Analysis of High Rise Building For Storey shear And Storey Moment With And Without Transfer Floor System

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Abstract- *A transfer floor is the floor system which supports a system of vertical and lateral load resisting elements and transfers its loading action to a different underneath system. Transfer systems are generally used in multifunction structures, in which the lower stories of the building usually are used as open public areas, while floors above that transfer system could accommodate typical residential or office spaces. A comparative analytical study for structural performance of high rise building with and without transfer floor is presented. A number of models are analyzed using elastic linear response spectrum technic. The vertical position of the transfer system with respect to the building height is investigated. The numerical analysis is carried out to investigate which floor system improves the global behavior of structure. For this seismic response of buildings such as storey shear and storey moment were numerically evaluated.*

Keywords- Transfer slab, Response spectrum analysis, Seismic loads, Storey shear, Storey moment.

I. INTRODUCTION

The need to have buildings with various operational demands has been increased in large populated cities. To accommodate the multiple architectural requirements, the location, orientation, and dimensions of the vertical and lateral load resisting elements vary every certain number of stories. In such cases, a transfer floor is commonly used to solve this persistent structural-architectural conflict. Transfer slab can redistribute the loads from superstructure above transfer plate to widely spaced columns and core walls below transfer slab. They easily facilitate incorporation of architectural layout to provide a column free open space area at lower stories, Because of such advantages, there is extensive use of transfer plate in high rise building especially in areas where seismic hazards are not considered. A transfer floor is the floor system which supports a system of vertical and lateral load resisting elements and transfers its straining action to a different underneath system. Transfer systems are generally used in multifunction structures, in which the lower stories of the building usually are used as open public areas, while floors above that transfer system could accommodate typical residential or office spaces. Several structural systems could be used for such buildings as the lateral resisting system below/above the transfer floor may be moment-resisting frames, core walls and structural walls. The transfer structures may be in form of transfer girders or transfer slabs.

II. LITERATURE REVIEW

Prof. P.S. Lande, Parikshit D Takale,[2018] have presented "Analysis of high rise building with transfer floor." in International Research Journal of Engineering and Technology (IRJET) Introduction of the transfer floor in the lower part of the structure is better than having it is at higher location. For girder type of transfer system there is reduction in storey moment and storey shear values below the transfer level as compared to slab type transfer system. Girder type transfer system improves the global behavior of the structure. The displacement distribution shown in displacement graph reveals that every building has a flexural behavior mode up to its transfer floor level. At this level, a large inertial force hit the building due to the significant mass of the transfer level which results a large displacement.

Y.M. Abdlebasset et al [2016] has presented a "State-of-the art review on structural and seismic behavior of high rise buildings with transfer floors". In Electronic Journal of Structural Engineering. It covers the effect of transfer floor systems types and the structural irregularity classification. It also covers some codes of practice limitations for such irregular buildings. The review discusses the transfer structures local deformations and stresses concentration. The review discusses the effect of the sudden change in the building stiffness on the seismic behavior of the building and outline the story drifts distribution along the building height. The commonly adopted numerical models for these irregular building are briefly outlined and the effect of the vertical location of the transfer floor with respect to the building height is presented. And concluded that irregularity in upper stories would have a little effect on the floor displacements, while, irregularity in lower stories would have a significant effect on the height-wise distribution of floor displacements.

Yoshimura et al [2014] have presented “A Nonlinear Analysis of a Reinforced Concrete Building with a Soft First Storey Collapsed by the 1995 Hyogoken-Nanbu Earthquake.” In Electronic Journal of Structures. He argued that the immense change in the lateral stiffness at the transfer floor from a stiff shear wall system above to a relatively flexible column-girder system below may create a soft (or weak) storey and violates the seismic design concept of “strong column weak beam”. Yoshimura (1997) also concluded that “if first storey mechanism might occure, the collapse could be unavoidable even for buildings with base shear strength of as much as 60% of the total weight”

Zhang Ling Abdelbasset et al [2011] have presented “Dynamic analysis of elastoplastic performance of tall building with arch transfer floor subjected to sever earthquake.” in Journal of Beijing Jiaotang University.a direct consequence of such irregularity is that the deformation of a soft-storey mechanism under moderate to severe earthquakes or lateral wind loads imposes high ductility demands on the elements in the vicinity of the transfer floors. Therefore, if this irregularity is not taken into consideration during the design stages, it becomes a major source of damage during strong earthquakes a major drawback of any transfer floor is the abrupt change in the building's lateral stiffness in the vicinity of its level.

Tassios T.P et al[2009] have presented paper on “Seismic Response of Reinforced Concrete Frames with Strength and Stiffness Irregularities”. In ACI Structural Journal.

In which two six-story, three-bay, reinforced concrete frames, one having a tall first story, and the other a discontinuous interior column were designed and discussed structural effects of these particular irregularities and state that, the transfer floor level, the building almost acts as a free cantilever with its fixation located at the transfer floor level with the rest of the building under the transfer floor approximately acts like a fixed-fixed flexural member.

III. METHODOLOGY

Taking into the consideration the need and objectives of dissertation,

1. A 10 storey and 20 storey building is taken into account and the analysis is carried out by using response spectrum analysis.
2. Considering earthquake loads as loading for the structure according to Indian standards, IS1893:2016 by using structural analysis software.
3. The analysis results such as storey shear and storey moment are evaluated for validation.
4. The vertical position of transfer slab with respect to building height is investigated.
5. The analysis and comparison of building with transfer slab and building without transfer slab are studied to investigate the seismic behavior of high rise building with transfer floor.

IV. SEISMICRESPONSE OF ANALYSED BUILDING

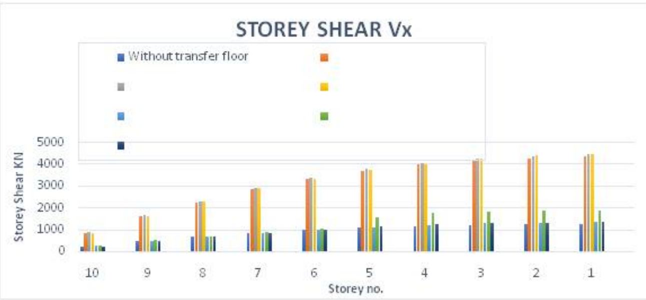
A 10 storey and 20 storey building is taken into account and the analysis is carried out by using response spectrum analysis considering earthquake loads as loading for the structure according to Indian standards, IS1893:2016 by using structural analysis software. The analysis results are performed for building such as storey shear, storey moment. The vertical position of transfer slab with respect to building height is investigated. The analysis and comparison of building with transfer slab and building without transfer slab are studied to investigate the seismic behavior of high rise building with transfer floor.

4.1 Storey Shear for 10 and 20 storey building.

The following graph shows storey shear distribution for 10 and 20 storey building model with transfer slab provided at different floor levels as 1st floor to 6thfloor and 1st floor to 7th floor respectively

Table 1.1 storey shear of 10 storey

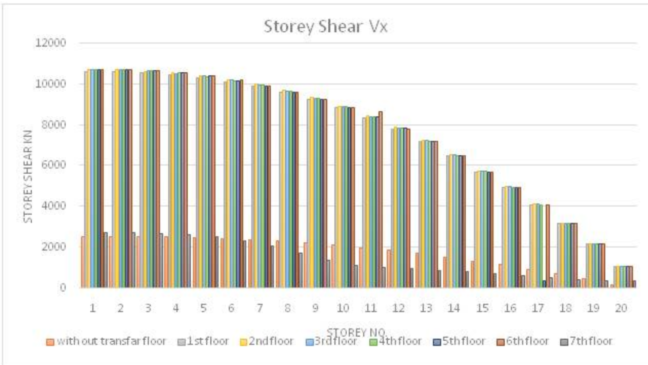
Storey No.	Without transfer floor	With transfer floor at level					
		1^{st}slab	2^{nd}slab	3^{rd}slab	4^{th}slab	5^{th}slab	6^{th}slab
10	243.23	862.052	875.60	865.23	248.68	261.90	243.67
9	468.91	1620.374	1645.84	1627.08	479.42	504.90	469.77
8	659.64	2261.236	2296.78	2270.60	674.42	710.27	660.85
7	836.89	2857.860	2902.88	2889.79	855.64	901.12	838.42
6	989.92	3338.436	3390.9	3352.25	1001.88	1055.14	1014.96
5	1090.75	3710.658	3769.08	3726.05	1050.19	1585.02	1150.95
4	1172.16	3984.159	4046.48	3840.66	1071.74	1775.12	1232.52
3	1227.31	4169.391	4060.93	4255.82	1286.80	1834.51	1287.77
2	1259.78	4170.457	4386.90	4404.88	1320.01	1869.47	1320.29
1	1274.24	4349.684	4452.92	4452.92	1334.79	1885.05	1334.79



Graph 1.1 storey shear for 10 storey

Table 1.2 storey shear of 20 storey

Storey No.	Without transfer floor	With transfer floor at level						
		1^{st}slab	2^{nd}slab	3^{rd}slab	4^{th}slab	5^{th}slab	6^{th}slab	7^{th}slab
20	218.46	1098.43	1108.30	1106.15	1103.59	1100.69	1097.50	370.20
19	487.77	2184.43	2204.23	2199.95	2194.85	2189.09	2182.75	407.97
18	736.67	3188.39	3217.05	3210.79	3203.38	3194.95	3185.69	462.85
17	965.67	4111.96	4148.92	4140.85	4131.27	412.42	4108.48	525.57
16	1175.33	4957.53	5002.09	4992.38	4980.80	4967.72	4953.33	633.23
15	1366.21	5727.37	5778.85	5767.61	5754.26	5739.15	5722.52	731.25
14	1554.48	6505.78	6564.26	6551.49	6536.32	6519.16	6500.27	830.54
13	1728.62	7210.00	7274.80	7260.85	7243.84	7224.82	7203.89	920.24
12	1883.72	7837.22	7907.67	7892.25	7874.02	7853.34	7830.58	100011
11	2020.52	8390.44	8465.86	8449.39	8429.83	8407.69	8683.33	107054
10	2139.78	8872.74	8952.49	8935.08	8914.39	8890.98	8865.22	113198
9	2242.31	9287.38	9370.87	9352.64	9330.98	9306.48	9279.51	138479
8	2328.96	9637.63	9724.43	9705.52	9683.05	9657.62	9629.64	172942
7	2400.63	9927.63	1001687	9997.39	9974.24	9948.05	9919.22	207893
6	2458.28	1016076	1025209	1023215	1020846	1018165	1022568	235625
5	2502.94	1034138	1043434	1041404	1038993	1041978	1046123	254874
4	2535.76	1047408	1056822	1052767	1056533	1059333	1059381	263698
3	2557.98	1056395	1061891	1066675	1068319	1068339	1068361	268719
2	2571.07	1059787	1072916	1073630	1073636	1073642	1073649	274812
1	2577.24	1065002	1076000	1076000	1076000	1076000	1076000	274689



Graph 1.2 storey shear for 20 storey

[1] It is evident from the graph1.1 and graph 1.2 that significant increase in the storey shear is observed in the building with lower transfer system located up to 30% H, but significant decrease in the storey shear is observed from 40%H.

[2] Percentage reduction in storey shear for transfer floor system at 40%H level is about 9% when compared with without transfer slab.

4.2 Storey moment for 10 and 20 storey building.

The following graph shows storey moment distribution for 10 and 20 storey building model with transfer slab provided at different floor levels as 1st floor to 6th floor and 1st floor to 7th floor respectively.

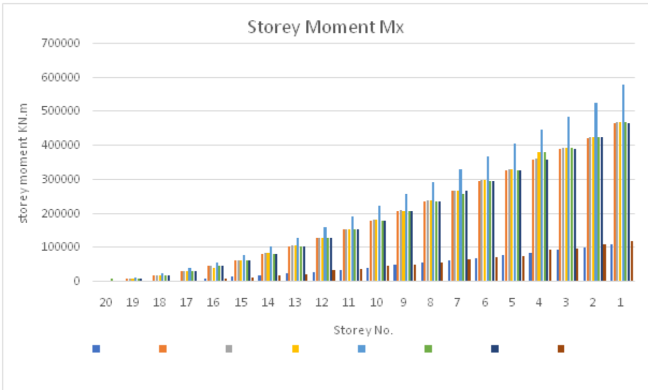
Table 1.3 storey moment of 10 storey

Storey No.	Without transfer floor	With transfer floor at level					
		1st slab	2nd slab	3rd slab	4th slab	5th slab	6th slab
10	729.75	2586.15	2626.80	2596.86	746.051	785.70	731.03
9	2136.45	7447.27	7564.34	7478.12	2184.33	2300.43	2140.36
8	4115.41	1423098	14454.69	14289.32	4207.61	4431.25	4122.92
7	6626.06	2280488	23163.34	22899.32	6774.67	7134.62	8838.19
6	9565.85	3282015	33336.07	32956.09	9780.20	10300.4	9683.09
5	1283810	43952.1	44643.10	44134.25	1312578	15055.2	1313597
4	1635460	5590466	56783.46	56136.23	1677902	2038052	1683354
3	2003653	6841284	69488.25	68903.71	2063943	2588406	2069685
2	2381588	8124821	82648.97	82118.35	2459944	3149248	2465775
1	2891287	9864694	10046067	99930005	2993860	3903268	2996.92

Graph 1.3 storey moment for 10 storey

Table 1.4 storey moment of 20 storey

Storey No.	Without transfer floor	With transfer floor at level						
		1st slab	2nd slab	3rd slab	4th slab	5th slab	6th slab	7th slab
20	655.38	3295.30	3324.92	3318.45	4094.95	8302.08	3292.51	755.38
19	2118.21	9849.10	9937.63	9918.30	12239.14	9689.33	9840.76	3118.21
18	4328.73	19414.29	19588.80	19550.70	24126.46	19454.21	19397.84	5328.73
7	7225..55	31750.19	32035.59	31973.28	39454.85	31615.46	31723.29	8225..55
16	10751.75	46622.79	47041.87	40950.37	57936.51	48718.58	46683.29	10751.75
15	14850.40	63804.92	64378.44	64253.22	79288.13	63936.11	63750.85	13850.40
14	19513.85	83322.27	84071.23	83907.71	103541.66	83493.50	83251.67	18513.85
13	24699.71	104952.28	105895.66	105689.68	130420.50	105168.03	104863.35	23699.71
12	30350.88	128463.96	129518.59	129366.57	159637.65	128728011	128955.11	35350.88
11	36412.44	153635.29	155016.27	154714.76	190917.17	153951.19	153505.11	38412.44
10	42831.78	180253.52	181873.76	181520.01	223994.71	180924.16	180100.79	47831.78
9	49558.73	208115.69	209986.37	209577.94	258618.05	208543.81	207939.35	49758.73
8	56545.63	237029.11	239159.69	239894.51	294547.74	237516.48	236828.27	56545.63
7	63747.54	266812.03	269210.31	268686.68	331557.92	257360.54	266585.95	67747.54
6	71122.39	297294.33	299966.61	299383.15	369437.20	297905.61	297263.01	72122.39
5	78631.24	328318.48	331269.63	330625.29	407989.83	329104.97	328646.72	76651.24
4	86238.52	359740.72	362974.32	382268.31	447193.30	380944.97	360428.18	96538.52
3	93912.45	391432.59	394951.06	394268.56	486834.10	392995.16	392479.03	99912.45
2	101625.68	423283.22	427138.55	426477.49	526672.19	425204.44	424688.52	1116256
1	111934.68	465883.33	470178.58	469517.50	579906.58	468244.45	467728.53	1215346



Graph 1.4 storey moment for 20 storey

[1] Building with lower level transfer slab have a higher storey moment as compared to similar building with transfer floor at higher level.

[2] It is evident from the graph 1.3 and graph 1.4 that significant increase in the storey moment is observed in the building with transfer system located up to 30% H, but significant decrease in the storey moment is observed from 40%H.

V. CONCLUSIONS

Transfer floor system affects the storey shear and storey moment due to weight of slab, but it provides stability to the structure and reduces storey drift, storey displacement as compared to building without transfer slab.

Storey shear is increasing for transfer floor system up to 30%H and at 40%H and 35%H it is significantly decreasing for both 10 and 20 storied building(where H- total building height)`Percentage reduction in storeyshear for transfer floor system at 40% H to 35% H is about 9% and 14% for both 10 and 20 storied buildings respectively.

Building with lower level transfer floor have a higher storey shear compared to similar buildings with transfer floor at higher level due to higher stiffness of lower part of building and due to the abrupt change in the mobilized mass.

Up to 30% H storey moment is increasing and at 40% H and 35% H it is significantaly decreasing for both 10 and 20 storied buildings respectively.

For building without transfer floor type shows reduction in storey moment and storey shear values as compared to building with transfer slab.

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