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Dynamic Analysis of Hirise Building (2 Basements + GF + 16 Upper Floors + Terrace)

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Abstract- This study presents the dynamic analysis of a reinforced concrete high-rise building comprising two basements, ground floor and sixteen upper floors using ETABS. Dead, live and seismic loads are assigned according to IS 875 and IS 1893 (Part 1):2016. Response spectrum analysis is used to evaluate time period, storey displacement, drift, base shear and overturning moment. The study demonstrates the effectiveness of ETABS in predicting seismic behaviour and ensuring code compliance.

I. INTRODUCTION

High-rise buildings require careful evaluation of lateral load effects because earthquake and wind forces increase with height. Dynamic analysis considers the inertia, stiffness and damping characteristics of the structure and provides a more realistic estimate of structural response than equivalent static analysis. ETABS is widely used for modelling reinforced concrete buildings due to its integrated analysis and design capabilities.

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II. OBJECTIVES

- Develop a complete ETABS model.
- Apply gravity and seismic loads.
- Perform response spectrum analysis.
- Evaluate displacement, drift, shear and time period.
- Assess compliance with IS 456, IS 875 and IS 1893.

III. SCOPE OF STUDY

The work is limited to linear dynamic analysis of the proposed reinforced concrete building. The study includes modelling, loading, analysis and interpretation of ETABS results. Nonlinear analysis and soil-structure interaction are outside the scope.
Literature Review and Building Description

IV. LITERATURE REVIEW

4.1 Previous Study 1

Previous research on reinforced concrete high-rise buildings shows that response spectrum analysis provides reliable estimates of seismic response. Researchers have reported that storey drift, lateral displacement, base shear and torsional response are strongly affected by structural stiffness, shear wall location and plan irregularity. ETABS is widely adopted for seismic analysis because it integrates modelling, loading, analysis and design.

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V. BUILDING DESCRIPTION

The proposed building consists of two basement levels, one ground floor and sixteen upper floors. The structural framing system comprises reinforced concrete slabs, beams, columns and shear walls. The model is developed in ETABS using the architectural and structural drawings supplied for the project.

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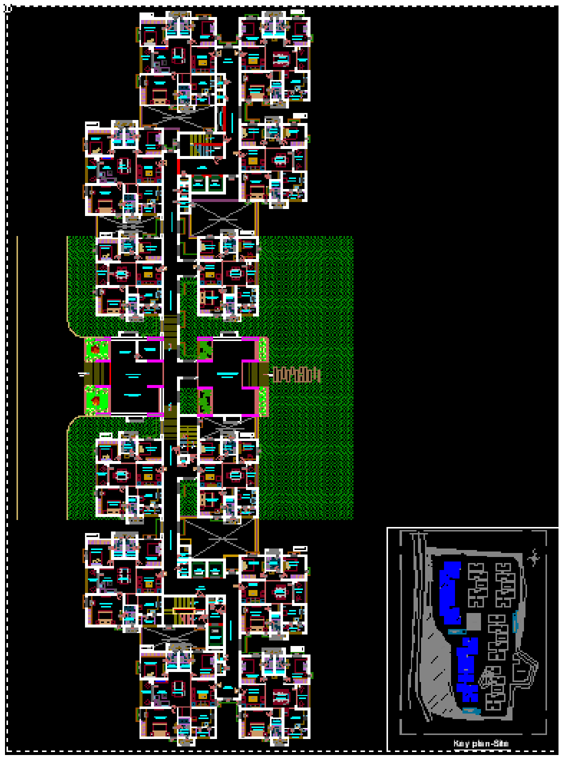

Figure 5.1 Ground Floor Plan

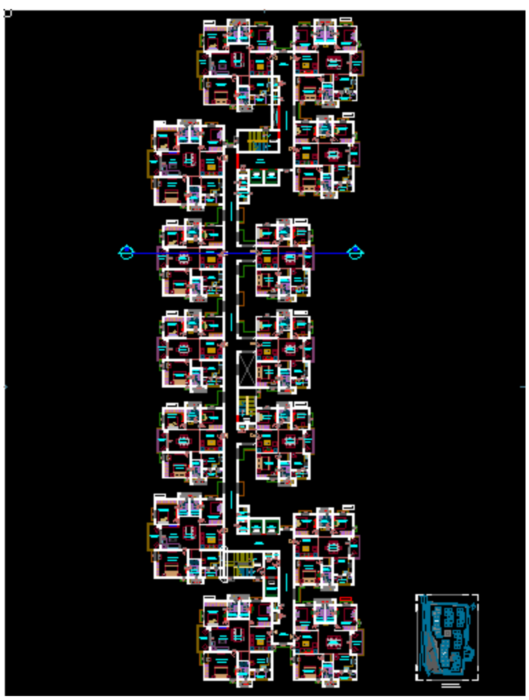

Figure 5.2 Typical Floor Plan

Figure 5.3 Soil Investigation

VI. ETABS MODELLING

The building geometry was created using grid lines and storey data. M35 concrete and Fe500 reinforcement were defined. Beams, columns, slabs and shear walls were assigned appropriate section properties. Rigid diaphragms were provided at every floor. Dead, live and seismic loads were assigned according to IS 875 and IS 1893. Response spectrum analysis was selected for evaluating seismic behaviour.

VII. MATERIAL PROPERTIES

Property	Value
Concrete	M35
Steel	Fe500
RCC Unit Weight	25 kN/m³
Floor Finish	1.5 kN/m²

VIII. LOAD CALCULATIONS

Typical floor height=2.95 m.

200 mm wall load= $(0.2\times25\times(2.95-0.45))=12.5$ kN/m.

100 mm wall load= $(0.1\times25\times(2.95-0.45))=6.25$ kN/m.

160 mm wall load=10.0 kN/m.

300 mm wall load=18.75 kN/m.

Toilet SDL=2.4 kN/m²; Balcony SDL=3.4 kN/m²; Utility SDL=4.3 kN/m².

Parking LL=3.75 kN/m²; Terrace SDL=5.6 kN/m²; Podium LL=15 kN/m².

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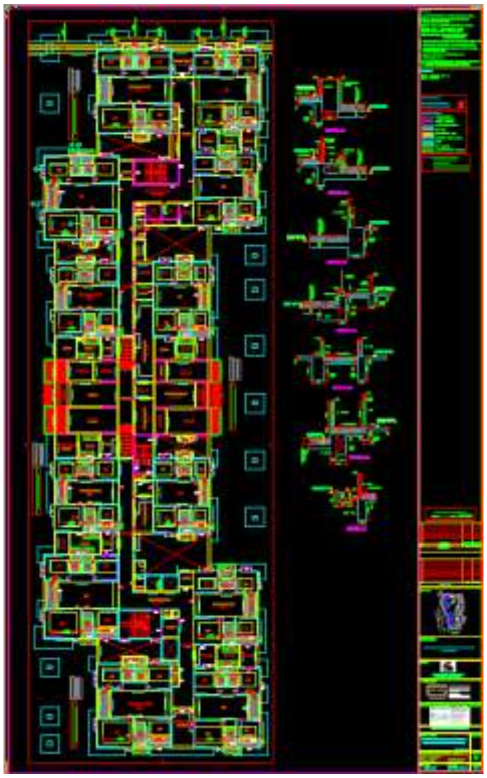

Figure 8.1 Ground Floor Shuttering

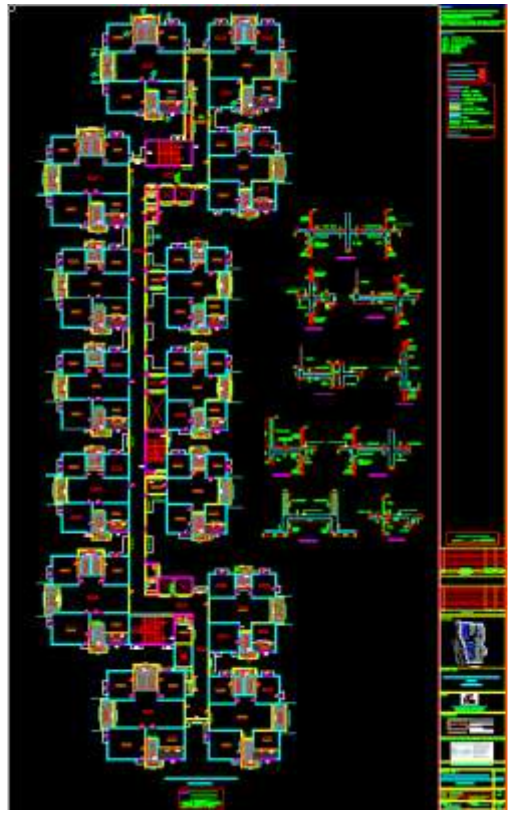

Figure 8.2 Typical Floor Shuttering

Figure 8.3 Site Cross Section

Dynamic Analysis and Results

IX. RESPONSE SPECTRUM ANALYSIS

Response Spectrum Analysis was performed in ETABS according to IS 1893 (Part 1):2016. The design response spectrum was defined based on seismic zone, importance factor, response reduction factor and soil type. Modal responses were combined using standard modal combination procedures to estimate maximum structural response.

X. TIME PERIOD

The fundamental natural time period is an important parameter governing seismic response. The calculated time periods obtained from ETABS were compared with analytical calculations to verify the modelling accuracy.

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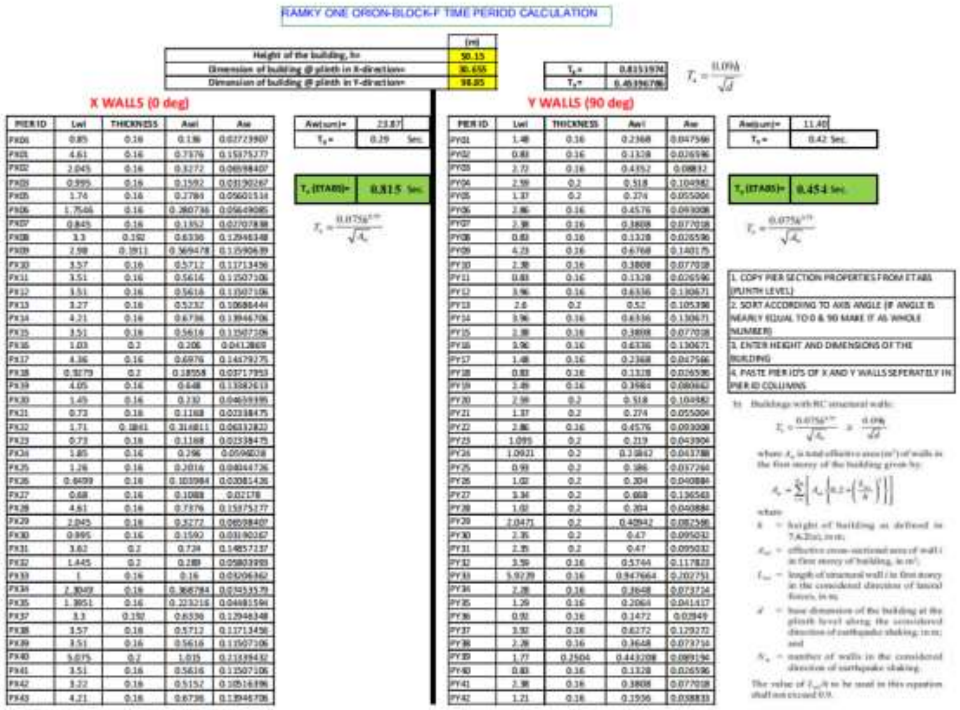

Figure 10.1 Time Period Calculation - Sheet 1

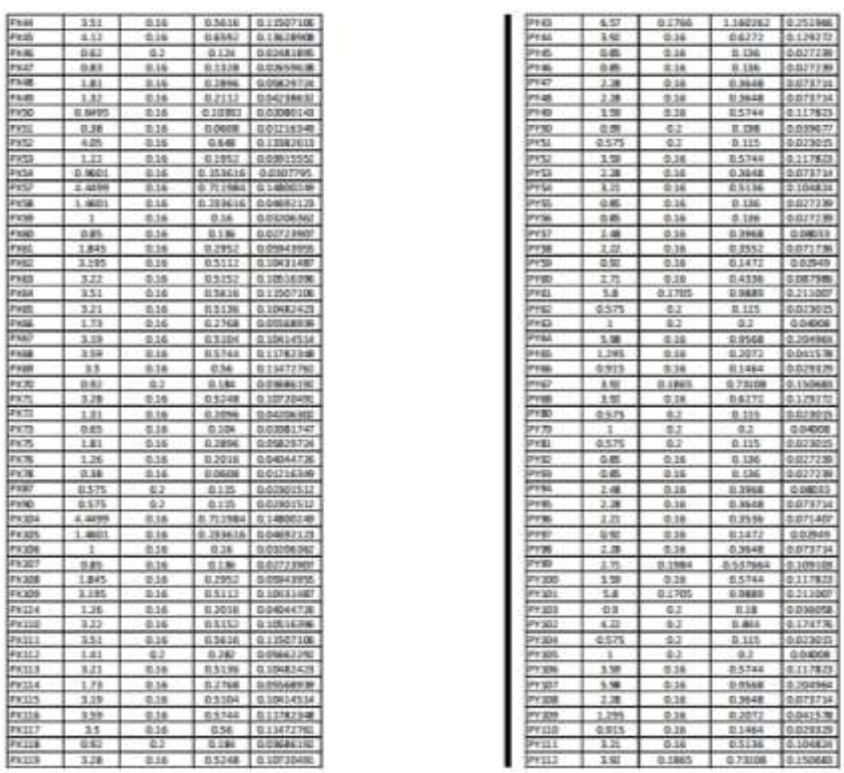

Figure 10.2 Time Period Calculation - Sheet 2

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PX120	1.31	0.16	0.2096	0.04206302
PX123	1.81	0.16	0.2896	0.05829724
PX126	0.38	0.16	0.0608	0.01216349
PX127	4.61	0.16	0.7376	0.15375277
PX128	2.045	0.16	0.3272	0.06598407
PX129	0.995	0.16	0.1592	0.03190267
PX130	0.575	0.2	0.115	0.02301512
PX131	1.5742	0.2	0.31484	0.06327822
PX132	3.3	0.192	0.6336	0.12946348
PX133	3.57	0.16	0.5712	0.11713456
PX134	3.51	0.16	0.5616	0.11507106
PX135	6.275	0.2	1.255	0.2706485
PX136	1	0.16	0.16	0.03206362
PX137	1.2949	0.16	0.207184	0.04157493
PX138	1.3951	0.16	0.223216	0.04481594
PX139	1	0.16	0.16	0.03206362
PX140	1.5742	0.2	0.31484	0.06327822
PX141	3.51	0.16	0.5616	0.11507106
PX142	3.22	0.16	0.5152	0.10516396
PX143	4.21	0.16	0.6736	0.13946706
PX144	3.51	0.16	0.5616	0.11507106
PX145	3.7325	0.2	0.7465	0.15343511
PX146	2.35	0.2	0.47	0.09503203
PX147	4.12	0.16	0.6592	0.13628908
PX148	0.62	0.2	0.124	0.02481895
PX149	4	0.16	0.64	0.13207153
PX150	1.2211	0.16	0.195376	0.03919103
PX04	0.85	0.16	0.136	0.02723907
PX01	4.61	0.16	0.7376	0.15375277
PX02	2.045	0.16	0.3272	0.06598407
PX03	0.995	0.16	0.1592	0.03190267
PX05	1.74	0.16	0.2784	0.05601514
PX06	1.7546	0.16	0.280736	0.05649085
PX07	0.845	0.16	0.1352	0.02707838
PX08	3.3	0.192	0.6336	0.12946348
PX09	2.98	0.1911	0.569478	0.11590639
PX10	3.57	0.16	0.5712	0.11713456
PX11	3.51	0.16	0.5616	0.11507106
PX12	3.51	0.16	0.5616	0.11507106
PX13	3.27	0.16	0.5232	0.10686444
PX14	4.21	0.16	0.6736	0.13946706
PX15	3.51	0.16	0.5616	0.11507106
PX16	1.03	0.2	0.206	0.0412869
PX17	4.36	0.16	0.6976	0.14479275
PX18	0.9279	0.2	0.18558	0.03717953
PX19	4.05	0.16	0.648	0.13382613
PX20	1.45	0.16	0.232	0.04659395
PX21	0.73	0.16	0.1168	0.02338475
PX22	1.71	0.1841	0.314811	0.06332822
PX23	0.73	0.16	0.1168	0.02338475

PY113	0.85	0.16	0.136	0.027239
PY114	0.85	0.16	0.136	0.027239
PY115	3.92	0.16	0.6272	0.129272
PY116	1.48	0.16	0.2368	0.047566
PY117	0.83	0.16	0.1328	0.026596
PY118	2.49	0.16	0.3984	0.080662
PY119	2.59	0.2	0.518	0.104982
PY120	1.37	0.2	0.274	0.055004
PY121	4.2	0.16	0.672	0.139113
PY122	6.69	0.16	1.0704	0.233128
PY123	2.8629	0.16	0.458064	0.093106
PY124	1.04	0.2	0.208	0.041689
PY125	2.3	0.2	0.46	0.092968
PY126	2.3	0.2	0.46	0.092968
PY127	2.59	0.2	0.518	0.104982
PY128	3.77	0.2	0.754	0.155061
PY129	2.3	0.2	0.46	0.092968
PY130	1.1	0.2	0.22	0.044106
PY131	3.67	0.2	0.734	0.150731
PY132	3.59	0.16	0.5744	0.117823
PY133	5.8	0.1829	1.06082	0.226353
PY134	2.28	0.16	0.3648	0.073714
PY135	2.28	0.16	0.3648	0.073714
PY136	1.77	0.16	0.2832	0.056993
PY137	0.83	0.16	0.1328	0.026596
PY138	1.29	0.16	0.2064	0.041417
PY139	0.92	0.16	0.1472	0.02949
PY140	3.92	0.16	0.6272	0.129272
PY141	3.92	0.16	0.6272	0.129272
PY142	2.38	0.16	0.3808	0.077018
PY143	0.83	0.16	0.1328	0.026596
PY144	2.59	0.2	0.518	0.104982
PY145	3.82	0.16	0.6112	0.125786
PY146	3.82	0.16	0.6112	0.125786
PY147	2.59	0.2	0.518	0.104982
PY148	1.48	0.16	0.2368	0.047566
PY149	0.83	0.16	0.1328	0.026596
PY150	2.49	0.16	0.3984	0.080662
PY151	1.37	0.2	0.274	0.055004
PY152	2.86	0.16	0.4576	0.093008
PY153	4.23	0.16	0.6768	0.140175
PY154	2.48	0.16	0.3968	0.08033
PY155	3.9	0.16	0.624	0.128574
PY156	3.9	0.16	0.624	0.128574
PY15A	0.83	0.16	0.1328	0.026596

Figure 10.3 Time Period Calculation - Sheet 3

XI. RESULTS AND DISCUSSION

Parameter	Observation
Storey Displacement	Maximum displacement observed at roof level.
Storey Drift	Within IS 1893 permissible limits.
Storey Shear	Maximum at lower storeys.
Base Shear	Satisfies design requirements.
Overturning Moment	Highest at foundation level.
Overall Behaviour	Stable response due to adequate stiffness and shear walls.

The analytical results indicate that the structural system performs satisfactorily under the prescribed seismic loading. Proper stiffness distribution and the inclusion of shear walls significantly reduce lateral displacement and storey drift.

XII. CONCLUSION

The dynamic analysis of the reinforced concrete high-rise building comprising two basements, ground floor and sixteen upper floors was successfully carried out using ETABS. The structural model was developed using appropriate material properties, member sections and loading conditions in accordance with IS 456:2000, IS 875 and IS 1893 (Part 1):2016.

Response spectrum analysis demonstrated that the building satisfies serviceability requirements with acceptable storey drift, displacement, base shear and overturning moment. The use of shear walls enhanced the lateral stiffness and improved the overall seismic performance of the structure.

XIII. FUTURE SCOPE

- Perform nonlinear pushover analysis.
- Carry out nonlinear time-history analysis using recorded earthquake motions.
- Investigate soil–structure interaction.
- Study different shear wall configurations.
- Optimize structural members for economy.
- Evaluate wind effects using wind tunnel data.
- Adopt performance-based seismic design.

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