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DESIGN AND ANALYSIS OF MULTI STOREY R.C.C. BUILDING HAVING FLOATING LIFT WITH AND WITHOUT TRANSFER GIRDER

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Abstract - *The present study compares the structural behaviour of a multi-storey reinforced cement concrete (RCC) building having a floating lift under two load-transfer configurations. Model-01 represents a floating lift without a conventional transfer girder, where the RCC lift wall is directly connected to the supporting beam system. Model-02 represents a transfer-girder arrangement in which a floating column is supported by a transfer girder and continued up to the terrace. Both models were developed in ETABS using comparable geometry, material properties and loading criteria. The building consists of 2 basements + Ground + 16 upper floors + Terrace, with a plan size of 27 m × 20.5 m. Response Spectrum Analysis was used to evaluate modal response, fundamental time period, base shear, storey displacement and storey drift. The fundamental period reduces from 4.018 s in Model-01 to 3.82 s in Model-02. ETABS base shear increases from 4398.06 kN to 4774.07 kN in X and from 4933.85 kN to 5355.67 kN in Y. Maximum earthquake displacement in X reduces from 233.599 mm to 189.433 mm, whereas Y-direction displacement increases from 78.144 mm to 137.525 mm. The study indicates that the transfer-girder system provides a stiffer and more conventional load-transfer arrangement, but increases structural mass, member size and planning requirements. The without-transfer-girder arrangement is a potential alternative when the wall-to-beam load-transfer region and supporting members are adequately designed. We can't take floating columns in framing also as it will sway the building and for transfer girder we have to increase one service floor also.*

Key Words: Floating lift, transfer girder, RCC building, ETABS, response spectrum analysis, base shear, storey displacement, storey drift.

1.INTRODUCTION

Modern multi-storey buildings increasingly require flexible architectural spaces and uninterrupted lower-level areas. Such requirements can create vertical discontinuities in the structural load path. A floating lift is one such arrangement in which the lift shaft does not continue directly to the foundation and its load is transferred to lower structural members. The present research focuses on the structural implications of providing the floating lift without a conventional transfer girder and compares it with a transfer-girder arrangement.

The final project report identifies the research gap as the limited investigation of floating lift systems as a distinct structural element, particularly where the transfer girder is eliminated. The literature reviewed in the project mainly addresses floating columns and transfer beams, while the wall-to-beam load-transfer mechanism of a floating lift is comparatively less investigated.

1.2 LITERATURE REVIEW

Ibrahim & Askar (2021) investigated the dynamic response of multi-storey RC frame buildings with and without floating columns under seismic loading. Their study demonstrated that introducing discontinuous vertical elements causes significant stiffness reduction, elongates modal periods, and amplifies lateral story displacement compared to regular framed structures.

Bhoge et al. (2021) analyzed G+6 storey R.C.C. buildings with floating columns using STAAD Pro V8i. They observed that vertical load discontinuities significantly increase bending moments and shear forces in supporting framing members, concluding that while floating elements offer architectural freedom, conventional continuous frames provide superior seismic resilience.

Agawane & Joshi (2021) presented a state-of-the-art review on the performance of multi-storey structures with floating columns. Their findings highlighted that vertical discontinuities lead to higher lateral drifts, lower fundamental frequencies, and localized stress concentrations at transfer joints.

Gujar & Jadhav (2019) performed construction sequence analysis (CSA) on G+10 R.C.C. buildings featuring floating columns using ETABS. Their comparative analysis revealed that single-step static analysis significantly underestimates transfer beam deflections and forces, whereas CSA accounts for sequential load accumulation, resulting in 45% to 60% higher deformation predictions.

Duduskar et al. (2018) investigated G+20 storey configurations with floating columns and shear walls. The study indicated that while floating columns increase storey displacement by 6% to 8%, introducing strategically located shear walls reduces lateral displacements by up to 46%, effectively mitigating stiffness irregularities.

Lingeshwaran et al. (2021) conducted Response Spectrum and Time History analyses on G+9 buildings with floating columns. They concluded that seismic excitation severely increases story drift in discontinuous frames, but integrating R.C.C. shear walls improves drift performance by 10% to 30%.

Mundada & Sawdatkar (2014) evaluated seismic responses of framed structures with floating columns. They demonstrated that floating columns increase local bending moments in supporting beams, and identified inclined compressive struts as an effective retrofit strategy to smooth the load path.

Patange et al. (2023) evaluated the effects of floating column locations (interior vs. exterior) on structural behavior using finite element software. They stressed that discontinuous vertical members must not be relied upon for lateral resistance without rigorous shear and connection detailing.

Shaikh et al. (2021) analyzed soil-structure interaction (SSI) effects on commercial frames containing floating columns. They cautioned against using floating columns on flexible soils due to severe drift amplification caused by foundation rotation.

Kalra et al. (2019) evaluated the seismic response of R.C.C. frames with internal and external floating columns in Seismic Zone IV, finding that internal floating elements exhibit better drift performance than perimeter placements.

1.3 OBJECTIVES

- To model and analyse a multi-storey RCC building having a floating lift using ETABS.
- To compare the floating-lift system without a transfer girder with a floating-column and transfer-girder arrangement.
- To evaluate the response under gravity, wind and seismic loading.
- To compare fundamental time period, base shear, storey displacement and storey drift.
- To assess the structural and practical implications of eliminating the transfer girder.

1.4 BUILDING CONFIGURATION

Two three-dimensional ETABS models were developed. Model-01 contains a floating lift without a conventional transfer girder, with the RCC wall directly connected to the supporting beam system. Model-02 contains a transfer girder supporting a floating column that continues vertically up to the terrace.

Parameter	Model-01	Model-02
Arrangement	Floating lift without TG	Floating column with TG
Plan	27 m × 20.5 m	27 m × 20.5 m
Storeys	2B + G + 16 + Terrace	2B + G + 17 + Terrace
Typical height	3.15 m	3.15 m
Building height	63.9 m	66.9 m
Concrete	M30 / M35	M30 / M35
Reinforcement	Fe500	Fe500
Seismic zone	III, Z=0.16	III, Z=0.16
R	5.0	5.0
I	1.2	1.2

(i.e. TG=Transfer Girder)

2. METHODOLOGY

The methodology includes literature review, identification of the research gap, preparation of the two structural configurations, definition of geometry and material properties, assignment of structural sections, application of gravity, wind and seismic loads, response spectrum analysis, extraction of response parameters and comparative evaluation.

2.1 Model-01: Without transfer girder

In the first model, the floating lift was provided without a conventional transfer girder. In this arrangement, an RCC wall was provided directly from the supporting beam at the required level. The reinforcement of the RCC wall was considered to be developed from the supporting beam, thereby providing a direct load-transfer mechanism between the wall and the beam. The RCC wall was terminated at the top of the respective floor, and the same arrangement was repeated at the upper floors. Thus, the conventional transfer girder was eliminated and an alternative structural load-transfer mechanism was investigated, in which the lift wall directly transfers its forces to the supporting beam. the RCC wall and supporting beam form the direct load-transfer mechanism.

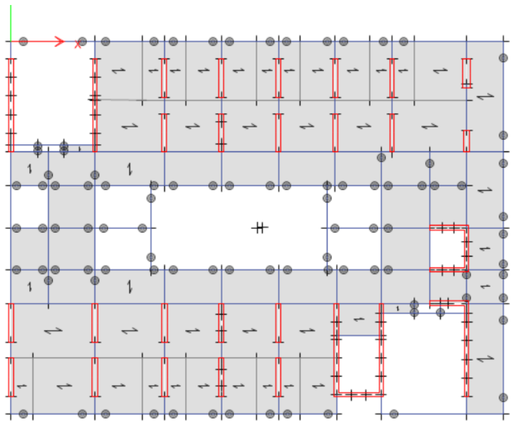


Fig no. 1 ETABS plan

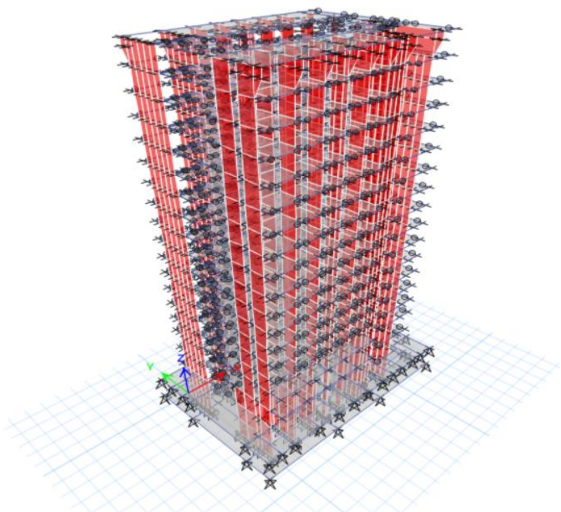


Fig no.2 3D View of ETABS

2.2 Model-02: With transfer girder

In the second model, a conventional transfer-girder arrangement was adopted. A transfer girder was provided at the required level to support the floating column. The floating column was then continued vertically up to the terrace level. In this configuration, the loads from the floating column are transferred to the transfer girder and subsequently to the supporting structural system. This model was considered as the comparative configuration for evaluating the behaviour of the floating lift system with a transfer girder.

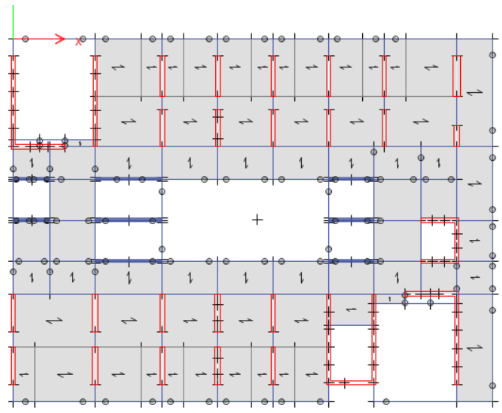


Fig no. 3 ETABS plan

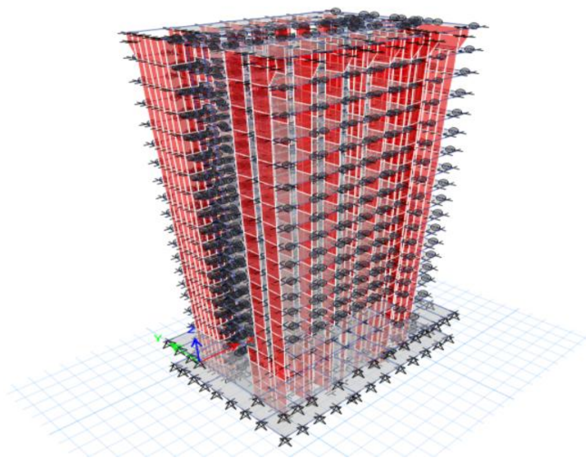


Fig no.4 3D View of ETABS

3. RESULT AND DISCUSSION

3.1 Modal Mass Participation

The final report shows different modal characteristics for the two models. For Model-01, the first three modes include approximately 70.03% UX and 66.00% UY participation in the principal translational modes. For Model-02, the corresponding principal modal participation is approximately 63.20% UX and 60.65% UY. The difference reflects the changed stiffness and mass distribution caused by the transfer girder and larger supporting members.

3.2 Fundamental Time Period

Mode	Without TG (s)	With TG (s)
1	4.018	3.820
2	2.133	2.970
3	2.029	2.849

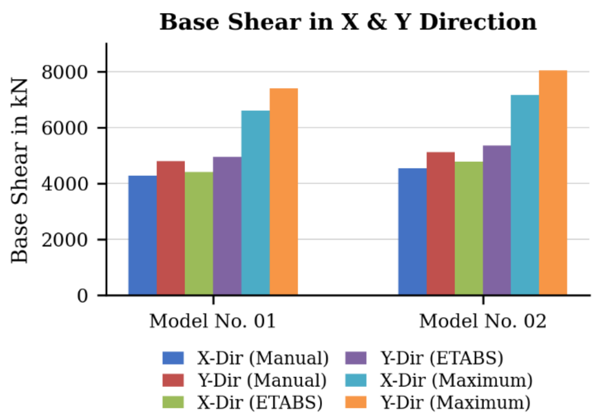
The fundamental time period decreases from 4.018 s to 3.82 s after introducing the transfer girder, indicating an increase in effective stiffness in the first mode.

3.3 Base Shear

Response	Without TG	With TG	Change
Manual X (KN)	4261.64	4533.63	+6.40%
Manual Y (KN)	4779.72	5100.33	+6.70%
ETABS X (kN)	4398.06	4774.07	+8.55%
ETABS Y (kN)	4933.85	5355.67	+8.55%
Maximum X (kN)	6597.10	7161.11	+8.55%
Maximum Y (kN)	7400.10	8033.50	+8.56%

The transfer-girder model develops higher base shear in both principal directions. The increase is consistent with the higher seismic weight and modified structural system reported in the final project.

Chart no.1 Base Shear in X and Y direction



3.4 Storey Displacement

Parameter	Without TG	With TG
Maximum EQ X (mm)	233.599	189.433
Maximum EQ Y (mm)	78.144	137.525
Wind maximum X (mm)	34.833	56.949
Wind maximum Y (mm)	30.936	48.772

In X direction, the transfer-girder model reduces maximum earthquake displacement from 233.599 mm to 189.433 mm, indicating improved lateral stiffness. In Y direction, displacement increases from 78.144 mm to 137.525 mm, demonstrating that the effect of the transfer girder is direction-dependent.

Chart no.2 Storey Displacement in X and Y direction (earthquake)

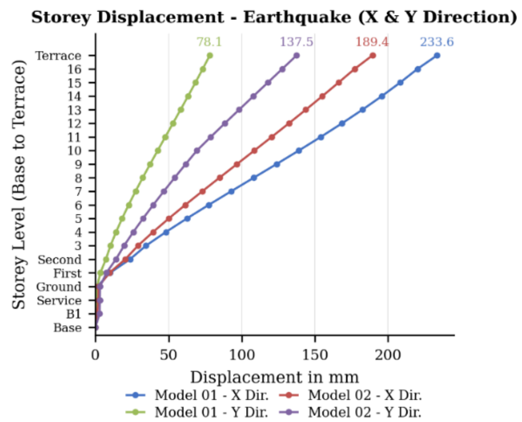
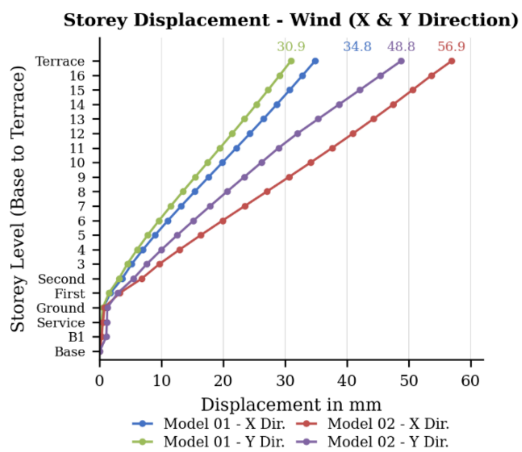


Chart no.3 Storey Displacement in X and Y direction (wind)



3.5 Storey Drift

The project report adopts the IS 1893:2016 storey-drift criterion of 0.004 times the storey height. Model-01 has a maximum reported X-direction drift of approximately 0.004605 around Storey 8, whereas Model-02 has a maximum reported drift of approximately 0.003353 around Storey 9. The transfer-girder model therefore shows a lower and more balanced reported drift response in the upper storeys.

4. COMPARATIVE DISCUSSION

The transfer-girder system increases structural mass and stiffness because of heavy transfer girders and larger supporting columns. This reduces the fundamental period and X-direction earthquake displacement, but also increases base shear. The transfer arrangement requires greater structural depth and planning space, and the final report identifies the need for an additional service floor/level to accommodate the transfer girders. Also floating column will be design for gravity only.

The without-transfer-girder model provides a simpler architectural arrangement and avoids the major transfer girder. However, the raft slab for lift pit becomes the critical region. The RCC wall-to-beam junction becomes the load-transfer region and requires adequate reinforcement development, anchorage, local shear and bending capacity and proper structural connectivity.

Parameter	Without Transfer Girder	With Transfer Girder
Additional service floor	Not specifically required for TG	Required for transfer-girder arrangement
Structural mass	Lower	Higher
Fundamental period	4.018 s	3.820 s
Base shear X	4398.06 kN	4774.07 kN
Base shear Y	4933.85 kN	5355.67 kN
Maximum EQ displacement X	233.599 mm	189.433 mm
Maximum EQ displacement Y	78.144 mm	137.525 mm
Critical region	Raft slab/lift pit	Transfer girder/supports
Construction demand	Comparatively lower	Higher

5. CONCLUSIONS

- This review highlights the importance of structural continuity, load transfer mechanisms, and stiffness distribution in multi-storey R.C.C. buildings.
- Requirement of additional service floor: In comparison with the without-transfer-girder model, the transfer-girder model requires an additional floor/level to accommodate the transfer girders and their supporting structural arrangement. This results in additional space and planning requirements and affects the overall architectural and functional arrangement of the building.
- Effect of increased mass and structural stiffness: In the transfer-girder model, the use of heavy transfer girders and larger column sizes required to receive and transfer the girder loads increases the overall structural mass. Due to the increased member sizes and stiffness, the transfer-girder model may show lower deflection compared with the without-transfer-girder model. However, this improvement comes with increased concrete, reinforcement and construction requirements, making the system comparatively less economical.
- Floating column and connected beam behaviour: In the transfer-girder model, the floating columns are considered primarily as gravity-load-carrying columns, rather than being relied upon as moment-resisting columns. The beams connected to the floating columns are therefore required to be treated consistently with the intended gravity-load-transfer mechanism, with appropriate simple-support/modelling assumptions where applicable, so that unintended framing action and sway behaviour are not introduced into the structural model.
- While conventional transfer girders provide a proven method for accommodating discontinuous vertical elements, they add significant dead mass, cost, and floor height constraints. Floating lift cores without transfer girders offer a flexible architectural solution.
- The proposed research framework provides a structured approach for analytical modeling, dynamic response spectrum analysis, and feasibility evaluation, establishing a clear path for future detailed investigations.

FUTURE SCOPE

1) **Construction sequence analysis (CSA):** Conducting staged construction sequence modeling in ETABS to capture incremental dead loads and differential shortening during the step-by-step construction of suspended lift walls.
2) **Non-linear dynamic time history analysis:** Evaluating structural performance under real earthquake ground motions to assess non-linear plastic hinge formation at the wall-to-beam junction.
3) **Soil-structure interaction (SSI):** Investigating the impact of varying soil conditions (soft, medium, and hard soils) on base shear, foundation .settlement, and overall structural response.

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