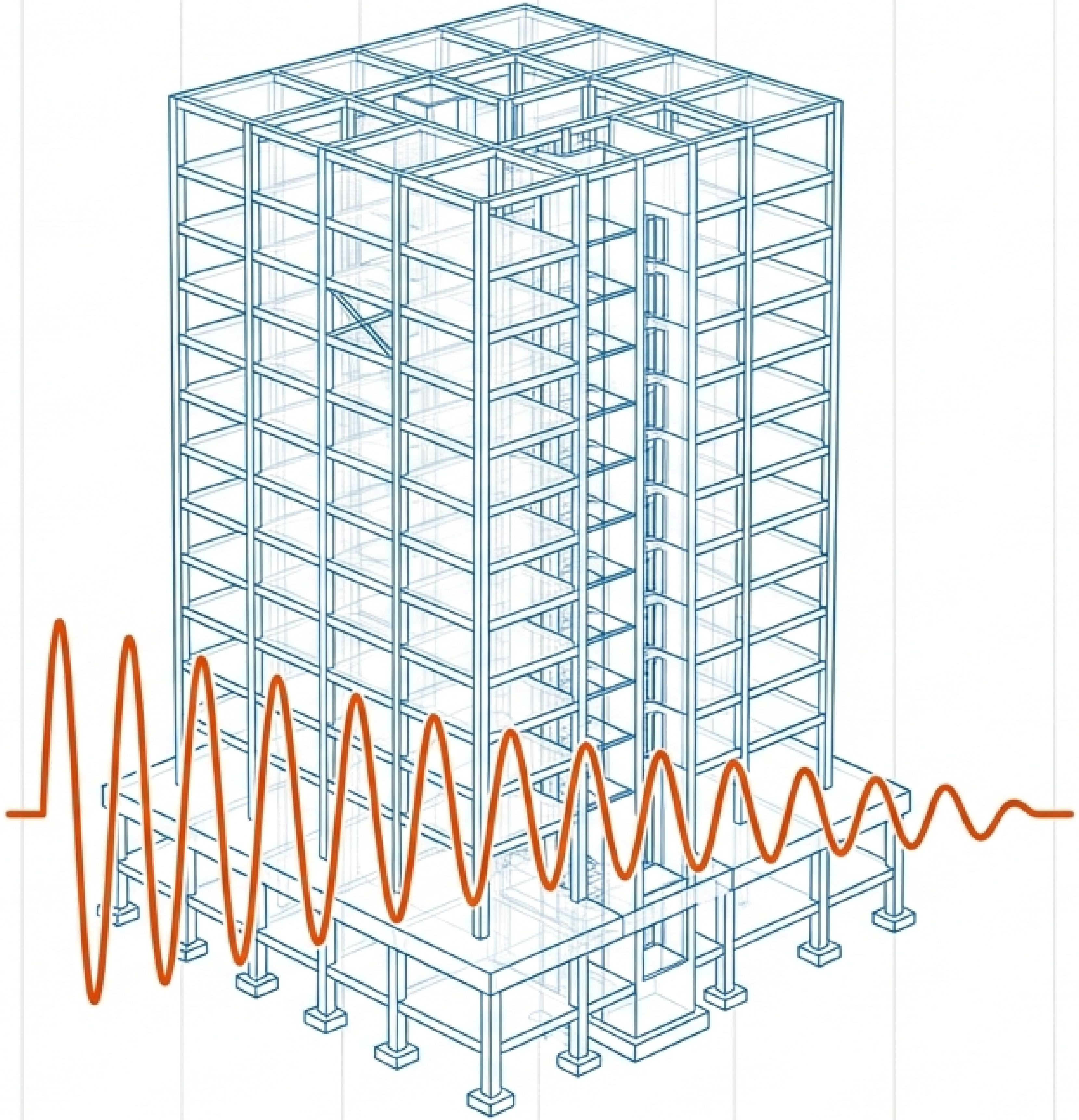
Engineering Editorial

Mastering IS 1893:2025 in ETABS

From Linear to Time History Analysis

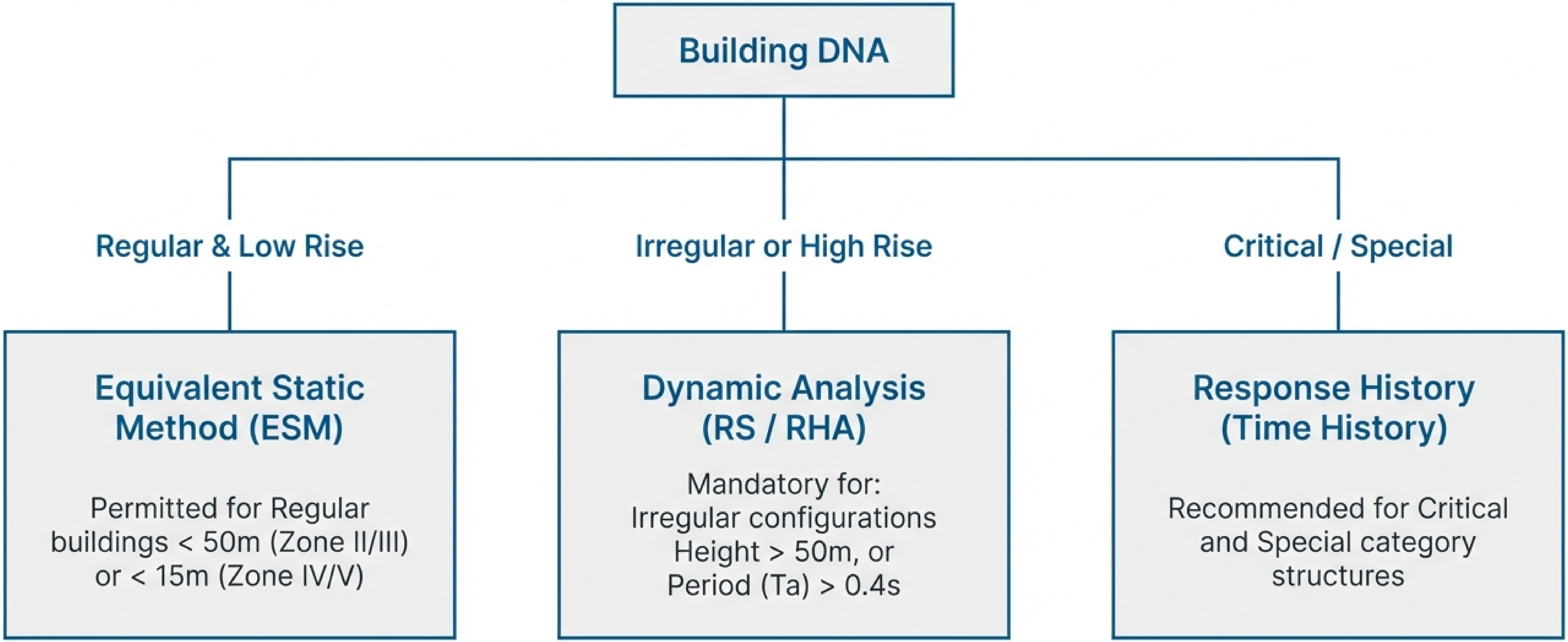
A comprehensive workflow for Equivalent Static, Response Spectrum, and Response History methods based on the latest Indian Standard code implementation strategies.



CSI India Modeling Guidelines

Choosing the Right Weapon: The Analysis Matrix

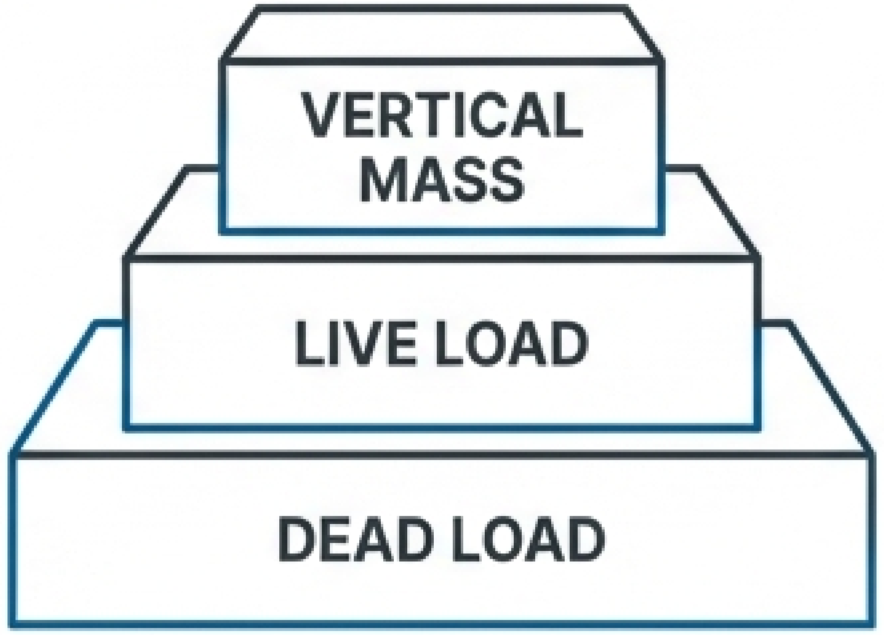
Based on Table 9 of Part 5 (IS 1893:2025)



The Digital Twin: Modeling Prerequisites

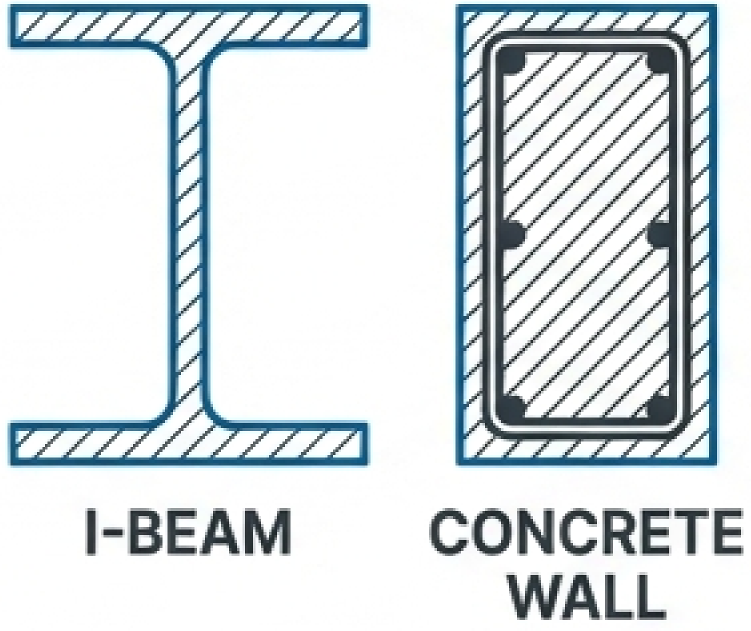
Based on Table 9 of Part 5 (IS 1893:2025)

Mass Source Definition



- Formula: Dead Load (100%) + Live Load (25%)
- **Note:** Include vertical masses if required by geometry.

Stiffness Modifiers (Table 3)

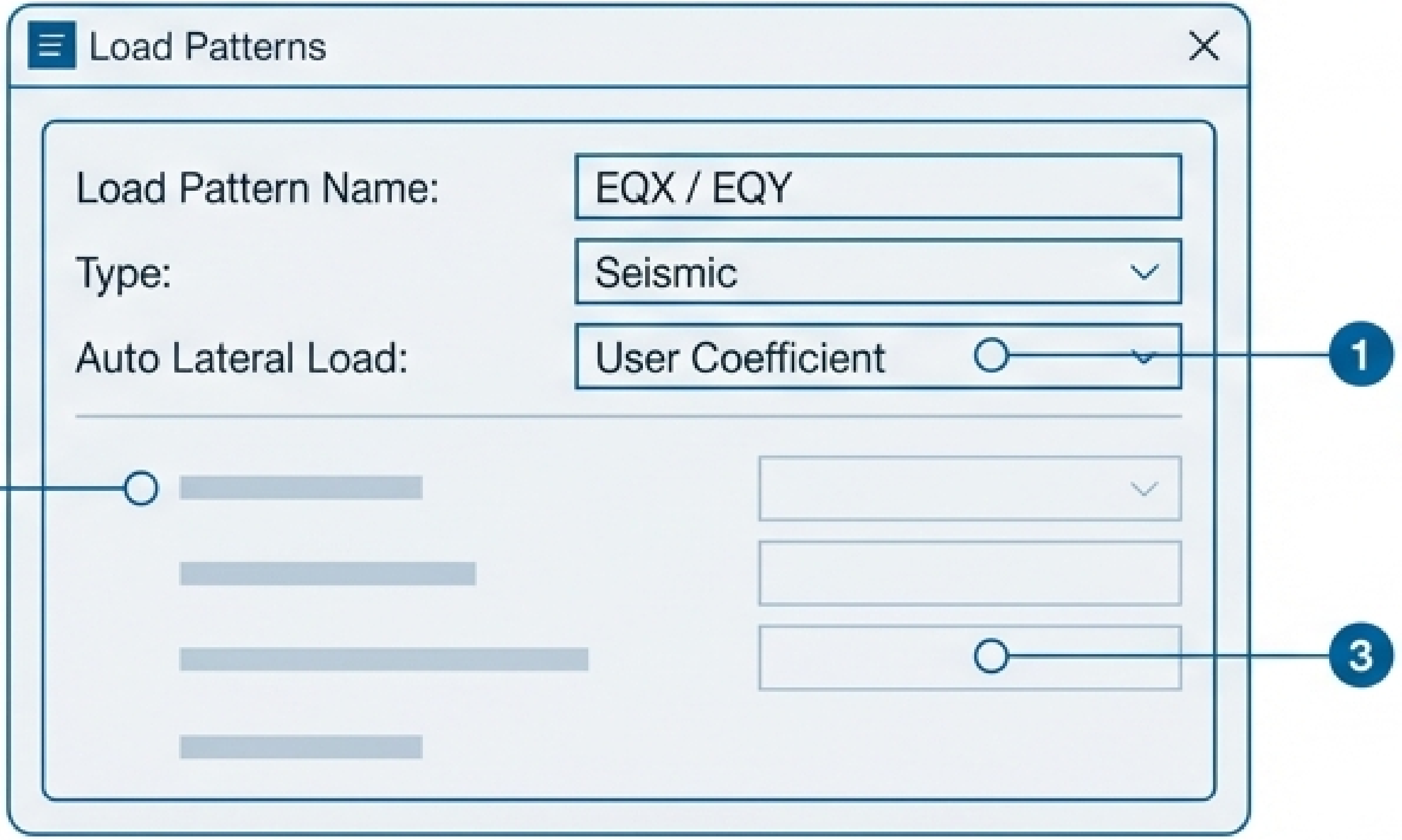


Beams:	0.35 Ig (Moment of Inertia)
Columns:	0.70 Ig (Area & Inertia)
Walls:	0.70 Ig (Area & Inertia)

Critical Wall Note: Apply 0.70 to F12 (In-plane shear) and M22 (Out-of-plane bending).

- **Boundary Conditions:** Explicitly include shear deformations in stiffness matrices.

The Baseline: Equivalent Static Method (ESM)



Settings: Select Zone (e.g., Zone III) and Soil Type.

Parameter Calculation: Use Plugin or Manual Calculation for Base Shear Coefficient (Ah) and Exponent (k).

Period Method: Use Approximate Natural Time Period (Ta).

⚠ **Optimization Tip:** Use Ritz Vectors instead of Eigen vectors for faster convergence and better capture of vertical excitation modes.

The 80% Rule: Verifying Static Applicability

Modal Participating Mass Ratios				
Case	**Mode**	**Period**	**Sum UX**	**Sum UY**
Modal	1	0.74s	0.7300	0.0000
Modal	2	0.62s	0.7300	0.7200
Modal	3	0.45s	0.7305	0.7210

The Constraint: ESM is valid only if the first translational mode accounts for **≥ 80%** of mass participation.

The Reality: In this example, Mode 1 participation is **~73%**.

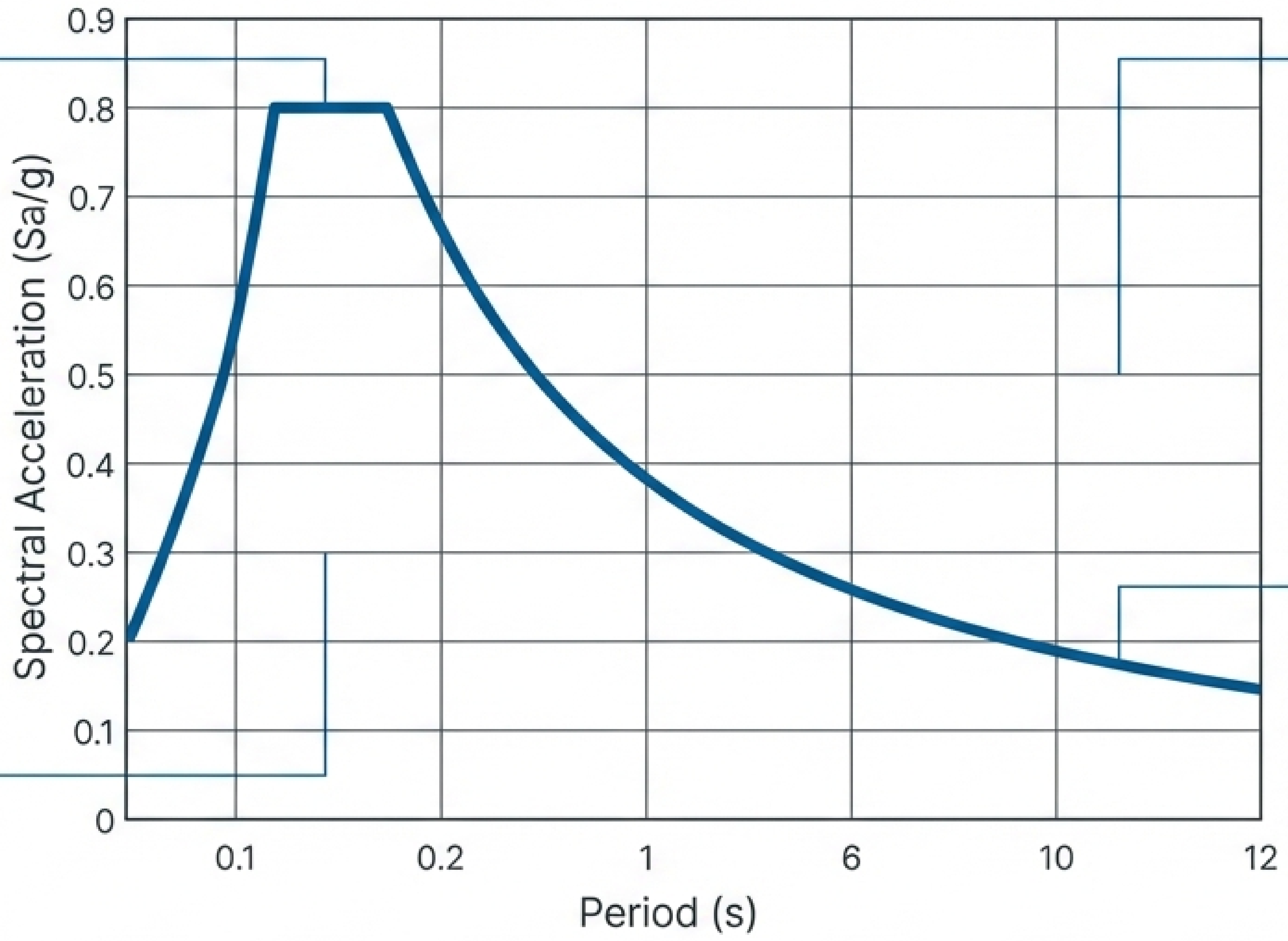
The Verdict: **FAILED. < 80%** requires escalation to Dynamic Analysis. ⚠

Check: Verify Mode 1 & 2 are well-separated and identify Torsional modes.

Response Spectrum: Defining the Function

Function Definition:
Generated using IS 1893:2025 parameters (Zone, Soil Type).

Mass Participation Requirement:
≥ 90%
(Total Modes).



Combination Method:
CQC (Complete Quadratic Combination).

Directionality: Define functions for Horizontal (X, Y) and a separate function for Vertical (Z).

Configuring Dynamic Load Cases

Load Case Data

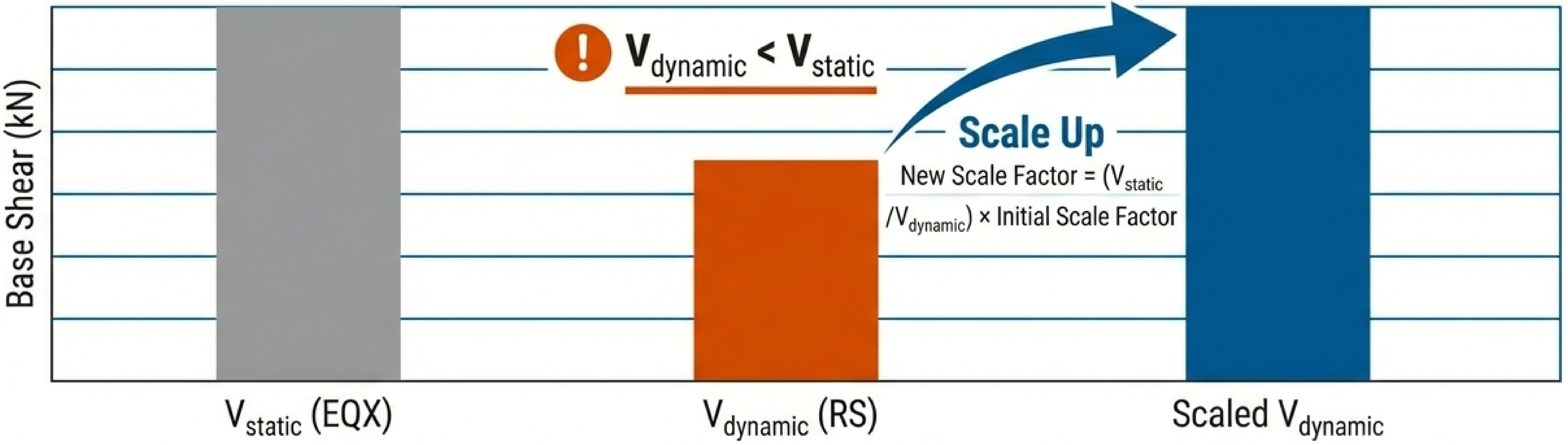
Load Case Name:	RS_X
Load Type:	Acceleration
Load Name:	U1
Function:	IS_1893_Func
Scale Factor:	[Formula Placeholder]

$$\text{Scale Factor} = \frac{I \cdot g}{2R}$$

Note: g must be in model units (e.g., 9810 mm/s²).

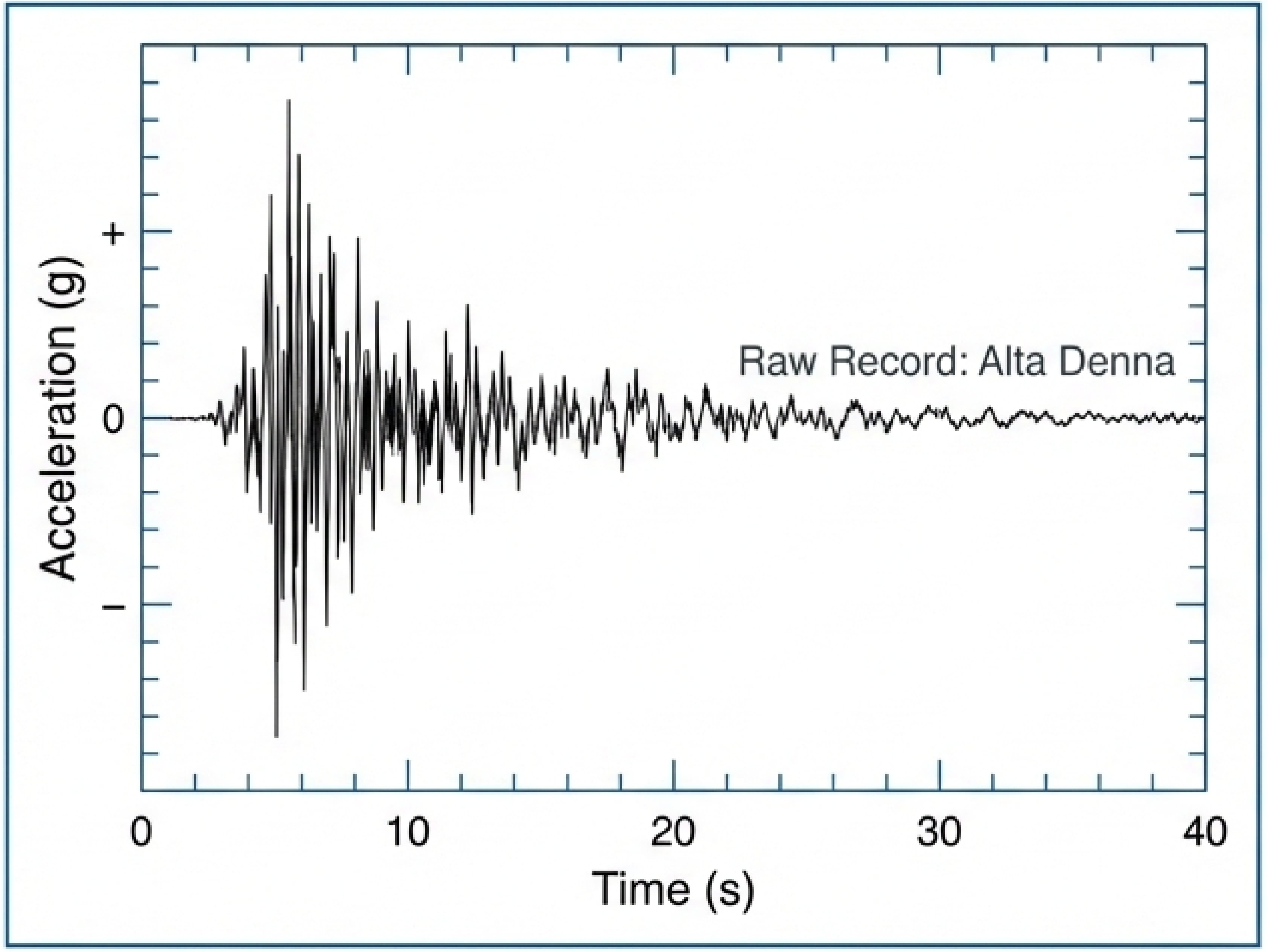
- **Damping:** Constant 5% modal damping.
- **Vertical Excitation:** Apply specific vertical spectrum function without the Response Reduction (R) factor.

The Scaling Mandate: Dynamic vs. Static Base Shear



- **The Rule**: Dynamic forces cannot be lower than Static forces.
- **Condition**: If $V_{dynamic} < V_{static}$
- **Action:** New Scale Factor = $(V_{static} / V_{dynamic})$ × Initial Scale Factor
- **Note:** Deformation responses do not need amplification. Vertical Z spectrum requires no scaling.

Response History: Sourcing Ground Motion Data



Data Sources:

- **BIS Records:** 30 ground motions for Zones II-IV (far-field), 60 for near-field.
- **Raw Data:** Example shown is 'Alta Denna' (2000 points @ 0.02s).

Requirement:

3 pairs of ground motions (X, Y, Z).

The Challenge:

Raw data is often unscaled and incompatible with design spectrum.

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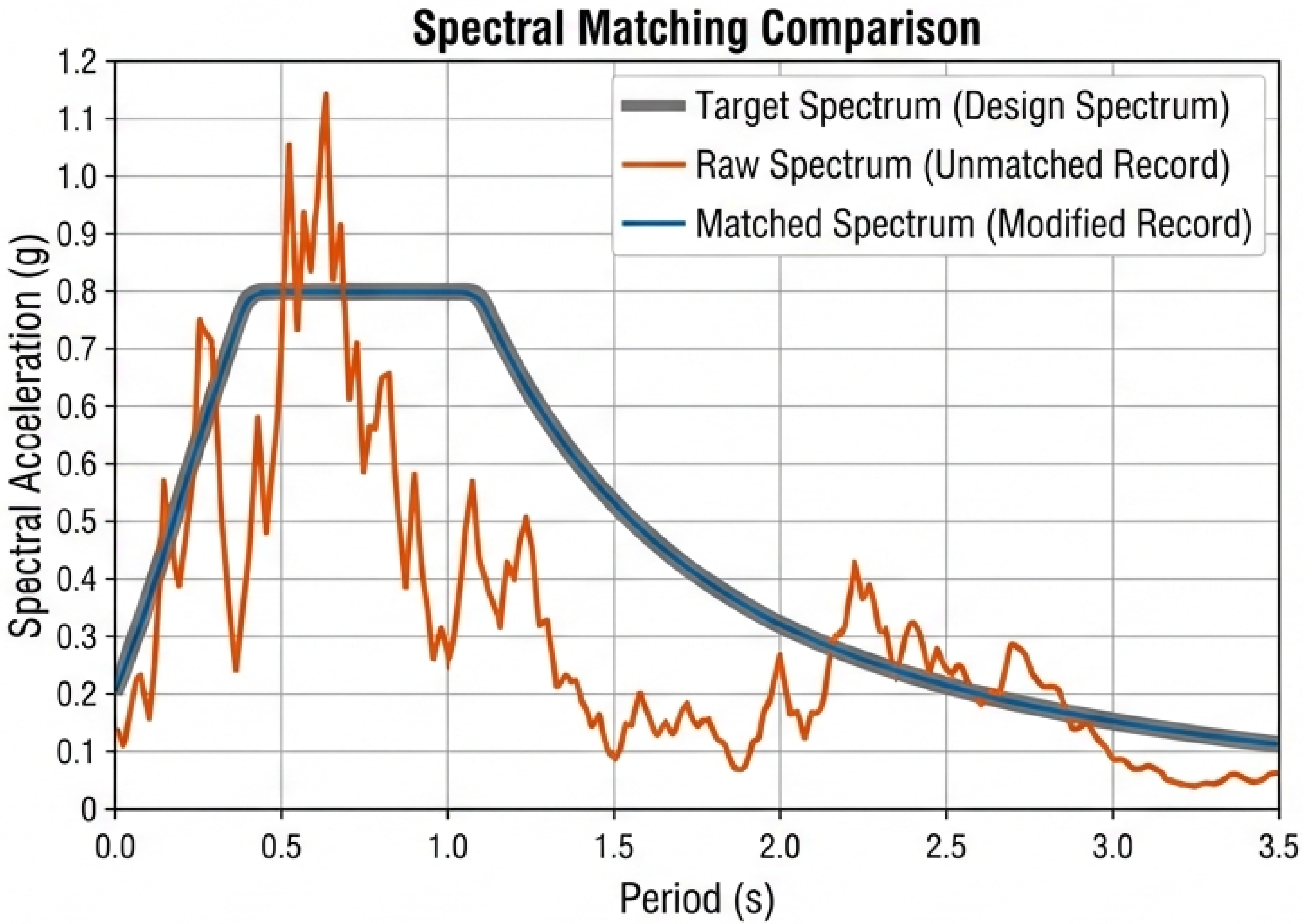
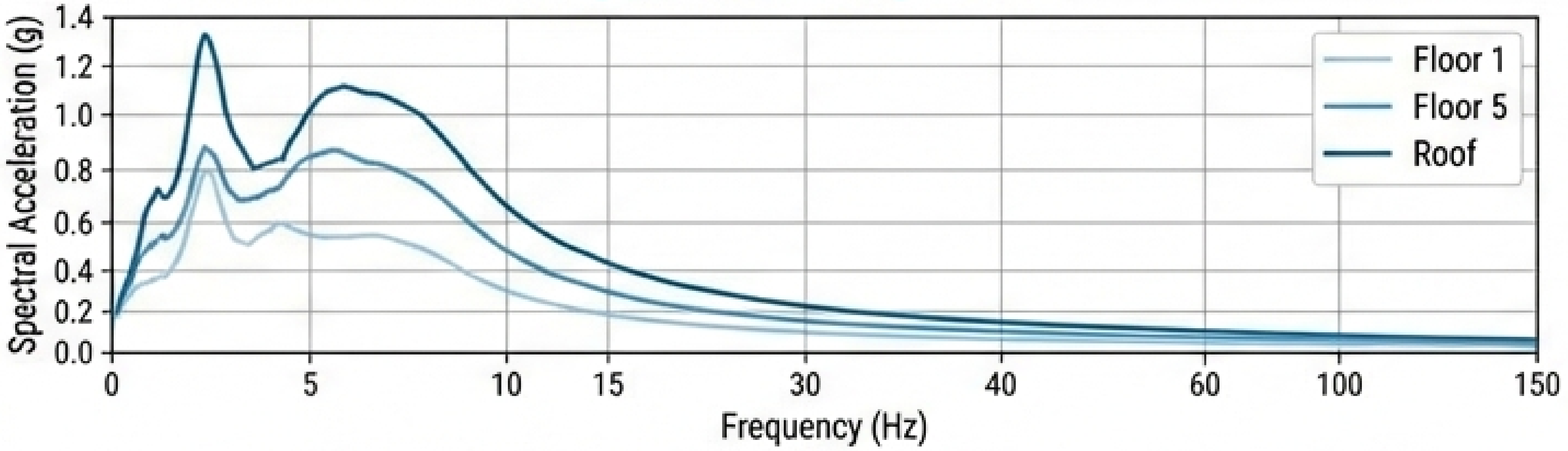
Spectral Matching: Taming the Raw Data



- **Tool:** ETABS 'Match to Response Spectrum'.
- **Target:** Horizontal Design Spectrum (Z-factor & Soil corrected).
- **Input:** Raw Time History Record.
- **Result:** A statistically modified time history that aligns with code requirements, ready for analysis.

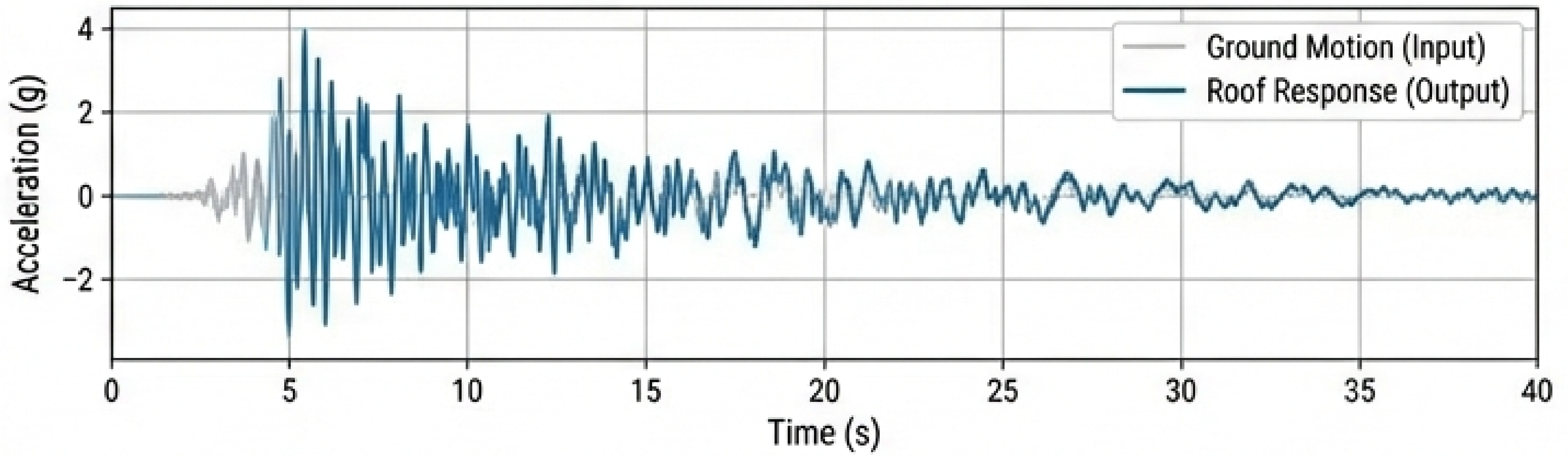
Running Response History & Extracting Insights

Output: Floor Spectra



Essential for designing secondary systems and MEP.

Output: Plot Functions



Execution Settings:

- **Type:** Linear Modal History (Transient)
- **Scale Factor:** 1.0 g (if matched) or I·g/R (if using BIS scaled data).

Load Combinations & The Omega Factor

Load Combinations	
Gravity	1.5 DL + 1.5 LL
Seismic (Orthogonal)	1.2 DL + 1.2 LL + 1.2 EQX + 0.36 EQY

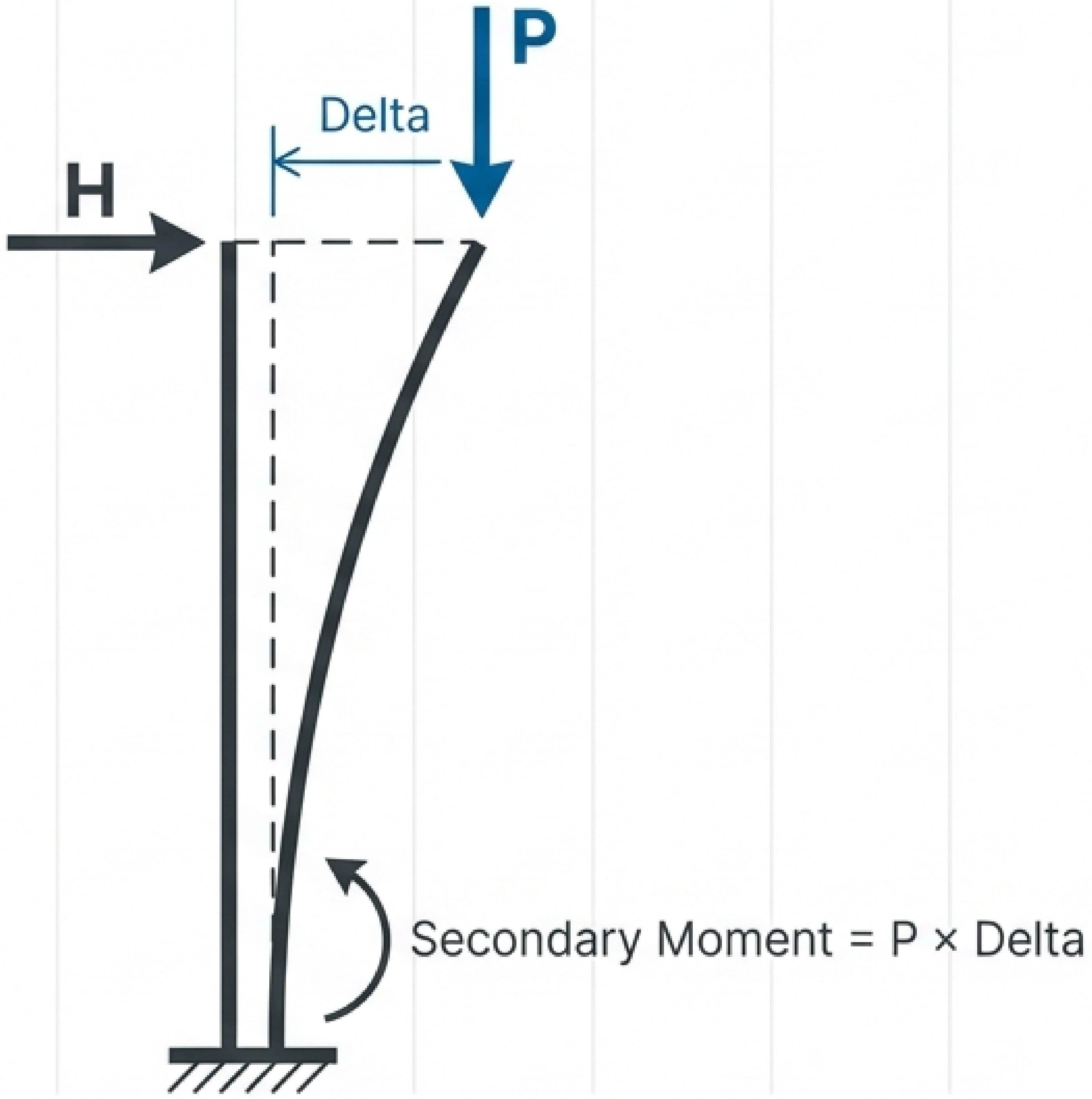
The Omega (Ω) Challenge

Code Requirement: Overstrength factors for vertical elements (Columns/Walls).

Implementation Strategy: Multi-Model Approach.

- **Model A:** Standard combinations.
- **Model B:** Manual combinations with **Ω** applied.
- **Design: Envelope** of Model **A + Model B**.

Stability Checks: P-Delta & The Q-Factor



The Code Check:

- Calculate Stability Index (Q).
- If Q < 0.4: Linear Analysis Permitted.
- If Q > 0.4: P-Delta Mandatory.

Expert Recommendation:

Always perform P-Delta analysis (Iterative Based on Loads) to capture realistic secondary effects, regardless of Q.

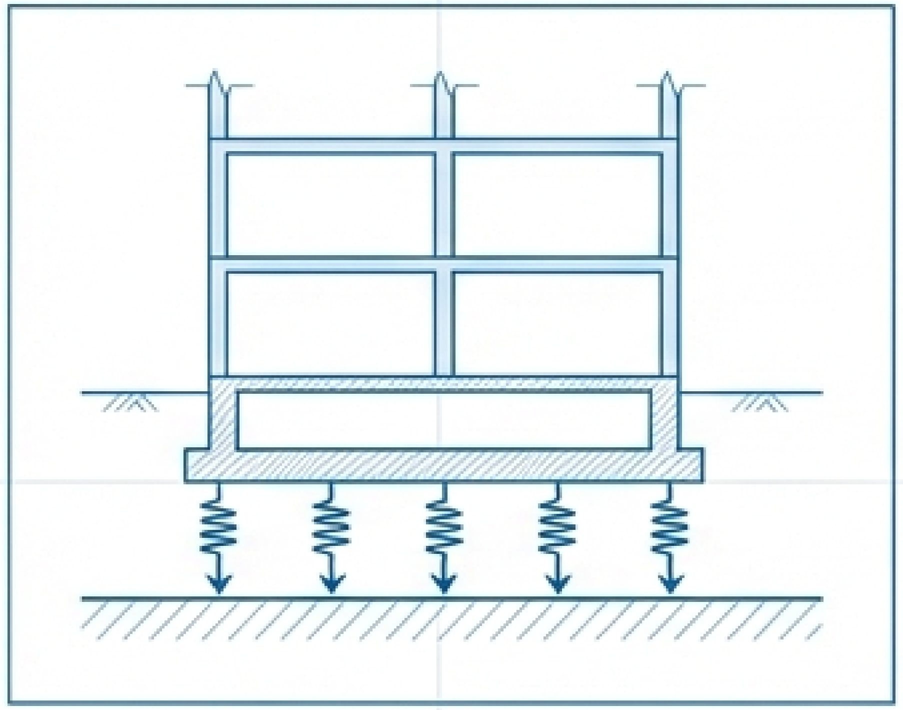
Tip: Check 'K factors' in design summary to review Q.

The Compliance Checklist: IS 1893:2025

- [ ] **Mass Participation (Static): ≥ 80%** (First Mode)
- [ ] **Mass Participation (Dynamic): ≥ 90%** (Total)
- [ ] **Base Shear Check: $V_{\_dynamic} \geq V_{static}$ (Scale if failed)**
- [ ] **Scale Factors:** Applied as **$I \cdot g / 2R$**
- [ ] **Torsion:** Calculated eccentricity overrides (1.8 factor)
- [ ] **Stiffness:** Modifiers applied to all frames/shells (Table 3)

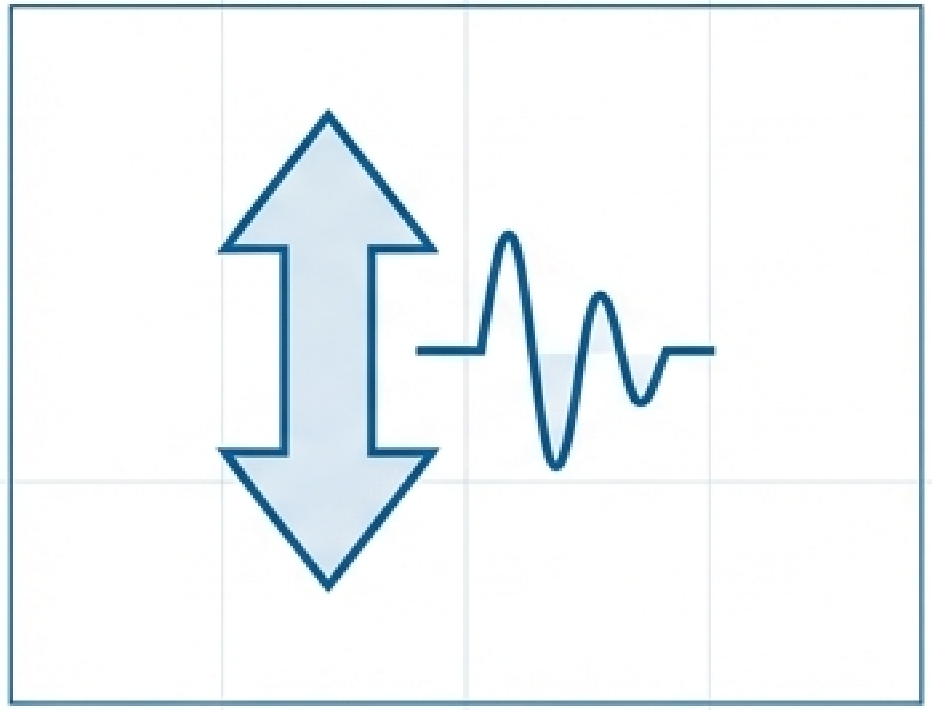
NotebookLM

Edge Cases & Expert Nuances



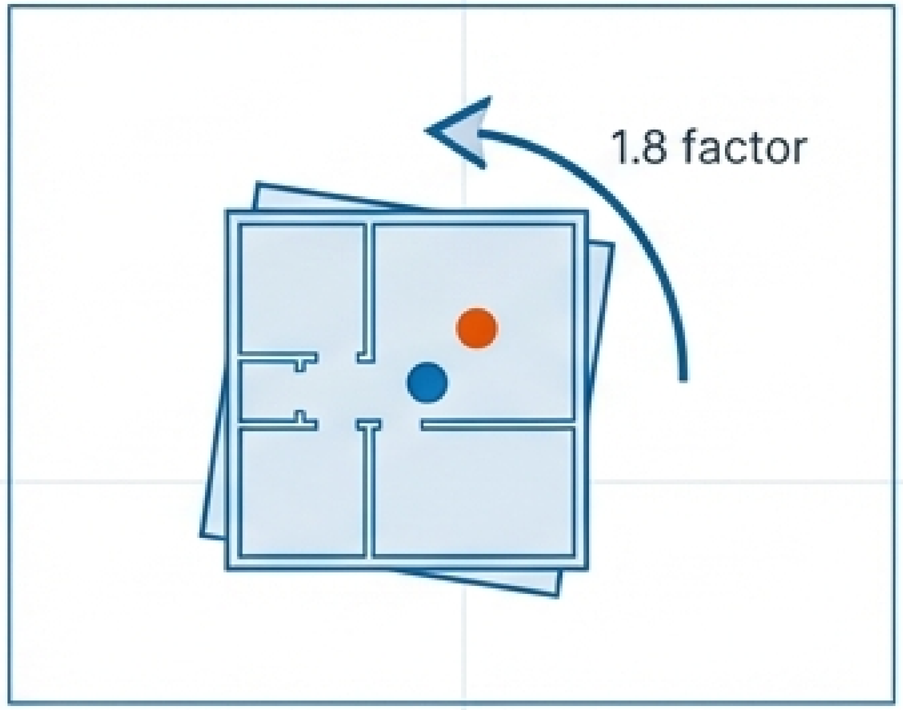
Raft Foundations

Do not assume fixed bases. Explicitly model soil flexibility (springs) per code guidance.



Vertical Excitation

Use specific Vertical Spectrum function. Do **NOT** apply the Response Reduction Factor (R).



Torsional Eccentricity

Avoid default 'Design Eccentricity'. Manually calculate overrides (1.8 factor) for precise control.

"Simulation is only as good as the inputs. Model accurately, verify constantly."