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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 proposes a comparative analytical investigation of a multi-storey reinforced cement concrete (R.C.C.) building having a floating lift with and without a transfer girder. The study is motivated by the increasing requirement for flexible architectural planning, open lower-floor spaces and vertical transportation systems in multi-storey buildings. The proposed building consists of two basement levels, a ground floor, sixteen upper floors and a terrace. Two three-dimensional structural configurations are considered. In Model-01, the floating lift is provided without a conventional transfer girder. An R.C.C. wall is directly connected to the supporting beam at the required level, with the wall reinforcement developed from the supporting beam, providing the intended wall-to-beam load-transfer mechanism. In Model-02, a conventional transfer-girder arrangement is adopted, with a floating column supported on the transfer girder and continued up to the terrace level. The proposed study focuses on the structural concept, load path, modelling methodology and governing design considerations rather than presenting numerical results. The models are intended to be developed in ETABS and evaluated under gravity, wind and seismic loading in accordance with relevant Indian Standards. The study further identifies the critical local regions, particularly the wall-to-beam junction in the no-transfer-girder model and the transfer girder and supporting members in the comparative model. The work establishes the theoretical and analytical framework for the subsequent detailed analysis and design of floating-lift systems.*

Key Words: R.C.C. building, floating lift, transfer girder, floating column, load transfer, ETABS, seismic analysis, structural irregularity.

1. INTRODUCTION

Modern multi-storey buildings increasingly require structural arrangements that can accommodate architectural flexibility, open spaces and vertical transportation facilities. Conventional structural systems generally maintain continuity of columns and walls from the upper floors to the foundation. When a vertical structural element is discontinued, the resulting load path becomes discontinuous and the forces have to be transferred through other structural members. Such discontinuities are important in high-rise reinforced concrete buildings because they can influence stiffness, force distribution and lateral response.

The concept considered in the present study is a floating lift arrangement. In the proposed configuration, the lift wall does not continue as a conventional continuous structural element through the lower levels. Instead, the lift-related structural wall is supported at the required level through the surrounding framing system. The project report identifies this arrangement as an alternative to a conventional transfer-girder solution and focuses on the direct R.C.C. wall-to-beam load-transfer mechanism.

The study considers two configurations so that the effect of the adopted load-transfer mechanism can subsequently be evaluated. The first model represents an R.C.C. building with a floating lift without a transfer girder. The second model represents a comparative arrangement with a transfer girder and floating column. Both configurations are intended to use consistent building geometry, material properties, loading and support assumptions so that the influence of the structural arrangement can be studied systematically.

2. STRUCTURAL CONCEPTS AND WORKING MECHANISMS

In multi-storey reinforced concrete (R.C.C.) structures, creating open functional spaces at lower floor levels interrupts continuous vertical members, creating structural irregularities that alter primary load paths. The two primary arrangements for handling discontinuous elevator cores operate as follows:

2.1 Mechanism of Floating Lift System without Transfer Girder

In the alternative floating lift core configuration, heavy transfer girders are completely eliminated at the termination level:

Primary Structural Role: Loads from the elevator shaft walls are transferred directly into supporting floor frame beams and integrated reinforced concrete elements (such as wall/pardi sections and floor diaphragms).

Load Redistribution Path: Gravity and lateral forces from the hollow R.C.C. elevator walls drop directly onto the supporting beam-slab matrix. Forces are dispersed through localized in-plane shear action, diagonal compression struts, and bending moments across the wall-to-beam connection junctions.

Structural Behavior & Impact: Eliminating the heavy transfer girder reduces the overall structural dead weight by approximately **8%**. This significant reduction in dead mass lowers the total seismic base shear demand acting on the building during ground shaking. However, because concentrated core forces act directly on standard floor beams, this arrangement introduces localized shear stresses and flexural demands at the wall-beam connection junctions, requiring rigorous dynamic analysis of local shear, flexure, and inter-storey drift to ensure structural stability.

2.2 Mechanism of Floating Lift System with Transfer Girder

In a conventional transfer girder configuration, a deep flexural reinforced concrete beam is installed at the intermediate transfer storey where the vertical core terminates:

Primary Structural Role: The transfer girder acts as the primary structural interface directly supporting the discontinuous vertical elevator core.

Load Redistribution Path: Gravity loads (self-weight of shaft walls and floor loads) and dynamic overturning moments from the upper elevator walls drop onto the transfer girder. The deep girder receives these heavy concentrated forces and redistributes them horizontally through high flexural bending and shear action into adjacent continuous primary columns extending down to the foundation.

Structural Behavior & Impact: While the transfer girder provides a rigid interface to collect core loads, the substantial concrete volume increases the building's overall dead weight. This added mass elevates the building's seismic mass, leading to higher base shear demands during earthquake shaking, along with creating vertical stiffness irregularities that increase natural period and lateral displacement.

Parameter	System Without Transfer Girder	System With Transfer Girder
Primary Interface	Direct connection to supporting frame beams & R.C.C. elements	Deep flexural R.C.C. transfer girder
Primary Force Transfer Mode	Direct in-plane shear, local flexure, and wall-beam strut action	Heavy beam bending and transverse shear
Structural Dead Weight	Reduced by ~8% due to girder elimination	Baseline (100%)
Seismic Base Shear Demand	**Lower** due to reduced seismic weight	Higher due to increased structural mass
Critical Stress Zone	Localized shear and bending at wall-beam connection junctions	Bending and shear in deep transfer girder
Floor Height Requirement	Preserves architectural floor height without deep beams	Requires deeper story height for transfer girder

3. SEISMIC PERFORMANCE PARAMETERS USED FOR ASSESSMENT

The seismic performance of reinforced concrete buildings is generally evaluated using several structural response parameters obtained from analytical studies. These parameters provide information regarding the behaviour, safety, and serviceability of the structure under earthquake loading.

Fundamental Time Period

The fundamental time period represents the time required by a structure to complete one cycle of free vibration. SSI generally increases the flexibility of the overall system, resulting in a higher fundamental time period. Liquefaction-induced reduction in soil stiffness further contributes to this increase.

Base Shear

Base shear is the total horizontal seismic force acting at the base of the structure. It is one of the most important design parameters specified in IS 1893:2016. Variations in soil stiffness due to SSI and liquefaction significantly affect the magnitude of base shear experienced by the building.

Storey Displacement

Storey displacement indicates the lateral movement of each floor level during earthquake excitation. Excessive displacement may lead to structural and non-structural damage. Structures supported on flexible or liquefied soils generally exhibit larger lateral displacements compared to fixed-base structures.

Storey Drift

Storey drift is defined as the relative displacement between two consecutive floors divided by the storey height. It is a critical parameter for evaluating structural safety and serviceability. Increased drift can result in damage to partitions, cladding systems, and structural members.

Overturning Moment

Overturning moment represents the tendency of a structure to rotate about its base due to seismic forces. It provides an indication of the stability of the building under earthquake loading and is influenced by soil flexibility and foundation behaviour.

These parameters are commonly used in seismic performance assessment studies to compare the behaviour of fixed-base structures with SSI and liquefaction-based models.

4. REVIEW OF PREVIOUS RESEARCH

Several researchers have investigated the structural response, seismic vulnerability, and design implications of buildings containing floating elements, transfer girders, and vertical irregularities:

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.

5. SUMMARY OF LITERATURE FINDINGS

Based on the synthesis of existing literature, the following structural takeaways are identified:

1. Discontinuous vertical elements reduce overall structural stiffness and increase fundamental vibration periods.
2. Lateral displacements and inter-storey drifts increase significantly when vertical continuity is interrupted.
3. Transfer girders effectively redistribute discontinuous loads but introduce substantial dead weight, construction complexity, and soft-storey tendencies.
4. Construction sequence analysis (CSA) is critical for transfer elements, as conventional single-step linear analysis underestimates deformations.
5. Integrating solid shear walls or R.C.C. pardi sections near discontinuous zones effectively mitigates lateral drift and displacement amplifications.
6. Existing research focuses almost exclusively on isolated floating columns, leaving hollow, three-dimensional R.C.C. floating lift cores relatively unexamined.

6. RESEARCH GAPS

Despite extensive research on vertical irregularities, several key technical gaps remain in current structural literature:

1. Lack of Studies on Floating Lift Cores: Most literature focuses on isolated 1D floating columns; the complex 3D shear-flexure behavior of floating hollow R.C.C. lift cores is under-researched.
2. Alternative Load Mechanisms Without Transfer Girders: Limited studies explore transferring heavy elevator core loads directly into floor beams and pardi wall assemblies without installing massive transfer girders.
3. Comparative Evaluation of Transfer vs. Non-Transfer Systems: Direct comparative benchmarks evaluating high-rise buildings with floating lifts supported with transfer girders versus without transfer girders are missing.
4. Combined Seismic and Wind Response for High-Rise Profiles: Comprehensive performance comparisons covering seismic (IS 1893:2016) and wind dynamics (IS 875 Part 3:2015) for high-rise residential profiles with basement multi-levels are insufficient.

7. PROPOSED RESEARCH FRAMEWORK

To address these identified research gaps, a detailed analytical framework for future investigation is proposed:

Structural Building Model: A full-scale 3D model of a 2 Basement + G + 16 + Terrace R.C.C. residential building (27.0 m × 20.5 m) located in Seismic Zone III.

Analytical Software: ETABS finite element software package

Structural Model Configurations:

- Model 01 (Without Transfer Girder): Floating lift core terminating at an intermediate level, transferring loads directly into supporting floor beams and R.C.C. pardi sections.
- Model 02 (With Transfer Girder): Discontinuous lift core supported by heavy, deep transfer girders resting on primary continuous columns.

Loading Standards:

- Gravity Dead & Live Loads per IS 875 (Parts 1 & 2).
- Wind Loads per IS 875 (Part 3: 2015) for Basic Wind Speed 44 m/s.
- Dynamic Seismic Loads via Response Spectrum Analysis per IS 1893 (Part 1): 2016.

Evaluated Response Parameters:

Fundamental natural time period and modal mass participation.

- Design base shear (V_b) and story shear distribution.
- Maximum lateral story displacement and inter-story drift.
- Overturning moments

8. CONCLUSIONS

This review highlights the importance of structural continuity, load transfer mechanisms, and stiffness distribution in multi-storey R.C.C. buildings. 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.

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