildings superstructure due to the movement of support. This is more prominent for structures provided with individual footing or flexible rafts.

1.2 Building Description

A Nine storied building shown in figure 1 is taken having dimension 16m*16m and total height of building is 30m (depth of foundation -3m).Settlement of 25mm,50mm,75mm 100mm is provided to all supports to two rows only to make effect of differential settlement.

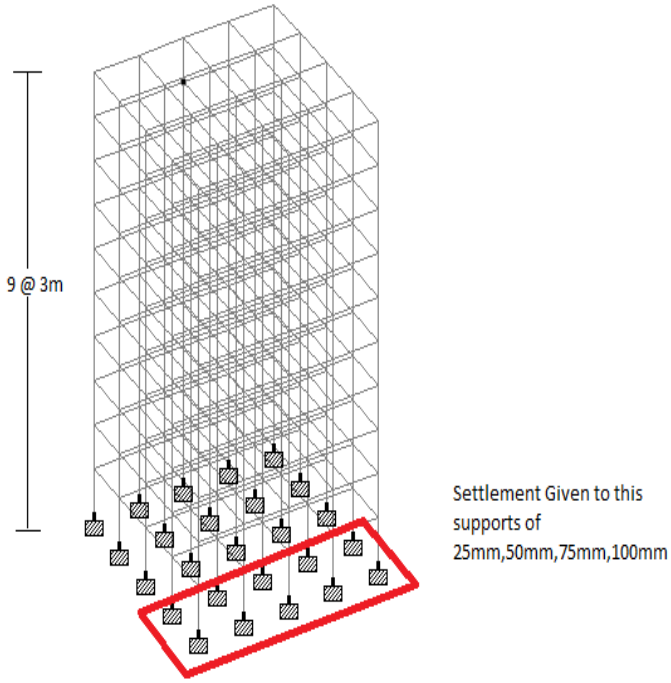


Fig -1: Geometrical Configuration of building

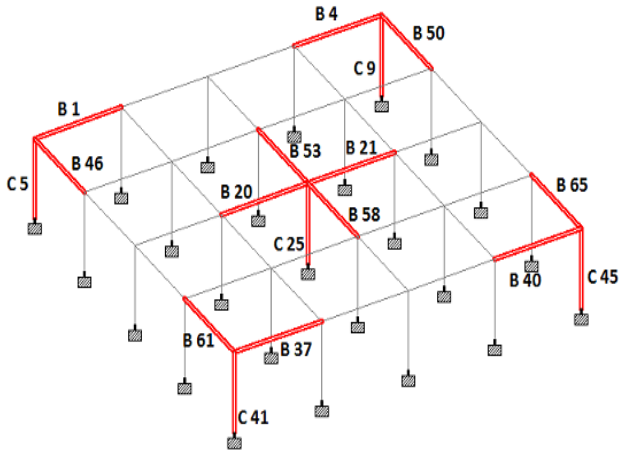
2. Modeling

Modeling is done using analysis & design software Staad-proV8i . In this total 15 columns are considered of corners & centers. 5 columns each for Ground floor, 5th floor & 9th floor. As given in table 1.

Table -1: Showing Numbering of Columns.

Sr No.	Floors	Column Numbers
1	Ground floor	5,9,45,41,25
2	5th floor	330,334,370,366,350
3	9th floor	590,594,630,626,610

Differential settlements of 25mm,50mm,75mm &100 mm respectively are applied to column no. C32-C36 & C41-C45 with keeping rest configurations same only differential settlement are provided to columns as shown in Fig-2. Loading such as Dead load,live load, Wind load & seismic load kept same for all condition i.e. for fixed support, spring support & when differential settlement are applied.



Floors	Columns No.	Beams no.
Ground Floor	5,9.45,41,25	1,46,4,50,65,40,37,61,53,21,58,20
5th Floor	330,334,370,366, 350	626,371,329,375,390,365,362,386,378,346,38 3,345
9th Floor	590,594,630,626, 610	586,631,589,635,650,625,622,646,638,606,64 3,605

Fig -2: Isometric View showing Beams & Columns selected for results of differential settlement of Ground floor

3. Results & Discussion

In the following section, the effect of Differential settlement on selected columns i.e. corners & centers columns & beams are mentioned. In first case fixed supports are considered and axial forces, shear forces and bending moments are note down. Then in second case one by one differential settlement of 25mm,50mm,75mm,100mm respectively applied to selected columns as shown in figure 3. To the same building and reactions noted down. And lastly in third case spring supports are applied instead of fixed support by considering modulus of subgrade reaction as K=40000.and results are note down and comparison between three cases presented.

NOTE : In this Report only effects of differential settlement on Ground floor columns are discussed along with positive forces & moments only. Negative forces and moments are not mentioned in the results.

3.1 : Effect of differential settlement on FX on Ground floor Corner & Center Column

From results it is noted that Fx increases as the amount of settlement increases, maximum Fx is near to support where differential settlement applied & minimum at other supports. And it is also noted that Fx is maximum when spring support is given.

Table -2: Variation of FX in Ground floor Columns

Fx Variation in Ground Floor						
Column	Fixed	25 mm	50 mm	75 mm	100 mm	Spring
5	1761	1071	417	103	103	2237
9	176	107	417	103	103	2237
45	176	2397	3034	3671	4307	2237
41	1761	2397	3034	3671	4307	2237
25	290	5615	8326	11037	13748	2561

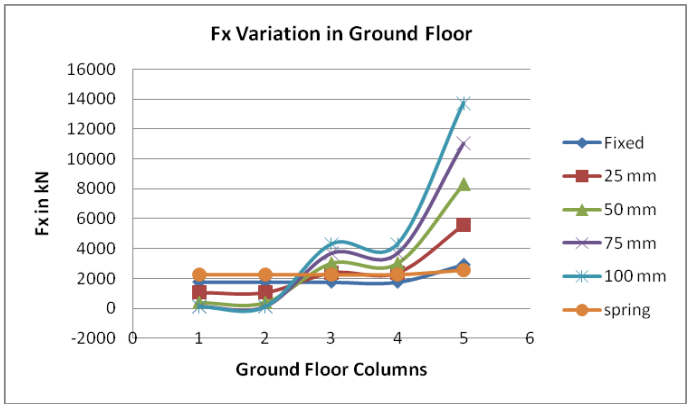


Chart – 1: Variation of FX in ground floor Column

3.2 : Effect of differential settlement on FY on Ground floor Corner & Center Column

From results it is noted that Fy do not effect due to differential settlement. Same values for Fy are noted in all cases except Spring support. Spring support also having very minor changes in Fy values.

Table -3: Variation of FY in Ground floor Columns

Fy Variation in Ground Floor						
Column	Fixed	25 mm	50 mm	75 mm	100 mm	Spring
5	16	16	16	16	16	15
9	34	34	34	34	34	36
45	34	34	34	34	34	36
141	16	16	16	16	16	15
25	35	35	35	35	35	37

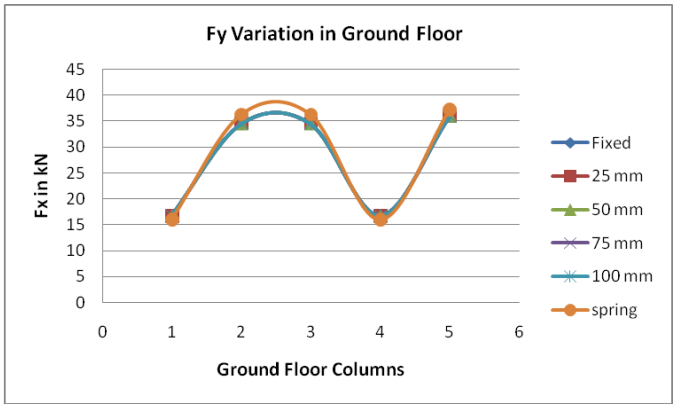


Chart – 2: Variation of FY in ground floor Column

3.3 : Effect of differential settlement on FZ on Ground floor Corner & Center Column

From results it is noted that Fz do not effect Corner Columns due to differential settlement, its remain same as incase of fixed support. But Fz at centre columns increases if amount of differential settlement increases.

Table -4: Variation of FZ in Ground floor Columns

Fz Variation in Ground Floor						
Column	Fixed	25 mm	50 mm	75 mm	100 mm	Spring
5	33	16	16	16	16	35
9	33	16	16	16	16	35
45	17	16	16	16	16	16
41	17	16	16	16	16	16
25	35	102	170	237	305	35

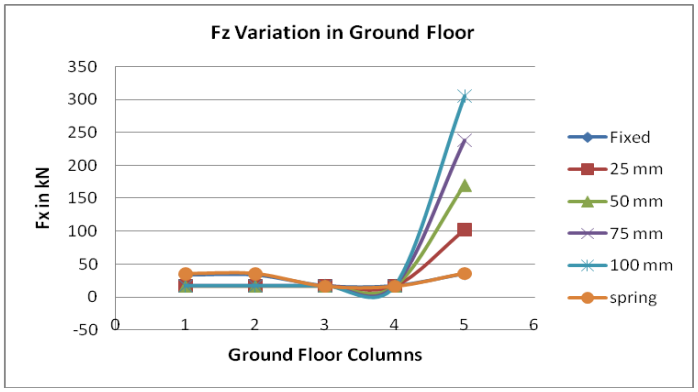


Chart – 1: Variation of FZ in ground floor Column

3.4 : Effect of differential settlement on MX on Ground floor Corner & Center Column

From table it is noted that corner columns having some moments as shown in below table and the value for Mx remain same in all condition even if Differential settlement is given to building for corner columns But in case of center columns value of Mx is zero.& it is also noted that when spring support is applied to building Mx do not effect & gives no moments.

Table -4: Variation of MX in Ground floor Columns

Mx Variation in Ground Floor						
Column	Fixed	25 mm	50 mm	75 mm	100 mm	Spring
5	0.36	0.36	0.36	0.36	0.36	0
9	0.361	0.361	0.361	0.361	0.361	0
45	0.36	0.36	0.36	0.36	0.36	0
41	0.361	0.361	0.361	0.361	0.361	0
25	0	0	0	0	0	0

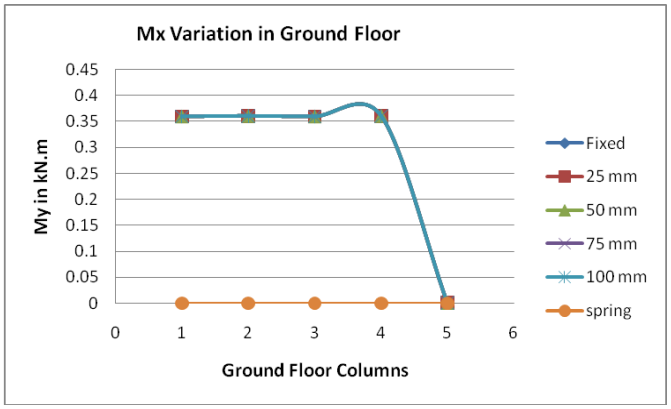


Chart – 4: Variation of MX in ground floor Column

3.5 : Effect of differential settlement on MY on Ground floor Corner & Center Column

From results it can be state that MY is more dominant. Than MX&MZ. as it affects more in corners columns when differential settlement is given to building but centre columns decreases & remain constant even if amount of differential settlement increases. And it is also noted that MY in spring do not gives is zero.

Table - 5: Variation of MY in Ground floor Columns

My Variation in Ground Floor						
Column	Fixed	25 mm	50 mm	75 mm	100 mm	Spring
5	44	128	212	296	380	0
9	44	128	212	296	380	0
45	59	149	239	329	419	0
41	59	149	239	329	419	0
25	63	46	42	42	42	0

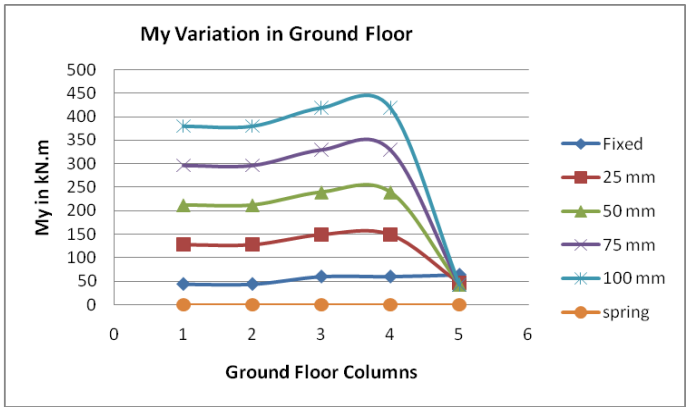


Chart – 5: Variation of MY in ground floor Column

3.6 : Effect of differential settlement on MZ on Ground floor Corner & Center Column

As we have already seen that MX do not affect due to differential settlement in same way it also noted that MZ do not effect due to differential settlement. Its value remain same as incase of spring support.But when we applied spring support to building MZ values comes equal to zero.

Table - 6: Variation of MZ in Ground floor Columns

Mz Variation in Ground Floor						
Column	Fixed	25 mm	50 mm	75 mm	100 mm	Spring
5	55	55	55	55	55	0
9	74	74	74	74	74	0
45	74	74	74	74	74	0
41	55	55	55	55	55	0
25	79	79	79	79	79	0

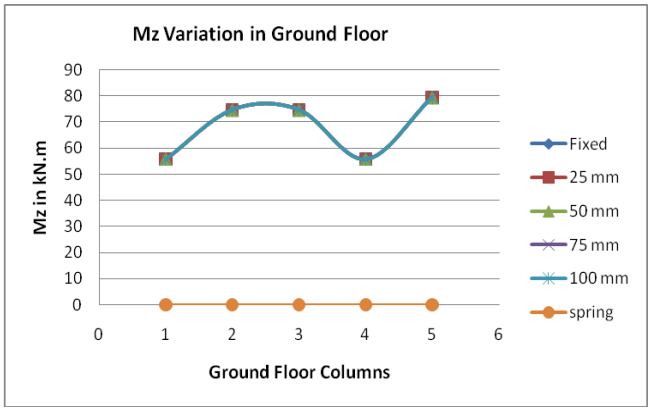


Chart – 6: Variation of MZ in ground floor Column

4. CONCLUSIONS

Effect of differential settlement on superstructure is studied in this paper in terms of forces & moments changes in Ground floor Columns after applying differential settlement of 25mm,50mm,75mm,100mm.and results compared with fixed support & spring supports. From above discussion & study below mentioned points are concluded.

1)From above results it can be concluded that if Differential settlement occurs in the building then FX in columns is affected more than FY & FZ in case of Shear Force.
2) When differential settlement is given there is no changes found in FZ values. But FZ at centre column increases with increase in Differential settlement from 25mm to 100mm. and there in NO change found at the corner columns with increment of differential settlement.
3) MZ having no effect of differential settlement & of any other support. MX In corner column do not change when differential settlement occurs & at centre its value comes zero.
4)MY at corner columns increases when Differential settlement increases & MY at centre columns decreases when Differential settlement increases. MY is Maximum when fixed supports given.
5)Corner columns are having maximum FX & Centre columns having minimum FX. FY increases when spring support is applied compared to fixed support. And MX & MY ground floor spring support value is ZERO & slightly increases with increase in floors.

REFERENCES

[1] Agrawal R.and Hora M.S.(2010), "Effect of differential settlements on nonlinear interaction behavior of plane frame – soil system", ARPN Journal of engineering and applied sciences,Vol.5, No.7,pp.75-87

[2] Ms.I.L.sneha (IJETR-2014) Study on vertical settlement and lateral Displacem,ent in Different types of soils.

[3] Settlement of Building & Associate Damage by J.B.Burland & C.P. Worth

[4] M.A.Sabry and M.Sabry, Dept.of civil Engineering.Cairo Univ.,Giza, " Office building settlement and Remediation

[5] Roy R. and Duuta S.C.(2001), "Differential settlement among isolated fottings of building frames; ghe problem, its estimation and possible measures",international journal of applied mechanics and engineering, Vol.6,No.1,pp.165-186

[6] Terence A.Weigel, Kenneth J.Ott,Joseph hagerty, "Load Redistribution in frame with settling footings

[7] IS: 9214-1979 " Method of Determination of Modulus of Subgrade Reaction (K-Value) of soils in field"

[8] IS:8009-1976 "Code of Practice for calculation of Settlement of Foundations"

[9] IS: 456-2000 " Code of Practice for general structural use of plain and Reinforced Concrete"

[10] IS :87-1987 "code of practice for Design load for Building and Structures".