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Technology, Social Impact

New Empirical Formula for Fundamental Period of Tall Buildings in India by Ambient Vibration Test

INTRODUCTION

- Urbanization is rapidly increasing in every city in India. There are several earthquake safety issues involved in planning, designing and constructing tall buildings.
- Among several aspects, the fundamental natural period 'T' of the building is one of the important parameters in the earthquake resistant design of buildings.

OBJECTIVE

- The main objective of the present study is to evaluate suitability of present formulae for high-rise building using ambient vibration test and, if necessary, propose new formulae for Indian tall buildings.

EXPERIMENTAL STUDY

- The current ambient vibration study has been carried out on 21 high-rise buildings located in Hyderabad and Mumbai city.
- The power law and linear regression analysis is adopted to establish the relation between the period and the various building parameters such as height (H), width (D) and product of lateral dimension (A) of the buildings.
- The evaluation of the regression analysis is done with the help of standard error of estimate Se and the coefficient of determination R2.

CONCLUSION

1. The current empirical expression found to be over-conservative for RC SW buildings. Empirical expression of RC SW wall should be stated separately and should not be included in 'other' category.
2. The empirical expression for estimating the fundamental natural periods for RC SW buildings with infill panels can be taken as follow

$$T = 0.01H^{1.1}$$

Where, H is height of building from the base (in m)

3. For RC buildings above 20 floors (>60m) fundamental natural period can be be found out b

$$T = 0.01H^{1.1}$$

Where, H is height of building from the base (in m)

RESULTS

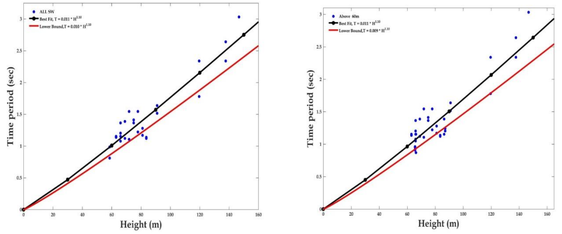

Figure: Plot of experimental data and proposal expression for natural period of (a) RC SW buildings (b) RC buildings above 20 floors with infill wall panel

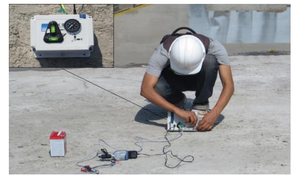

Figure: Building Vibration Sensor

Figure: Examples of typical high-rise buildings

Table: Fundamental Period of RC buildings above 20 storey (>60m) measured using ambient vibration test

S. No.	Building ID	Number of Storey	Height (m)	Typical F.F. Height (m)	Type	Dimensions (m)		Time period (sec)	
						Longer (L)	Shorter (D)	Longer (TL)	Shorter (TD)
1	MUM02	21	63.00	3.00	Residential	49.07	24.80	1.137	1.154
2	HYB12	22	65.60	3.00	Residential	28.94	26.56	0.920	0.963
3	HYB13	22	65.60	3.00	Residential	44.55	28.97	0.952	0.910
4	HYB53	22	66.00	2.95	Residential	27.00	27.00	1.050	1.050
5	MUM14	22	66.00	3.00	Residential	26.40	23.30	1.365	1.204
6	HYB18	22	66.00	3.00	Residential	81.08	25.45	1.078	1.154
7	HYB23	17	66.23	3.90	Commercial	67.64	24.45	0.871	1.154
8	MUM01	23	69.00	3.00	Residential	49.07	24.80	1.122	1.388
9	MUM15	25	71.86	3.00	Residential	24.67	13.63	1.107	1.545
10	MUM03	25	75.00	3.00	Residential	48.19	40.62	1.412	1.365
11	MUM16	26	77.86	3.00	Residential	37.60	16.80	1.222	1.545
12	HYB20	27	81.00	3.00	Residential	73.43	20.58	1.170	1.280
13	HYB32	26	83.60	3.26	Residential	50.46	42.31	1.138	1.122
14	HYB42	28	86.37	3.00	Residential	43.11	40.38	1.388	1.154
15	HYB19	24	87.14	3.75	Commercial	80.26	46.03	1.241	1.204
16	MUM08	31	90.95	2.90	Residential	52.54	35.18	1.517	1.638
17	MUM06	37	119.60	3.20	Residential	46.39	29.72	1.780	2.340
18	MUM07	37	137.70	3.60	Residential	51.54	37.85	2.340	2.642
19	HYB31	42	146.75	3.40	Residential	33.34	29.50	3.033	3.033
20	MUM09*	35	110.80	3.20	Hotel+Office	65.84	34.92	3.723	2.925
21	MUM10*	37	115.40	3.20	Proposed Office	48.60	37.50	3.561	2.482

**Outlier; MUM=Mumbai; HYB=Hyderabad*

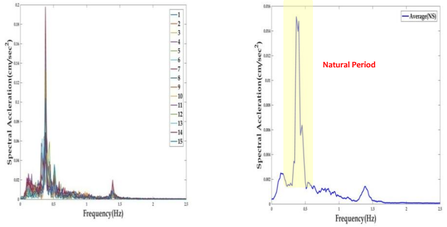

Figure: Identification of Natural Frequency

Table: Proposed Formulae

Type	Formula	S.E.E. (S_e)	IS 1893: 2002	S.E.E. (S_e)
RC SW	$T = 0.01H^{1.1}$	0.135	$T = \frac{0.09H}{\sqrt{D}}$	0.238
Above 60 m	$T = 0.01H^{1.1}$	0.143		0.213

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