Analyzing Dynamic Wind Effects on High Rise Building: A Comparative Study using of Indian and American Wind Standards

A DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE

OF

MASTER OF TECHNOLOGY
IN

STRUCTURAL ENGINEERING

Submitted by

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May, 2024

CANDIDATE’S DECLARATION

I , **Ayush Gupta** , **2K22/STE/04** of MTech (structural engineering), hereby declare that the project Dissertation titled “**Analyzing Dynamic Wind Effects on High Rise Building: A Comparative Study using of Indian and American Wind Standards**” which is submitted by me to the **Department of Civil engineering**, Delhi Technological University, Delhi in partial fulfilment of the requirements for the award of the degree of Master of Technology, is original and not copied from any source with proper citation. This work has not previously formed the basis for the award of the Degree, Diploma Associateship, Fellowship or other similar title or recognition.

Place: DELHI **Ayush Gupta**

Date: 31-05-2024 **(2K22/STE/04)**

CERTIFICATE

I hereby certify that the Project Dissertation titled **"Analyzing Dynamic Wind Effects on High Rise Building: A Comparative Study using of Indian and American Wind Standards"** which is submitted by **Ayush Gupta** (**2K22/STE/04)**, **Department of Civil engineering**, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi

Date: 31-05-2024

Dr. Pradeep K. Goyal

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ACKNOWLEDGEMENT

I **Ayush Gupta,** would like to express my deepest gratitude to all those who have contributed to the successful completion of this thesis.

First and foremost, I extend my sincere appreciation to my supervisor, **Dr. Pradeep Kumar Goyal**, for their invaluable guidance, support, and expertise throughout the entire research journey. Their insightful suggestions, constructive feedback, and unwavering encouragement have been instrumental in shaping this thesis.

I would also like to thank my friends and family for their unwavering support and understanding throughout this journey. Their encouragement, motivation, and belief in my abilities have been a constant source of strength.

This thesis would not have been possible without the support, guidance, and contributions of all those mentioned above. I am truly grateful for their invaluable assistance, and their involvement has played a significant role in the successful completion of this research.

Ayush

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ABSTRACT

This M.Tech thesis presents a comprehensive comparison of wind loading codes for high-rise buildings, focusing on the American Society of Civil Engineers (ASCE) 7-22 and the Indian Standard (IS) 875 (2015) - Part 3. The study evaluates the response of buildings to wind loads through dynamic analysis, considering various dynamic wind characteristics. A set of 150m high-rise buildings of different shapes were subjected to analysis, alongside an 80m height building for further examination of different building geometries.

The comparative analysis primarily focuses on terrain category 3 for both codes, with a meticulous examination of parameters such as design wind pressure at different heights, base shear, storey drift and storey displacement. The aim of this research is to provide insights into the variations between international wind loading standards, particularly in comparison with the Indian wind loading standard.

Through rigorous analysis and comparison, this study sheds light on the disparities in wind load assessments and their implications on structural design and safety. The findings presented in this thesis contribute to enhancing understanding and improving the application of wind loading codes in the design and construction of tall buildings, facilitating better structural performance and resilience in diverse geographical contexts.

CHAPTER - 1

INTRODUCTION

1.1. Soaring Ambition Meets Nature's Fury: High-Rise Buildings and the Challenge of Wind

Modern Indian cities are rapidly transforming, with high-rise buildings becoming increasingly prominent. These structures, like the World Trade Centre Mumbai and The Imperial in Delhi, not only redefine skylines but also symbolize economic growth and a burgeoning urban population. However, their majestic presence often belies a hidden vulnerability – the invisible force of wind.

1.2. A Unique Susceptibility: Height, Exposure, and the Dynamics of Wind

High-rise buildings are particularly susceptible to wind compared to their lower counterparts. Their height exposes them to stronger and more consistent wind speeds, which exert significant lateral forces on their slender profiles. These forces can induce vibrations, sway, and even structural instability if not properly accounted for during the design process.

The dynamics of wind further complicate the challenge. Unlike static loads like gravity, wind is a dynamic force that constantly fluctuates in direction and intensity. This dynamic nature can cause resonance – a phenomenon where wind frequencies match the natural frequencies of a building, leading to amplified vibrations and potential structural damage.

1.3. Beyond Aesthetics: Wind's Impact on Comfort and Safety

The effects of wind on high-rise buildings extend beyond aesthetics and occupant comfort. Excessive wind-induced vibrations can lead to discomfort, nausea, and even fear for occupants. More importantly, these vibrations can cause fatigue in structural elements over time, leading to the development of cracks and compromising long-term safety. In extreme cases, wind forces can be strong enough to cause catastrophic failure, as tragically exemplified by the collapse of the Tacoma Narrows Bridge in

1940.

1.4. The Crucial Role of Wind Loading Codes: Balancing Innovation with Safety for Indian High-Rises

To ensure the safety and integrity of high-rise buildings in India, engineers rely on wind loading codes. These codes establish a standardized and systematic approach for evaluating the effects of wind on structures. They provide methodologies, criteria, and standards for analyzing wind pressures, forces, and the dynamic responses of buildings.

By incorporating the provisions of wind loading codes into the design process, engineers can ensure that high-rise buildings are robust enough to withstand wind forces while maintaining their architectural integrity. This allows for the construction of innovative and sustainable high-rises that contribute to India's urban landscape without compromising the safety of occupants.

1.5. Understanding the Fundamentals: Key Terms for M.Tech. Thesis

Throughout this M.Tech. thesis project, we will encounter some essential terms related to wind engineering and high-rise building design:

- **Wind Loading:** The process of assessing the effects of wind on structures, including wind pressures, forces, and resulting dynamic responses.
- **Structural Integrity:** The ability of a structure to resist external loads and environmental conditions without experiencing excessive deformation, failure, or compromise in its safety.
- **Terrain Categories:** Classifications of terrain types based on their roughness characteristics (open flat terrain, suburban areas, urban centers), which influence wind flow patterns and speeds around buildings.
- **Design Wind Pressure:** The pressure exerted by the wind on a building's surface, used in structural design calculations to determine the required strength and stiffness of building elements. Crucial for Indian standards due to the potential for high wind speeds in some regions.
- **Base Shear:** The total lateral force acting at the base of a structure due to wind or seismic loads, which must be resisted by the building's foundation system.

This is a critical parameter for ensuring the stability of high-rise buildings under lateral wind loads.

- **Gust:** A gust is a brief increase in wind speed compared to the surrounding wind. Imagine a gentle breeze punctuated by short bursts of stronger wind.
- **Gust Factor:** This is a number that tells you how much stronger a gust can be compared to the average wind speed. It's calculated by dividing the **peak gust speed** (the strongest measured gust) by the **sustained wind speed** (the average wind speed over a set time, usually 10 or 60 minutes).

1.6. The Need for Comparative Analysis: A Global Landscape with a Focus on Indian Standards

High-rise buildings in India face unique wind challenges due to the country's diverse geography and climate. The Indian wind loading code (IS 875) is crucial for ensuring their safety, but it can benefit from a comparative analysis with global codes like ASCE 7-22. This analysis can help identify best practices for wind load evaluation, address knowledge gaps in handling specific wind events like cyclones, and ultimately enhance the development of the Indian code. By focusing on both localized considerations and learning from global practices, India can ensure robust and adaptable design standards for its high-rise structures

1.7 Scope and Objectives

This thesis aims to conduct a comprehensive comparative analysis of ASCE 7-22 and IS 875 (2015) - Part 3 in the context of high-rise building design. Specifically, the study seeks to evaluate the response of high-rise buildings to wind loads according to these codes, considering dynamic wind characteristics and key parameters such as design wind pressure, base shear, storey drift and storey displacement. By identifying disparities and providing insights into their implications for structural design practices, the study aims to enhance the application of wind loading codes, particularly in the context of Indian standards.

1.8 Methodology

The methodology employed in this study involves dynamic analysis techniques and computational simulations to assess building response to wind loads. Numerical models will be developed to represent high-rise buildings of varying heights and geometries, considering dynamic wind characteristics and terrain categories specified in ASCE 7-22 and IS 875 (2015) - Part 3. Comparative analysis will be conducted on key parameters, allowing for a detailed examination of the differences between the two codes.

1.9 Organization of the Thesis

The remainder of this thesis is structured as follows: Chapter 2 provides a comprehensive literature review on wind loading codes, high-rise building dynamics, and previous comparative studies. Chapter 3 and 4 discusses the model details and provide overall picture of model. Chapter 5 details the methodology employed in the comparative analysis, including numerical simulations and data collection procedures. Chapter 6 presents the comparative results and discusses their implications for structural design practices. Finally, Chapter 7 offers conclusions, recommendations, and avenues for future research. Through this organization, the thesis aims to provide a systematic and insightful examination of wind loading code disparities and their impact on high-rise building design.

CHAPTER 2
LITERATURE REVIEW

2.1- LITERATURE REVIEWED

Over the past few decades, numerous research studies and papers have been conducted on the response of major international wind codes and standard , we will provide an overview of relevant research studies and papers on this topic.

S. Ahmed et al. (2017), The research paper discusses a comparative study of five major international codes and standards with the latest Indian Code for wind load i.e. IS 875 Part-III(2015) for along wind loads on tall buildings and other provisions for along wind response on tall buildings by Gust Factor Method (GFM).

Dae Kun Kwon ,Ahsan Kareem(2013), A comprehensive comparison of wind loads and their effects on tall buildings is conducted utilizing eight major international codes/ standards: ASCE 2010 (USA), AS/NZ 2011 (Australia and New Zealand), AIJ 2004 (Japan), CNS 2012 (China), NBCC 2010 (Canada), Eurocode 2010 (Europe), ISO 2009 and IWC 2012 (India). The key areas of comparison include the provisions for survivability design as well as the serviceability requirements in the alongwind and acrosswind directions. As most codes/standards utilize a common theoretical framework for modeling dynamic load effects, basic equations here are recast in a general format in order to compare the influence of individual parameters on the overall recommendations of codes/standards.

Yin Zhou et al. (2013), This paper provides a thorough investigation into the discrepancies among major international codes and standards regarding the assessment of along-wind effects on tall structures. Despite the widespread use of the "gust loading factor" (GLF) approach in these codes, significant variability exists in the predicted wind effects under similar flow conditions. The study compares recommendations from ASCE 7-98 (United States), AS1170.2-89 (Australia), NBC-1995 (Canada), RLB-AIJ-1993 (Japan), and Eurocode-1993 (Europe). Key aspects analyzed include the definition of wind characteristics, mean wind loads, GLF, equivalent static wind loads, and resultant wind load effects. The findings reveal that the variability in predicted wind loads primarily stems from differences in the definition of wind field characteristics across the codes and standards. The paper includes a detailed example to illustrate the overall comparison and highlight key findings.

Gholamreza Amirinia et al. (2017), This study investigates the distinct characteristics of hurricane surface winds compared to non-hurricane winds and their influence on the along-wind response of high-rise buildings in open terrains. Specifically, it focuses on mean wind speed profiles, turbulence intensity, and turbulence spectra. After reviewing recent findings on hurricane boundary layer winds, the study examines the characteristics of high-rise buildings in terms of natural frequency and dimension aspect ratio, as well as the role of aerodynamic admittance in unsteady analysis. Three sample high-rise buildings with varying characteristics are selected for unsteady analysis of the along-wind effects of hurricanes. The results indicate that hurricane winds result in higher along-wind forces and responses for very-high-rise buildings compared to regular boundary layer winds, with this difference decreasing for lower heights and higher natural frequencies. While results for regular boundary layer winds align well with high-frequency force balance (HFFB) measurements, root-mean-square base moments are higher for hurricane winds compared to HFFB measurements

Chaudhary Rakesh et al (2019), This research paper conducts a comparative study of the latest Indian wind load code, IS 875 Part-III (2015), with two major international codes: ASCE-7-02 (United States) and AS/NZS1170.2-2011 (Australia and New Zealand), focusing on along-wind loads on high-rise buildings. Wind plays a crucial role in designing buildings, especially in coastal areas and regions with high average wind speeds. Different countries have their own wind codes for designing wind-resistant buildings. The paper compares the response of buildings to wind loads using static analysis, considering a 60m high-rise building with various geometrical shapes. The study evaluates static wind characteristics for terrain categories 2 and 3 using ETABS software and compares parameters such as Base Shear, Story displacement, and Story Drift. The aim is to compare the results of different wind loading codes and standards with the Indian code.

Himanshu Yadav et al(2023), The study focused on exploring interference effects on wind-induced moments between two nearby high-rise structures, emphasizing the importance of considering building proximity, aspect ratios, and wind incidence angles in design By analyzing Cp values, researchers can identify high-pressure areas leading to increased wind loads and low-pressure regions causing suction effects, aiding in informed decision-making during tall structure design Understanding force components along force vectors on wall zones is crucial for assessing structural integrity and load distribution in engineering applications, highlighting the significance of computing force coefficients accurately ANSYS Fluent was utilized to create and analyze reference models, Model A and Model B, to evaluate pressure distribution, aerodynamic performance, and structural stability of buildings, showcasing the software's capabilities in enhancing system analysis

2.2 SUMMARY OF LITERATURE REVIEW:

The comparative studies on wind load codes for tall buildings reveal significant variations in provisions and predicted effects across different standards. While there is a common theoretical basis, regional differences in wind characteristics and design priorities necessitate diverse approaches. The Indian Code (IS 875 Part-III, 2015) has specific provisions that cater to local requirements, while international standards show variability due to differing environmental conditions. The impact of extreme wind events like hurricanes further stresses the importance of tailored wind load assessments. Harmonizing certain aspects of these codes while accommodating regional specifics could improve the predictability and reliability of wind load calculations for tall buildings globally.

CHAPTER-3

RCC FRAMED STRUCTURES

An RCC framed structure is essentially an assembly of slabs, beams, columns and foundation inter -connected to every other as a unit. The load transfer, in such a structure takes place from the slabs to the beams, from the beams to the columns then to the lower columns and eventually to the foundation which successively transfers it to the soil. The floor area of a R.C.C framed structure building is 10 to 12 percent quite that of a load bearing walled building. Monolithic construction is achievable with R.C.C framed structures. monolithic buildings can easily resist vibrations, wind loading, earthquake more effectively than load bearing walled buildings. Speed of building for RCC framed structures is speedier.

3.1 - ASSUMPTIONS IN DESIGN: -

• Using partial factor of safety for loads in the clause 36.4 of IS-456-2000 Υt=1.5.

• Partial factor of safety for material in accordance with clause 36.4.2 is IS-456- 2000 is taken as 1.5 for concrete and 1.15 for steel.

• Using partial safety factors in the clause 36.4 of IS456- 2000 combination of load.

3.2 -LOAD COMBINATION TO BE CONSIDERED IN WIND LOAD: -

Load combination for limit state of collapse as per IS 456-2000.

1. 1.5(D+L)
2. 1.2(D+L+W X dir.)
3. 1.2(D+L+W Y dir.)
4. 0.9 DL + 1.5 W X dir
5. 0.9 DL+ 1.5 W Ydir

Total load cases = 5

3.3 - CODE AND STANDARDS CONSIDERED IN THIS PROJECT:

1. Indian standard (875(part 3)-2015)
2. American Society for Civil Engineering (ASCE)-7-22

3.4 WIND LOAD CALCULATION AS PER INDIAN STANDARD (875-2015 (PART 3))

Dynamic Wind Response

the essential wind speed for any site shall be obtained and modified to incorporate the subsequent effects to urge design wind speed, Vz at any height, Z for the chosen structure: (a) Risk level, (b) Terrain roughness and height of structure, (c) Local topography, and (d) Importance factor for the cyclonic region. It is mathematically expressed as follows:

Hourly Mean Wind Speed

The hourly mean wind speed at height z, for different terrains can be obtained as

$$\bar{V}_{z,H} = \bar{k}_{2,i} V_b$$

Where

$\bar{k}_{2,i}$ = hourly mean wind speed factor for terrain category 1

$$= 0.1423 \left[\ln \left(\frac{z}{z_{0,i}} \right) \right] \left(z_{0,i} \right)^{0.0706}$$

The design hourly mean wind speed at height z can-be obtained as:

$$\bar{V}_{z,d} = \bar{V}_{z,H} k_1 \bar{k}_{2,i} k_3 k_4$$

K_1 = probability factor (risk coefficient)

(5.3.1), K_3 = topography factor (5.3.3),

K_4 = importance factor for the cyclonic region (5.3.4)

$M_a = \sum F_z.Z$

$F_z = C_{f,z}.A_z..\bar{p}_d.G$

F_z = design peak along wind load on the building/structure at any height z

A_z = the effective frontal area of the building/structure at any height z, in m2

$\bar{p}_d$ = design hourly mean wind pressure corresponding to $\bar{V}_{z,d}$ and obtained as

$0.6\,\bar{V}^2{}_{z,d}$ (N/m^2)

$\bar{V}_{z,d}$ = design hourly mean wind speed at height z, in m/s

$C_{f,z}$ = the drag force coefficient of the building/ structure corresponding to the area Az

G = Gust Factor and is given by.

$$= 1+r.\sqrt{[g_v^2.B_s.(1+{}^{\Phi})2+\frac{H_s.g_r^2.SE}{\beta}]}$$

r = roughness factor which is twice the longitudinal turbulence intensity, $I_{h,i}$

g_v = peak factor for upwind velocity fluctuation,

= 3.0 for category 1 and 2 terrains, and

= 4.0 for category 3 and 4 terrains,

B_s = Background factor indicating the measure of slowly varying component of fluctuating wind load caused by the lower frequency wind speed variations

$$=\frac{1}{\left[1+\frac{\sqrt{0.26.(h-s)^2+0.4b_{sh}^2}}{L_h}\right]}$$

where

b_{sh} = average breadth of the building/structure between heights s and h

L_h = measure of effective turbulence length scale at the height, h, in m

$=85\left(\frac{h}{10}\right)^{0.25}$ for terrain category 1 to 3.

$=70\left(\frac{h}{10}\right)^{0.25}$ for terrain category 4

Φ= factor to account for the second order turbulence intensity

$$=\frac{g_v.I_{h,i}\sqrt{B_s}}{2}$$

$I_{h,i}$= turbulence intensity at height h in terrain category i

H_s = height factor for resonance response

$=1+\left(\frac{s}{h}\right)^2$

S= size reduction factor given by

$$=\frac{1}{\left[1+\frac{3.5f_a h}{V_{h,d}}\right]\left[1+\frac{4f_a b_{0h}}{V_{h,d}}\right]}$$

Where

b_{0h}= average breadth of the building/structure

between 0 and h.

E = spectrum of turbulence in the approaching wind stream

$$=\frac{\pi N}{(1+7\ .8N^2)^{5/6}}$$

where

N = effective reduced frequency

$= \frac{f_a L_h}{\bar{V}_{h,d}}$

f_a=first mode natural frequency of the building/structure in along wind direction, in Hz

$\bar{V}_{h,d}$=design hourly mean wind speed at height, h in m/s

β = damping coefficient of the building/structure (Table 36)

g_R = peak factor for resonant response

$= \sqrt{[2\ln(3600\, f_a)]}$

3.5 WIND LOAD CALCULATION AS PER AMERICAN STANDARD ASCE -7:22 :-

ASCE 7:22 defines the basic wind speeds based on Risk Catogories and location which can define Velocity pressure. the Velocity pressure is defined as:

$$qz = 0.00256 K_z K_{zt} K_e V^2 (lb/ft2); V, mi/h \; (26.10-1)$$

K_z=Velocity pressure exposure coefficient (26.10.1)

K_{zt} = Topographic factor, (26.8.2)

K_e =Ground elevation factor (26.9)

V=Basic wind speed, (26.5)

q_z= Velocity pressure at height z.

NOW, APPLYING WIND LOAD AS PER **DIRECTIONAL PROCEDURE**

WIND LOAD ON BUILDINGS: MAIN WIND FORCE RESISTING SYSTEM.

For **Enclosed, Partially Enclosed, and Partially Open Rigid and Flexible Buildings Design** wind pressures for the MWFRS of buildings of all heights in lb/ft2 (N/m2), shall be determined by the following equation:

$$p = q.K_d.GC_p - q_i.K_d.(GC_{pi})$$

Where,

$q = q_z$, for windward walls evaluated at height z above the ground;

$q = q_h$, for leeward walls, sidewalls, and roofs evaluated at height h

$q_i = q_h$, for windward walls, sidewalls, leeward walls, and roofs of enclosed buildings, partially open buildings, and for negative internal pressure evaluation in partially enclosed buildings;

$q_i = q_z$, for positive internal pressure evaluation in partially enclosed buildings, where height z is defined as the level of the highest opening in the building that could affect the positive internal pressure; For buildings sited in wind-borne debris regions, the enclosure classification with respect to glazed openings shall be in accordance with Section 26.12.3, and for positive internal pressure evaluation, qi may conservatively be evaluated at height h (qi =qh);

Kd = Wind directionality factor (see Section 26.6);

G = Gust-effect factor (see Section 26.11); For flexible buildings, Gf, determined in accordance with Section 26.11.5, shall be substituted for G;

Cp = External pressure coefficient from Figures 27.3-1, 27.3-2, and 27.3-3; and

(GCpi) = Internal pressure coefficient from Table 26.13-1.

Flexible Buildings or Other Structures For flexible buildings or other structures as defined in Section26.2, the gust effect factor shall be calculated by

$$G_f = 0.925\left(\frac{1 + 1.7 I_{\bar{z}}\sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1 + 1.7 g_v I_{\bar{z}}}\right) \qquad (26.11-10)$$

The background peak factors g_Q and g_v shall be taken as 3.4, and the resonant peak factor g_R is

$$g_R = \sqrt{2\ln 3{,}600 n_1} + \frac{0.577}{\sqrt{2\ln 3{,}600 n_1}} \qquad (26.11\text{-}11)$$

The background response factor, Q, and the intensity of turbulence at height z, I_Z, are defined in Section 26.11.4.

$$Q = \sqrt{\frac{1}{1 + 0.63\left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}}} \qquad (26.11\text{-}8)$$

$$L_{\bar{z}} = \ell\left(\frac{\bar{z}}{33}\right)^{\bar{\varepsilon}} \qquad (26.11\text{-}9)$$

$$I_{\bar{z}} = c\left(\frac{33}{\bar{z}}\right)^{1/6} \qquad (26.11\text{-}7)$$

z is the equivalent height of the building or structure defined as 0.6h, but not less than z_{min}, for all building or structure heights h. z_{min} and c are listed for each exposure in Table26.11-1.

The resonant response factor is

$$R = \sqrt{\frac{1}{\beta} R_n R_h R_B (0.53 + 0.47 R_L)} \qquad (26.11 - 12)$$

where n_1 is the fundamental natural frequency, and ß is the damping ratio, fraction of critical (e.g., for 2% use 0.02 in the equation).

The power spectral density of turbulence at the equivalent height of the structure $\bar{z}$, evaluated at the structure's natural reduced frequency, N_1, is

$$R_n = \frac{7.47 N_1}{(1 + 10.3 N_1)^{5/3}}$$

$$N_1 = \frac{n_1 L_{\bar{z}}}{\bar{V}_{\bar{z}}} \qquad (26.11\text{-}14)$$

where L is defined in Equation (26.11-9). The size effect factors related to the height, breadth, and depth of the building are

$$
\begin{aligned}
R_h &= \frac{1}{\eta_h} - \frac{1}{2\eta_h^2}\left(1 - e^{-2\eta_h}\right) \\
R_B &= \frac{1}{\eta_B} - \frac{1}{2\eta_B^2}\left(1 - e^{-2\eta_B}\right) \\
R_L &= \frac{1}{\eta_L} - \frac{1}{2\eta_L^2}\left(1 - e^{-2\eta_L}\right)
\end{aligned} \qquad (26.11\text{-}15a)
$$

where the turbulent coherence (correlation) factors in the corresponding directions, evaluated at the natural reduced frequency,are

$$
\begin{aligned}
\eta_h &= 4.6 n_1 h/\overline{V}_z \\
\eta_B &= 4.6 n_1 B/\overline{V}_z \\
\eta_L &= 15.4 n_1 L/\overline{V}_z
\end{aligned} \qquad (26.11\text{-}15b)
$$

The mean hourly wind speed (in ft/s or m/s) at the equivalent structure height, z, is

$$\overline{V}_{\bar{z}} = \bar{b}\left(\frac{\bar{z}}{33}\right)^{\bar{\alpha}}\left(\frac{88}{60}\right)V \qquad (26.11\text{-}16)$$

$$\overline{V}_{\bar{z}} = \bar{b}\left(\frac{\bar{z}}{10}\right)^{\bar{\alpha}} V \qquad (26.11\text{-}16.SI)$$

where b and o are constants listed in Table 26.11-1, z is obtained from Section 26.11.4, and V is the basic wind speed, mi/h (m/s).

CHAPTER - 4

DETAILS OF THE MODELS STUDIED

In order to evaluate the story displacement and base shear between different shapes of buildings, five sample building models are adopted. The finite element analysis software ETABS is used to create 3D model and analysed. The dynamic wind load analysis as per IS:875 part 3 and ASCE 7-22 is applied on all the form of building in plan. The various shapes models are square, rectangular, diamond, hexagonal, octagonal.

4.1 - MODELLING AND ANALYSIS OF MODEL 1(151.2m)

A study carried out on a high rise building which is a RCC frame structure residential type building assumed to be located in a Delhi and there is no vertical irregularities. Topography is flat in all direction building is rectangular in cross section (**35m by 35m**), building having height above ground surface is **151.2m**. roof is flat. Wind dir. is normal to the 35m wall face basic wind speed is **47m/s**. terrain category is considered 3 categories in both the wind codes.

Table 4.1 -Design parameters of 151.2m height building

No. of storey	G+41
Column	0.6 m x0.6 m
Beam	0.350 m x0.600 m
Slabs	0.15 m
Live load on slab	3 KN/m2
Floor finish	1.2 KN/m2
Grade of concrete in column	M 40
Grade of concrete in beam	M 30
Grade of steel	Fe 500
Total height	151.2m
Height of ground storey	3.6m
Height of floor to floor	3.6 m
Spacing of frame along length	5 m
Spacing of frame along width	5 m
Thickness of shear wall	0.30 m
Thickness of wall	0.23 m

PLAN OF 151.2 M HEIGHT BUILDING:

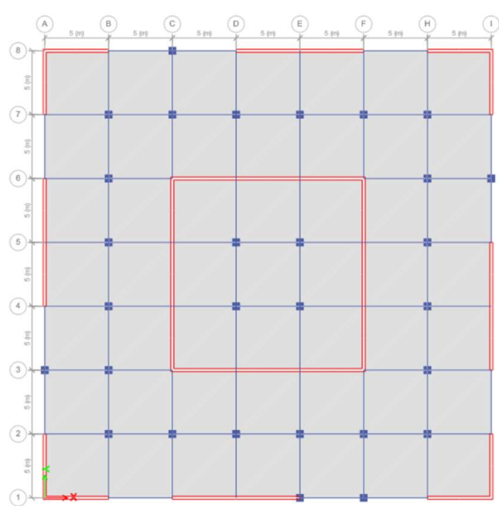


Figure 4.1: Plan of square building

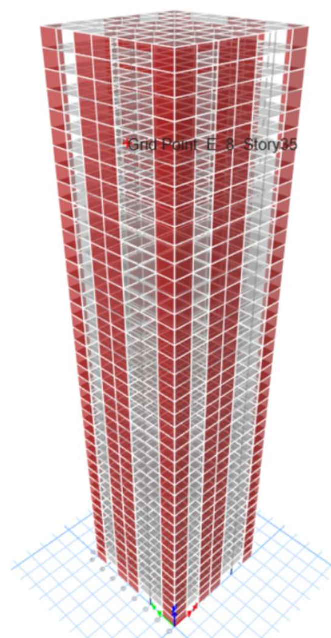


Figure 4.2: 3D view

4.2 MODELLING AND ANALYSIS OF MODEL (80m)

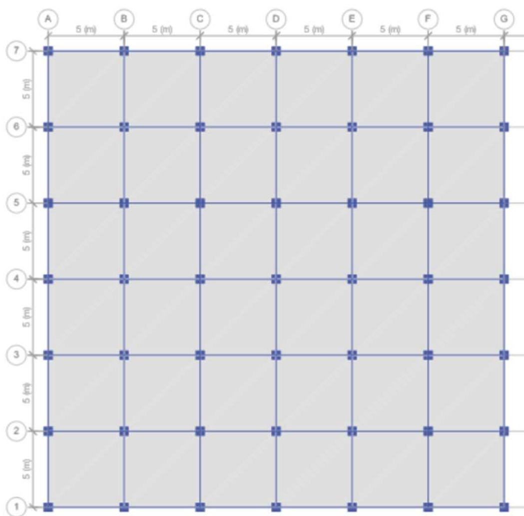
Another research is carried out to study the effect of various shapes of tall structures subjected to wind excitation. Four different shaped building models of 80m has been considered. These models are same characteristics as same height, and considered in same locality.

Table4.2 -Design parameters of 80m height building

No. of storey	22
Column	0.6 m x 0.6m
Beam	0.350 m x0.600 m
Slabs	0.15 m
Live load on slab	3 KN/m2
Floor finish	1.2 KN/m2
Grade of concrete in column	M 40
Grade of concrete in beam	M 40
Grade of steel	Fe 500
Total height	150 m
Height of ground storey	4.4 m
Height of floor to floor	3.6 m
Spacing of frame along length	5m
Spacing of frame along width	5m
Thickness of external wall	.230 m
Thickness of internal wall	.115 m

PLAN OF THE DIFFERENT SHAPES OF BUILDINGS: FIGURE OF 80M HEIGHT BUILDING:

SQUARE SHAPE:



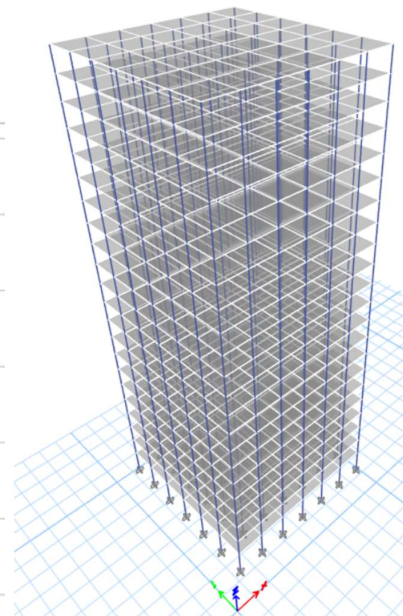


Figure 4.3: Plan of Square building **Figure 4.4:** 3D VIEW

RECTANGULAR SHAPE:

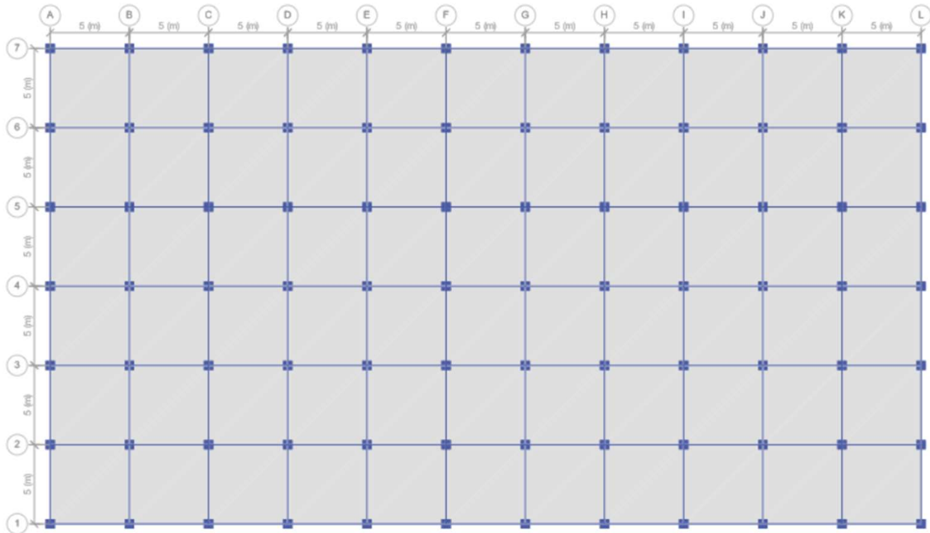


Figure 4.5: Plan of Rectangular building

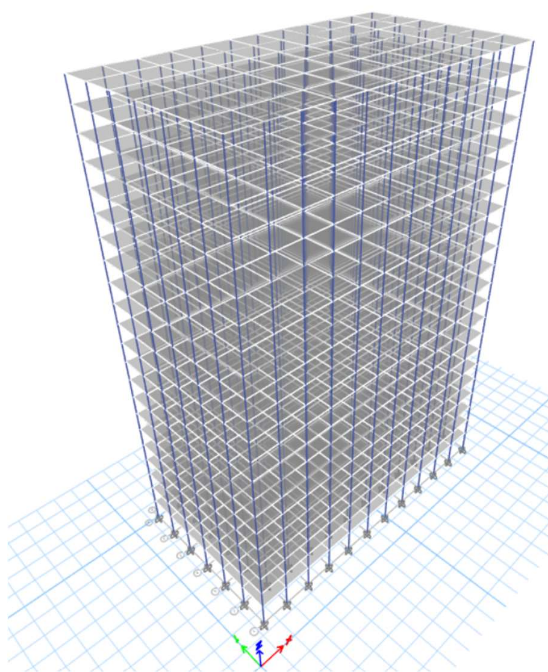
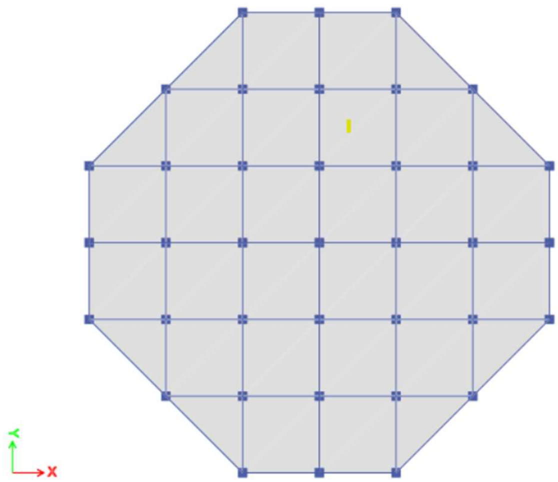


Figure 4.6: 3D View

OCTAGONAL SHAPE:



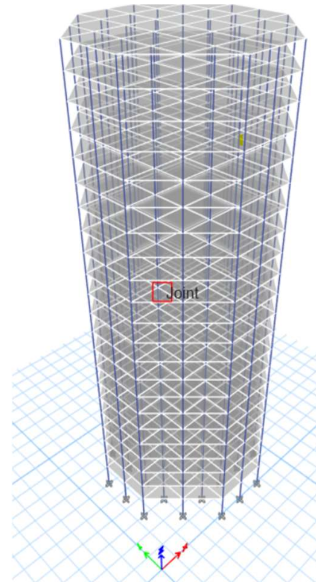
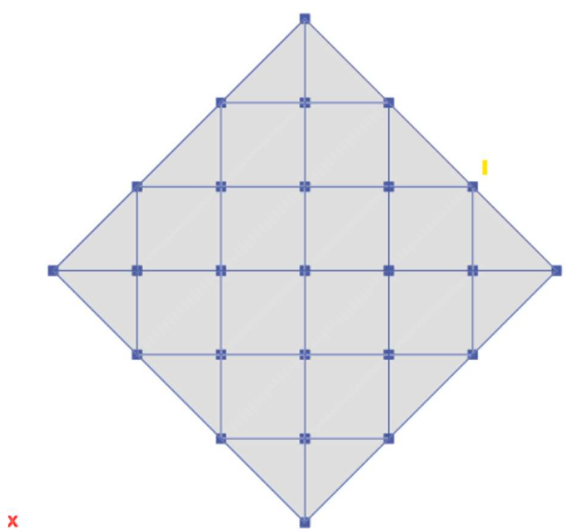


Figure 4.7: Plan of octagonal building

Figure 4.8: 3D View

DIAMOND SHAPE



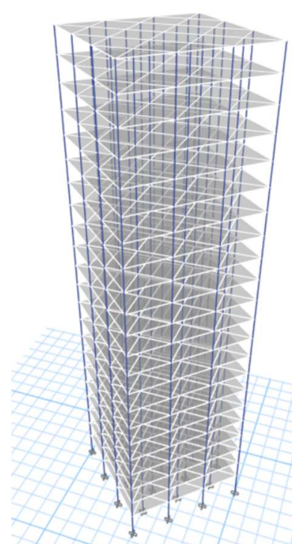


Figure 4.7: Plan of octagonal building

Figure 4.8: 3D View

CHAPTER -5

METHODOLOGY

Step 1: Define the Material and Section Properties in ETABS

- Objective: Establish the fundamental building blocks for the structural analysis.
- Actions:
    - Open ETABS software.
    - Navigate to the 'Define' menu and select 'Material Properties'.
    - Input the properties for concrete and steel (e.g., grade of concrete, yield strength of steel).
    - Define the section properties for beams, columns, slabs, and other structural elements.

Step 2: Create the Geometry and Assign the Properties

- Objective: Model the physical structure of the building.
- Actions:
    - Use the 'Draw' tools in ETABS to create the geometry of the structure (e.g., floors, beams, columns).
    - Assign the previously defined material and section properties to the respective elements.

Step 3: Supports and Property Assigning

- Objective: Define the boundary conditions and cross-sections.
- Actions:
    - Specify the support conditions at the base of the structure as 'fixed'.
    - Assign material properties and cross-sections to beams, columns, and slabs.
    - Ensure all structural elements are appropriately defined.

Step 4: Define the Load Patterns

- Objective: Set up various load conditions for analysis.
- Actions:
    - Navigate to 'Define' > 'Load Patterns'.

  - Define the load patterns as Dead Load (DL), Live Load (LL), Wind in X direction (WINDX), and Wind in Y direction (WINDY).

Step 5: Apply the Dead and Live Loads

- Objective: Apply static loads to the structure.
- Actions:
  - Apply Live Load (3 kN/m^2) and Floor Finish (1.2 kN/m^2) to the appropriate areas of the structure.
  - Use the 'Assign' menu to distribute these loads across the floors and slabs.

Step 6: Calculate the Dynamic Wind Load Manually

- Objective: Determine wind loads according to relevant standards.
- Actions:
  - Use IS Code and ASCE Code to manually calculate the wind loads.

Step 7: Apply the Manually Calculated Wind Forces in ETABS

- Objective: Incorporate dynamic wind loads into the model.
- Actions:
  - Define a user-defined load pattern in ETABS for the wind loads.
  - Apply the calculated wind forces in the X and Y directions to the structure.

Step 8: Analysis

- Objective: Perform structural analysis on the model.
- Actions:
  - Run the analysis in ETABS by clicking 'Run Analysis'.
  - Check for any errors or warnings and resolve them if necessary.

Step 9: Post-Analysis Results Computation

- Objective: Interpret the analysis results.
- Actions:
  - Extract results for story displacement, story drift, and base shear from ETABS.
  - Document these results systematically for further discussion and interpretation.

CHAPTER - 6

RESULTS AND DISCUSSION

6.1 Dynamic wind load on 80 m Height of building calculated by Is 875 part3 (2015).

6.1.1 Effect of the Shape of The Building on Lateral Displacements:

Table 6.1.1 - Comparison of Lateral Displacements in mm at different height.

Height (m)	Rectangular (mm)	Square (mm)	Diamond (mm)	Octagonal (mm)
80	252.177	206.905	218.696	127.736
76.4	250.515	205.375	216.384	126.546
72.8	248.067	203.201	213.34	124.91
69.2	244.651	200.236	209.454	122.766
65.6	240.212	196.438	204.718	120.111
62	234.731	191.797	199.14	116.95
58.4	228.202	186.313	192.729	113.29
54.8	220.62	179.988	185.502	109.139
51.2	211.986	172.828	177.475	104.507
47.6	202.301	164.842	168.668	99.407
44	191.57	156.04	159.102	93.852
40.4	179.799	146.435	148.801	87.854
36.8	166.997	136.039	137.795	81.431
33.2	153.176	124.869	126.114	74.602
29.6	138.351	112.943	113.793	67.385
26	122.543	100.285	100.87	59.802
22.4	105.783	86.925	87.39	51.879
18.8	88.117	72.903	73.403	43.644
15.2	69.63	58.284	58.967	35.129
11.6	50.513	43.193	44.155	26.375
8	31.263	27.928	29.096	17.451
4.4	13.275	13.223	14.112	8.54
0	0	0	0	0

6.1.2 Effect of the Shape of the Building on Storey Drifts:

Table 6.1.2 - Comparison of Storey Drifts at Different Heights in mm.

Height (m)	Rectangular (mm)	Square (mm)	Diamond (mm)	Octagonal (mm)
80	0.000462	0.000425	0.000642	0.000331
76.4	0.00068	0.000604	0.000846	0.000455
72.8	0.000949	0.000824	0.00108	0.000596
69.2	0.001233	0.001055	0.001315	0.000737
65.6	0.001522	0.001289	0.00155	0.000878
62	0.001814	0.001523	0.001781	0.001017
58.4	0.002106	0.001757	0.002008	0.001153
54.8	0.002398	0.001989	0.00223	0.001287
51.2	0.00269	0.002218	0.002446	0.001417
47.6	0.002981	0.002445	0.002657	0.001543
44	0.00327	0.002668	0.002861	0.001666
40.4	0.003556	0.002888	0.003057	0.001784
36.8	0.003839	0.003103	0.003245	0.001897
33.2	0.004118	0.003313	0.003423	0.002005
29.6	0.004391	0.003516	0.00359	0.002106
26	0.004656	0.003711	0.003744	0.002201
22.4	0.004907	0.003895	0.003885	0.002288
18.8	0.005135	0.004061	0.00401	0.002365
15.2	0.00531	0.004192	0.004114	0.002432
11.6	0.005347	0.00424	0.004183	0.002479
8	0.004997	0.004085	0.004162	0.002475
4.4	0.003017	0.003005	0.003207	0.001941
0	0	0	0	0

6.1.3 Effect of the Shape of the Building on Storey Base Shear:

Table 6.1.3 - Comparison of Storey Base Shear at Different Heights in Kn

Height (m)	Rectangular (mm)	Square (mm)	Diamond (mm)	Octagonal (mm)
80	-133	-114	-135	-135
76.4	-396	-338	-401	-401
72.8	-656	-558	-662	-662
69.2	-913	-774	-918	-918
65.6	-1166	-985	-1169	-1169
62	-1416	-1192	-1415	-1415
58.4	-1662	-1394	-1655	-1655
54.8	-1904	-1591	-1889	-1889
51.2	-2142	-1782	-2116	-2116
47.6	-2375	-1967	-2337	-2337
44	-2603	-2146	-2551	-2551
40.4	-2826	-2319	-2757	-2757
36.8	-3043	-2485	-2955	-2955
33.2	-3254	-2644	-3145	-3145
29.6	-3458	-2796	-3326	-3326
26	-3654	-2939	-3497	-3497
22.4	-3841	-3073	-3657	-3657
18.8	-4018	-3197	-3805	-3805
15.2	-4182	-3309	-3939	-3939
11.6	-4331	-3407	-4056	-4056
8	-4459	-3488	-4153	-4153
4.4	-4576	-3516	-4187	-4187
0	0	0	0	0

6.2 Dynamic wind load on 80 m Height of building calculated by ASCE 7-22.

6.2.1 Effect of the Shape of The Building on Lateral Displacements:

Table 6.2.1 - Comparison of Lateral Displacements in mm at different height.

Height (m)	Rectangular (mm)	Square (mm)	Diamond (mm)	Octagonal (mm)
80	155.2	141.498	149.138	87.344
76.4	150.951	140.51	147.639	86.575
72.8	146.549	139.118	145.689	85.53
69.2	141.912	137.225	143.213	84.169
65.6	137.008	134.8	140.2	82.484
62	131.831	131.83	136.649	80.476
58.4	126.377	128.31	132.559	78.144
54.8	120.644	124.235	127.931	75.488
51.2	114.629	119.6	122.767	72.511
47.6	108.329	114.403	117.072	69.213
44	101.74	108.641	110.848	65.598
40.4	94.862	102.312	104.103	61.667
36.8	87.691	95.415	96.842	57.426
33.2	80.226	87.949	89.075	52.877
29.6	72.465	79.916	80.811	48.027
26	64.406	71.316	72.062	42.882
22.4	56.05	62.156	62.841	37.448
18.8	47.396	52.445	53.166	31.734
15.2	38.453	42.209	43.055	25.751
11.6	29.239	31.514	32.535	19.511
8	19.834	20.548	21.666	13.045
4.4	10.455	9.818	10.639	6.462
0	0	0	0	0

6.2.2 Effect of the Shape of the Building on Storey Drifts:

Table 6.2.2 - Comparison of Storey Drifts at Different Heights in mm

Height (m)	Rectangular (mm)	Square (mm)	Diamond (mm)	Octagonal (mm)
80	0.001194	0.000274	0.000416	0.000214
76.4	0.001223	0.000387	0.000542	0.00029
72.8	0.001289	0.000526	0.000688	0.000378
69.2	0.001363	0.000674	0.000837	0.000468
65.6	0.001438	0.000825	0.000987	0.000558
62	0.001515	0.000978	0.001136	0.000648
58.4	0.001592	0.001132	0.001286	0.000738
54.8	0.001671	0.001287	0.001434	0.000827
51.2	0.00175	0.001444	0.001582	0.000916
47.6	0.00183	0.001601	0.001729	0.001004
44	0.001911	0.001758	0.001874	0.001092
40.4	0.001992	0.001916	0.002017	0.001178
36.8	0.002074	0.002074	0.002158	0.001263
33.2	0.002156	0.002232	0.002296	0.001347
29.6	0.002239	0.002389	0.00243	0.001429
26	0.002321	0.002545	0.002561	0.001509
22.4	0.002404	0.002697	0.002688	0.001587
18.8	0.002484	0.002843	0.002809	0.001662
15.2	0.00256	0.002971	0.002922	0.001733
11.6	0.00262	0.003046	0.003019	0.001796
8	0.00265	0.00298	0.003063	0.001829
4.4	0.00248	0.002231	0.002418	0.001469
0	0	0	0	0

6.2.3 Effect of the Shape of the Building on Storey Base Shear:

Table 6.2.3 - Comparison of Base Shear at Different Heights in Kn

Height (m)	Rectangular (mm)	Square (mm)	Diamond (mm)	Octagonal (mm)
80	-85.7465	-70.4578	-82.2105	-82.2105
76.4	-256.5535	-210.6099	-245.974	-245.974
72.8	-426.3015	-349.5865	-408.7221	-408.7221
69.2	-594.9483	-487.3451	-570.4143	-570.4143
65.6	-762.4475	-623.8398	-731.0064	-731.0064
62	-928.7485	-759.0198	-890.4496	-890.4496
58.4	-1093.7947	-892.8293	-1048.6897	-1048.6897
54.8	-1257.5235	-1025.2066	-1205.6669	-1205.6669
51.2	-1419.8647	-1156.0828	-1361.3136	-1361.3136
47.6	-1580.7387	-1285.3802	-1515.5536	-1515.5536
44	-1740.0551	-1413.0109	-1668.3003	-1668.3003
40.4	-1897.7096	-1538.8744	-1819.4535	-1819.4535
36.8	-2053.5804	-1662.854	-1968.8966	-1968.8966
33.2	-2207.5235	-1784.8126	-2116.4916	-2116.4916
29.6	-2359.3657	-1904.5864	-2262.0722	-2262.0722
26	-2508.8933	-2021.9756	-2405.4337	-2405.4337
22.4	-2655.836	-2136.7297	-2546.317	-2546.317
18.8	-2799.8389	-2248.5234	-2684.3816	-2684.3816
15.2	-2940.4116	-2356.9137	-2819.1575	-2819.1575
11.6	-3076.824	-2461.2521	-2949.9447	-2949.9447
8	-3207.8442	-2560.4696	-3075.562	-3075.562
4.4	-3346.8118	-2664.6071	-3208.799	-3208.799
0	0	0	0	

6.3 COMPARISON OF RESULTS ON 80M BUILDING BY IS 875 PART-3 AND ASCE 7-22.

6.3.1 For Rectangular Building

6.3.1.1 Comparison of Lateral Displacements in Rectangular Building

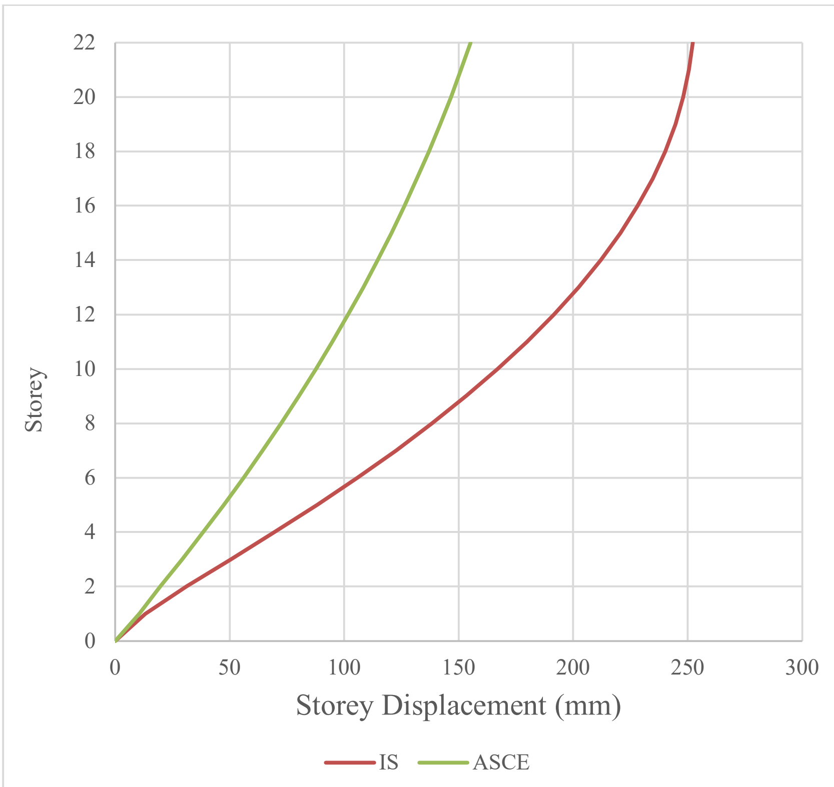


Figure 6.3.1.1: Comparison of Lateral Displacements in Rectangular Building in mm at different Storey .

6.3.1.2 Comparison of Storey Drift Ratio in Rectangular Building

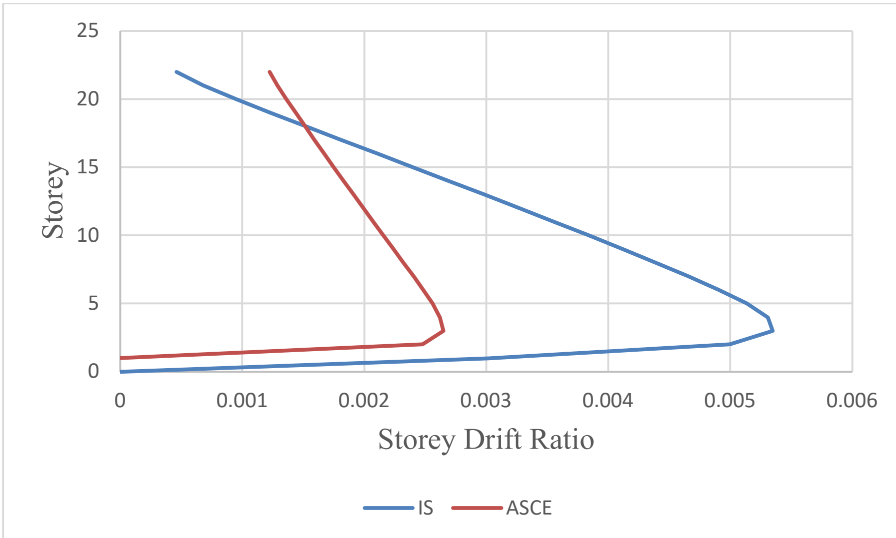


Figure 6.3.1.2: Comparison of story drift ratio in Rectangular Building at different height.

6.3.1.3 Comparison of Storey Base Shear in Rectangular Building

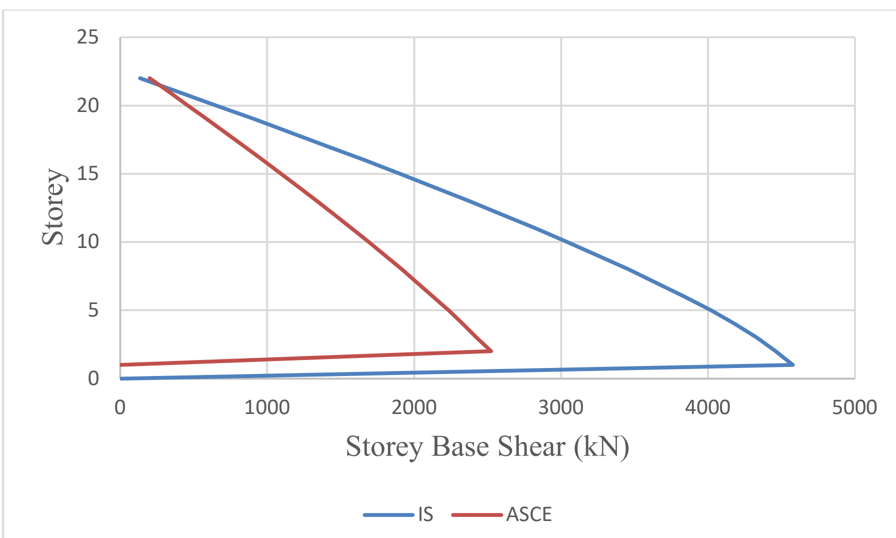


Figure 6.3.1.3: Comparison of story Base Shear(kN) in Rectangular Building at different height.

6.3.2 For Square building

6.3.2.1 Comparison of Lateral Displacements in Square Building

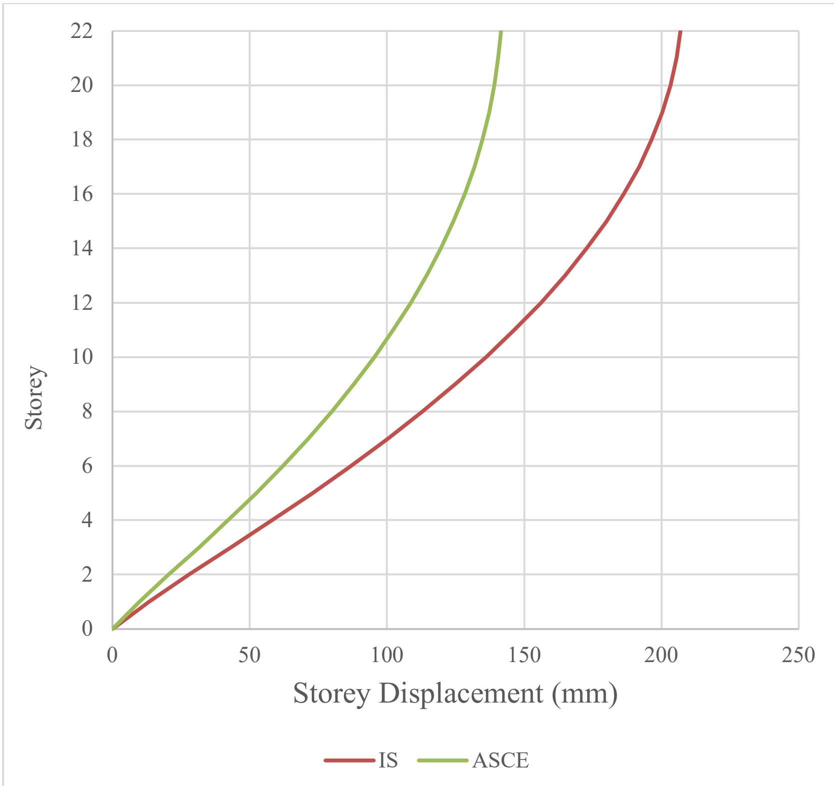


Figure 6.3.2.1: Comparison of Lateral Displacements in Square Building in mm at different Storey .

6.3.2.2 Comparison of Storey Drift Ratio in Square Building

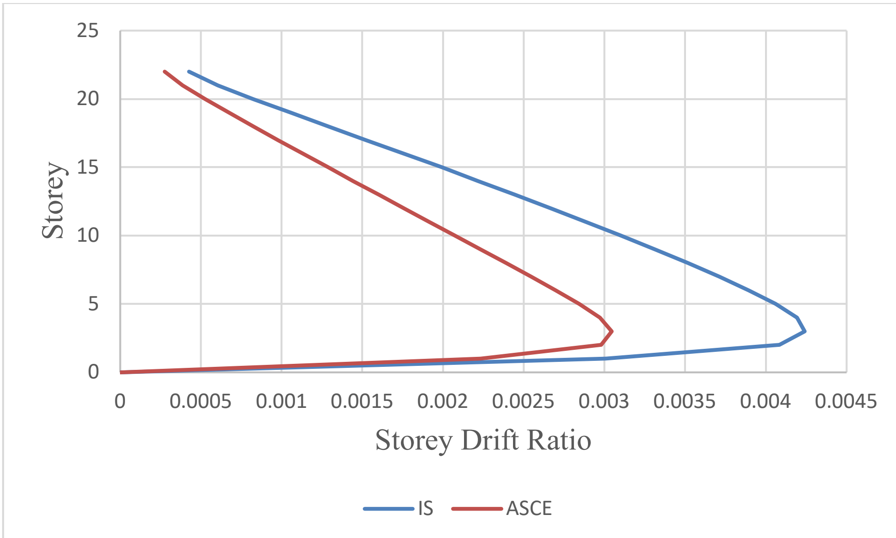


Figure 6.3.2.2: Comparison of story drift ratio in Square Building at different height.

6.3.2.3 Comparison of Storey Base Shear in Square Building

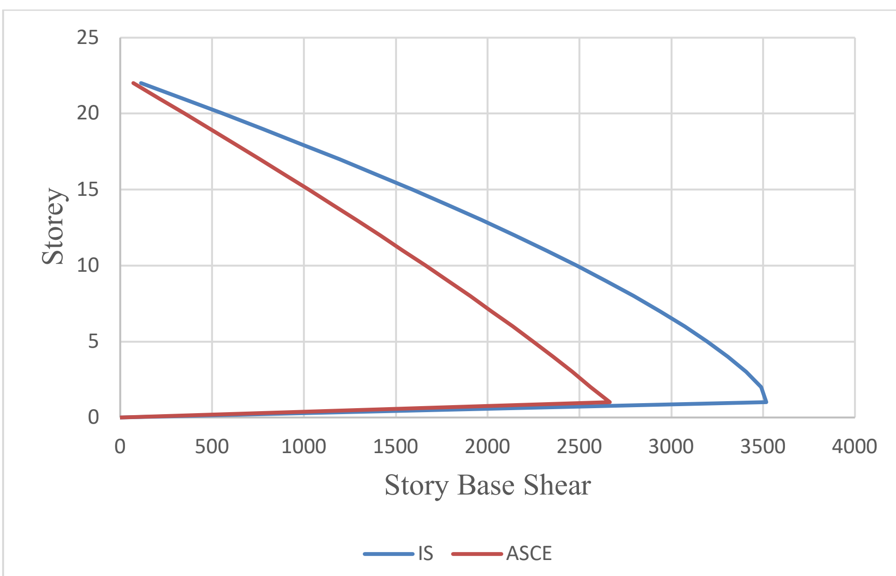


Figure 6.3.2.3: Comparison of story Base Shear(kN) in Square Building at different Storey.

6.3.3 For Diamond Shaped Building

6.3.3.1 Comparison of Lateral Displacements in Diamond Building

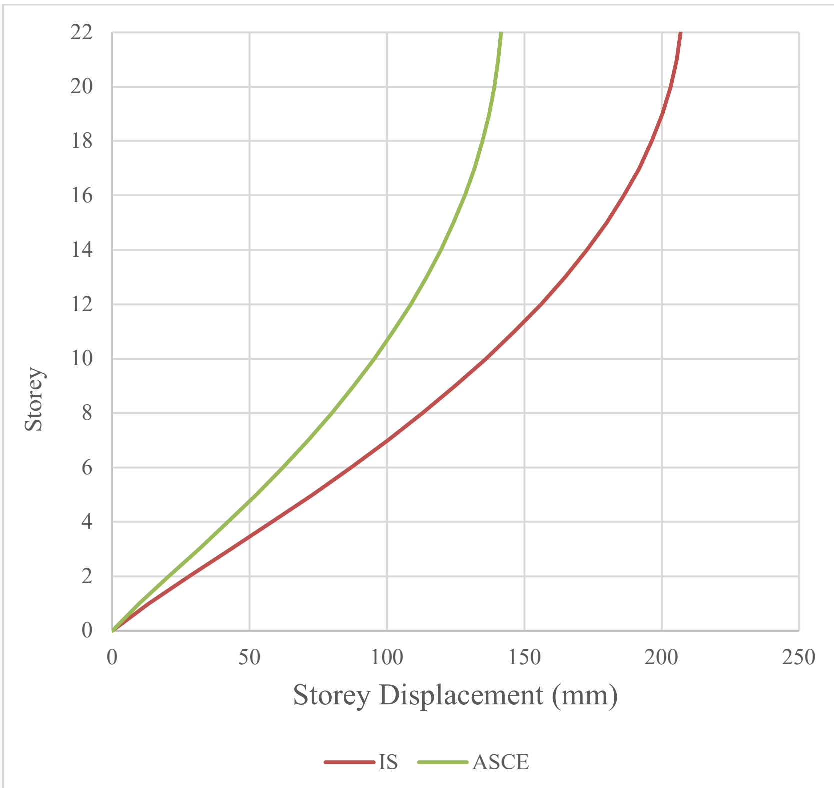


Figure 6.3.3.1: Comparison of Lateral Displacements in Diamond Building in mm at different Storey .

6.3.2.2 Comparison of Storey Drift Ratio in Diamond Building

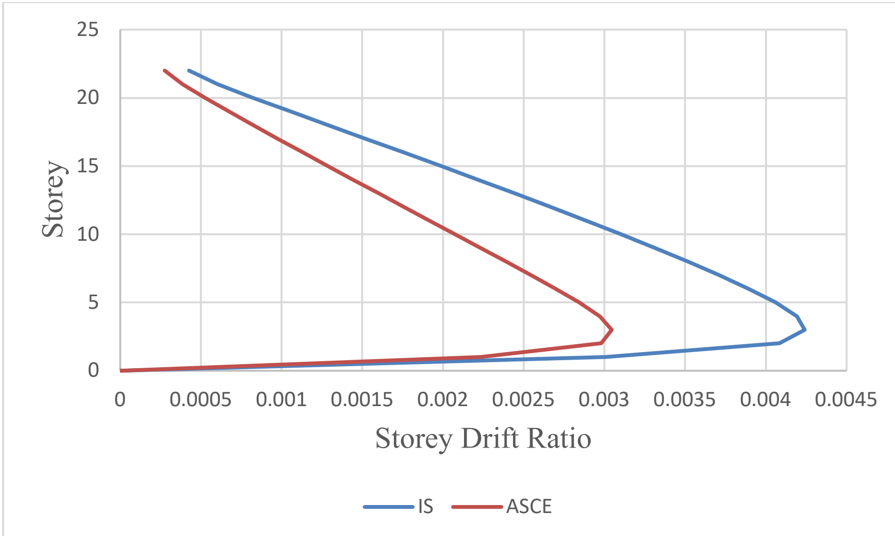


Figure 6.3.3.2: Comparison of story drift ratio in Diamond Building at different height.

6.3.3.3 Comparison of Storey Base Shear in Diamond Building

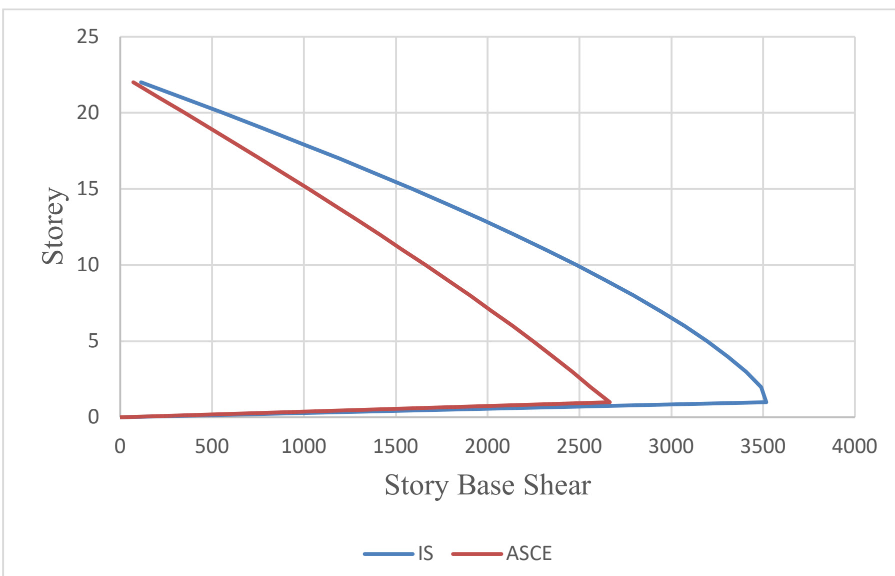


Figure 6.3.3.3: Comparison of story Base Shear(kN) in Diamond Building at different height.

6.3.4 For Octagonal Building

6.3.4.1 Comparison of Lateral Displacements in Octagonal Building

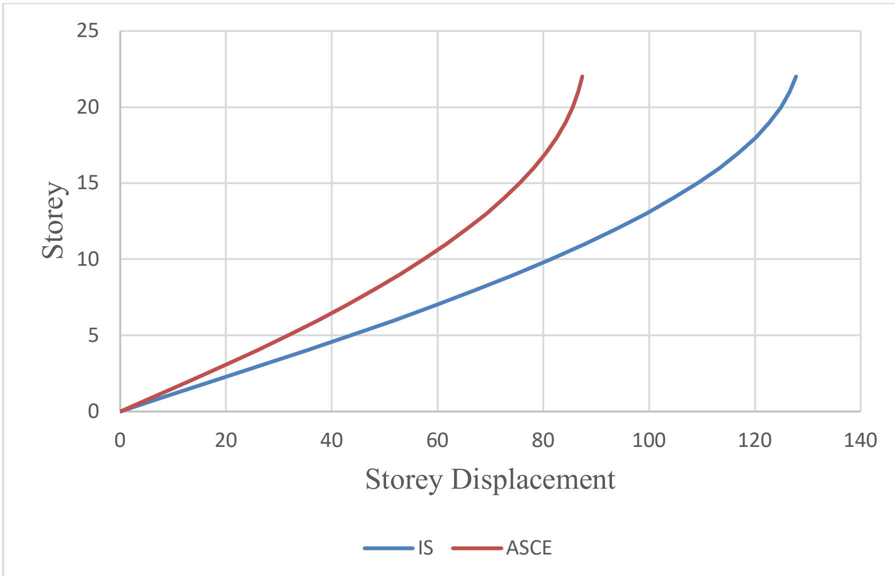


Figure 6.3.4.1: Comparison of Lateral Displacements in Octagonal Building in mm at different Storey .

6.3.4.2 Comparison of Storey Drift Ratio in Octagonal Building

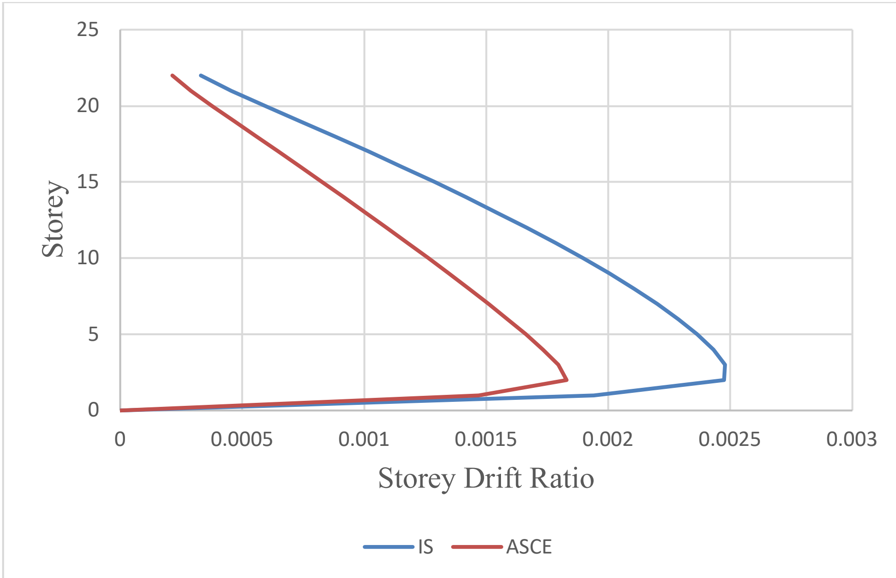


Figure 6.3.4.2: Comparison of story drift ratio in Octagonal Building at different height.

6.3.4.3 Comparison of Storey Base Shear in Octagonal Building

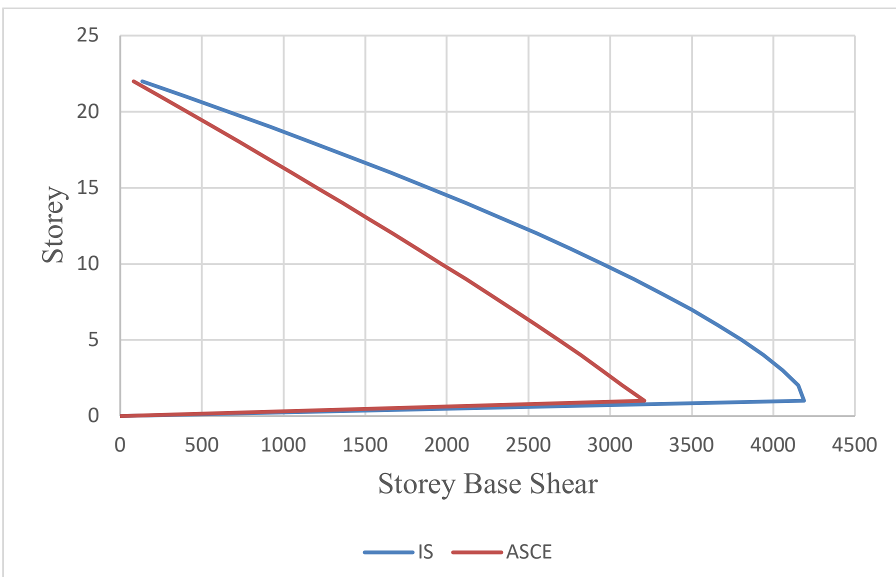


Figure 6.3.4.3: Comparison of story Base Shear(kN) in Octagonal Building at different height.

6.4 RESULTS OF 150M HEIGHT OF BUILDING AND WIND LOAD CALCULATED BY IS 875 PART3(2015) AND ASCE 7-22.

Table 6.4.1 - Comparison of Lateral Displacements in mm at different height

STORY	IS 875	ASCE 7-22
42	194.165	153.229
41	188.717	148.962
40	183.246	144.677
39	177.753	140.375
38	172.236	136.055
37	166.692	131.713
36	161.121	127.35
35	155.522	122.966
34	149.897	118.56
33	144.247	114.134
32	138.574	109.689
31	132.882	105.228
30	127.175	100.754
29	121.457	96.27
28	115.734	91.78
27	110.013	87.29
26	104.3	82.804
25	98.604	78.328
24	92.933	73.869
23	87.296	69.434
22	81.704	65.031
21	76.169	60.669
20	70.701	56.356
19	65.312	52.101
18	60.016	47.916
17	54.826	43.811
16	49.758	39.797
15	44.825	35.886
14	40.044	32.092
13	35.432	28.426
12	31.006	24.905
11	26.784	21.541
10	22.786	18.35
9	19.03	15.347
8	15.536	12.55
7	12.327	9.976

6	9.425	7.643
5	6.853	5.57
4	4.637	3.779
3	2.805	2.293
2	1.39	1.14
1	0.431	0.356

Table 6.4.2 - Comparison of story drift in mm at different height.

STORY	IS 875	ASCE 7-22
42	0.001513	0.001185
41	0.00152	0.00119
40	0.001526	0.001195
39	0.001533	0.0012
38	0.00154	0.001206
37	0.001548	0.001212
36	0.001555	0.001218
35	0.001563	0.001224
34	0.00157	0.001229
33	0.001576	0.001235
32	0.001581	0.001239
31	0.001585	0.001243
30	0.001588	0.001246
29	0.00159	0.001247
28	0.001589	0.001247
27	0.001587	0.001246
26	0.001582	0.001243
25	0.001575	0.001239
24	0.001566	0.001232
23	0.001553	0.001223
22	0.001538	0.001212
21	0.001519	0.001198
20	0.001497	0.001182
19	0.001471	0.001163
18	0.001442	0.00114
17	0.001408	0.001115
16	0.00137	0.001086
15	0.001328	0.001054
14	0.001281	0.001018
13	0.001229	0.000978

12	0.001173	0.000934
11	0.001111	0.000886
10	0.001043	0.000834
9	0.00097	0.000777
8	0.000891	0.000715
7	0.000806	0.000648
6	0.000714	0.000576
5	0.000616	0.000498
4	0.000509	0.000413
3	0.000393	0.00032
2	0.000266	0.000218
1	0.00012	9.90E-05

Table 6.4.3 - Comparison of Base Shear in mm at different height

BASE SHEAR		
STORY	IS	ASCE
42	177	131.3471
41	527	392.6388
40	874	652.5278
39	1218	911.0142
38	1558	1168.086
37	1895	1423.639
36	2228	1677.676
35	2557	1930.195
34	2883	2181.196
33	3205	2430.552
32	3523	2678.244
31	3837	2924.273
30	4147	3168.638
29	4452	3411.221
28	4753	3651.956
27	5050	3890.842
26	5342	4127.88
25	5630	4362.972
24	5913	4595.973
23	6191	4826.884
22	6464	5055.704
21	6732	5282.377
20	6995	5506.627
19	7253	5728.452

18	7505	5946.239
17	7752	6163.061
16	7993	6378.435
15	8228	6590.189
14	8456	6798.926
13	8678	7004.044
12	8893	7205.663
11	9100	7404.748
10	9299	7600.213
9	9490	7793.266
8	9672	7980.285
7	9844	8161.271
6	10004	8337.431
5	10152	8508.162
4	10285	8672.859
3	10401	8827.422
2	10494	8972.995
1	10554	9039.659

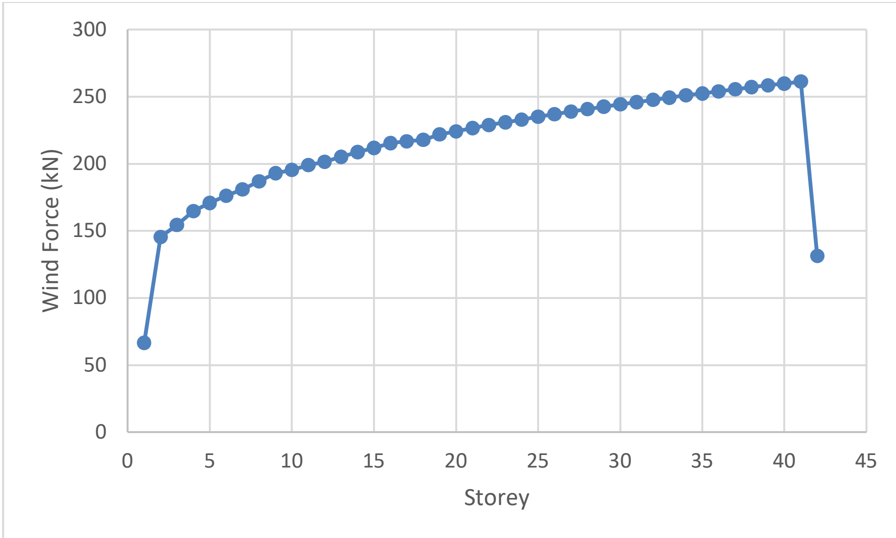


Figure 6.4.1: Wind Force as per IS 875:2015(Part3) in x dir

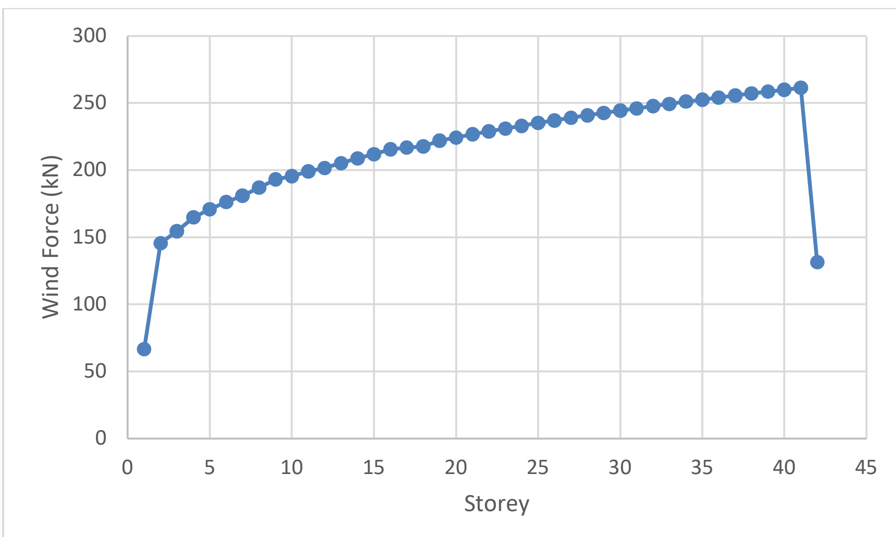


Figure 6.4.2: Wind Force as per ASCE 7-22.

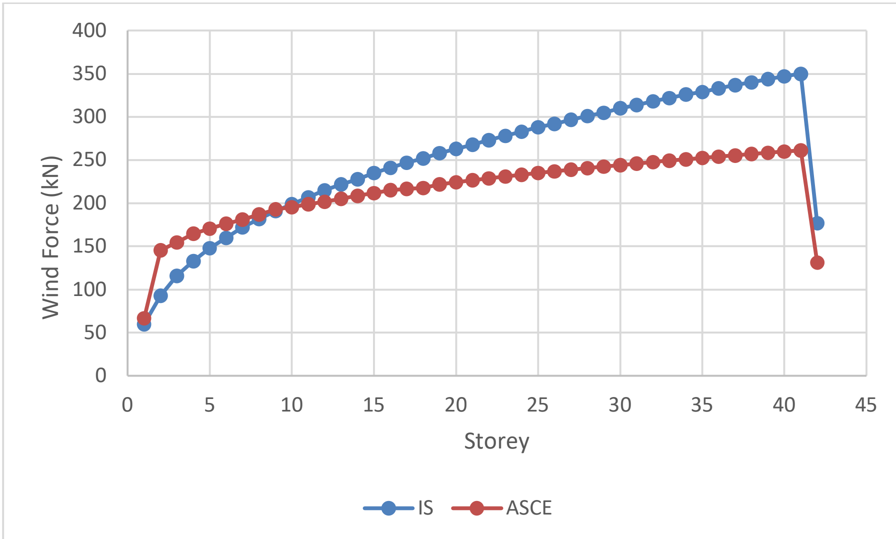


Figure 6.4.3: Comparison of Wind Force at different height.

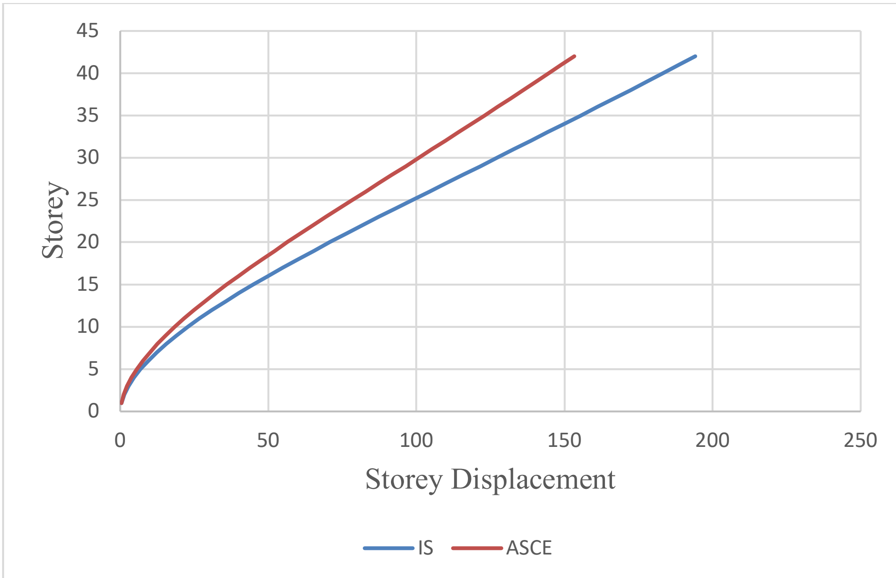


Figure 6.4.4: Comparison of Lateral Displacements in mm at different height.

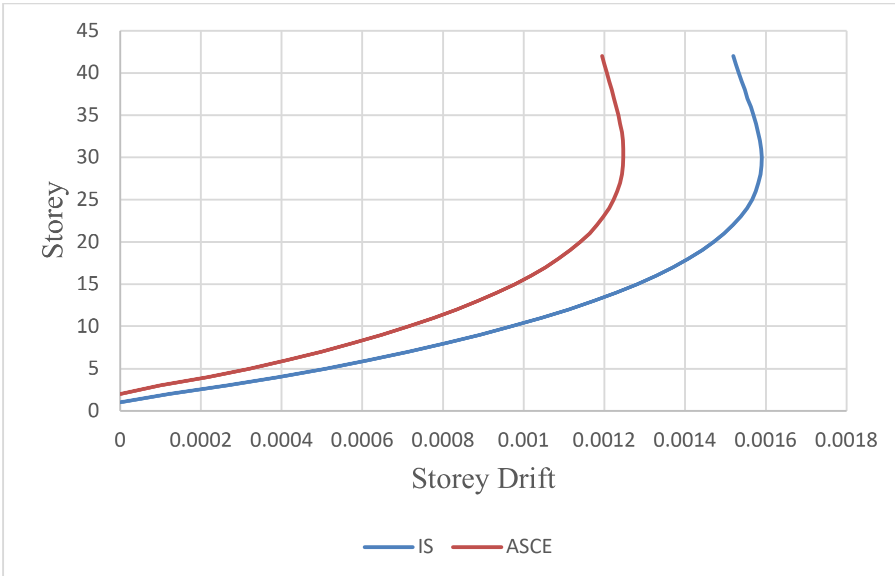


Figure 6.4.5: Comparison of story drift in mm at different height.

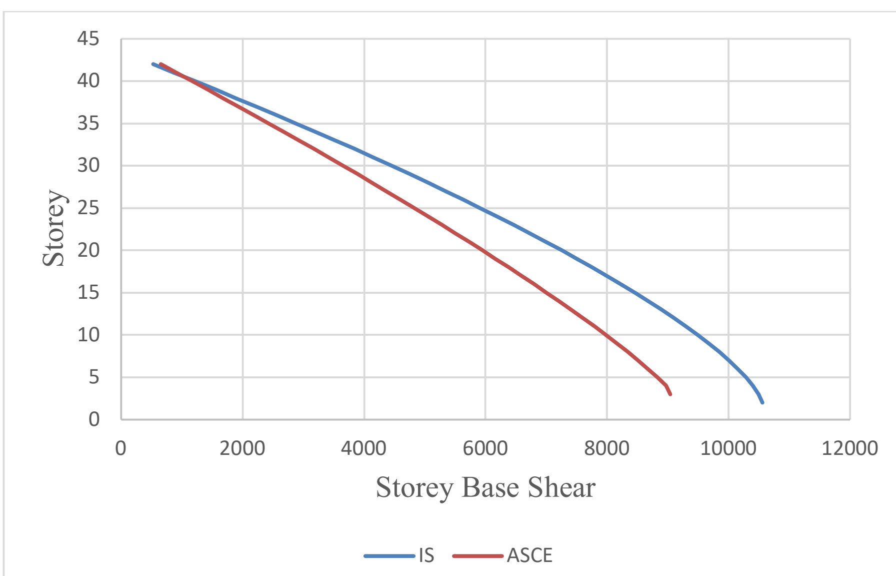


Figure 6.4.6: Comparison of story Base Shear in kN at different height.

CHAPTER – 7

CONCLUSION

Dynamic Wind Load on an 80 m High Building (IS 875 Part 3 (2015) and ASCE 7-22)

Lateral Displacements

- **Comparison of Standards**:
  - For both IS 875 Part 3 (2015) and ASCE 7-22, lateral displacements decrease as the height decreases.
  - IS 875 Part 3 (2015) generally yields higher lateral displacement values compared to ASCE 7-22 for all building shapes.
- **Effect of Shape**:
  - **Rectangular**: Shows the highest lateral displacement in both standards.
  - **Octagonal**: Shows the lowest lateral displacement, indicating a higher resistance to wind loads due to its shape.
  - **Diamond and Square**: Fall in between rectangular and octagonal shapes, with the diamond shape slightly more resistant than the square in most cases.

Storey Drifts

- **Comparison of Standards**:
  - Storey drifts follow a similar pattern, with IS 875 Part 3 (2015) generally showing higher drifts compared to ASCE 7-22.
- **Effect of Shape**:
  - **Rectangular**: Exhibits the highest storey drifts, indicating more flexibility and potentially less structural stability.
  - **Octagonal**: Exhibits the lowest storey drifts, suggesting a more stable structure under wind loads.
  - **Diamond and Square**: Again, fall in between, with the diamond shape performing slightly better.

Storey Base Shear

- **Comparison of Standards**:

  - Base shear values are significantly higher in IS 875 Part 3 (2015) compared to ASCE 7-22.
- **Effect of Shape**:
  - **Rectangular**: Shows the highest base shear values, indicating a higher load transfer to the base.
  - **Octagonal**: Shows the lowest base shear values, indicating better distribution of wind loads.
  - **Diamond and Square**: Intermediate performance, with diamond shapes showing slightly better load distribution.

Dynamic Wind Load on a 150 m High Building (IS 875 Part 3 (2015) and ASCE 7-22)

Lateral Displacements

- **Comparison of Standards**:
  - Both standards show a consistent decrease in lateral displacement from the top to the bottom stories.
  - IS 875 Part 3 (2015) results in higher lateral displacements compared to ASCE 7-22 at all story levels.
- **General Observations**:
  - Higher wind loads in IS 875 Part 3 (2015) lead to greater lateral displacements, implying more flexible building behavior under dynamic wind loads.

Storey Drifts

- **Comparison of Standards**:
  - Similar trends in storey drifts are observed, with IS 875 Part 3 (2015) showing slightly higher values than ASCE 7-22.
- **General Observations**:
  - Lower storey drifts in ASCE 7-22 indicate better performance in terms of structural stability and reduced lateral movement.

Storey Base Shear

- **Comparison of Standards**:
  - IS 875 Part 3 (2015) produces significantly higher base shear values compared to ASCE 7-22.

- **General Observations**:
  - Higher base shear values in IS 875 Part 3 (2015) imply greater forces acting at the base of the structure, necessitating more robust foundation design and lateral load resistance mechanisms.

Overall Conclusion

- **Comparison of Indian (IS 875 Part 3 (2015)) and American (ASCE 7-22) Standards**:
  - IS 875 Part 3 (2015) generally predicts higher lateral displacements, storey drifts, and base shear values compared to ASCE 7-22.
  - This indicates that the Indian standard tends to be more conservative, resulting in higher estimates of wind-induced effects on buildings.
- **Effect of Building Shape**:
  - **Rectangular**: Shows the highest values across all parameters, indicating less aerodynamic efficiency and higher wind-induced effects.
  - **Octagonal**: Consistently shows the lowest values, demonstrating superior performance in mitigating wind loads.
  - **Diamond and Square**: Intermediate performance, with diamond shapes slightly outperforming square shapes in most cases.
- **Design Implications**:
  - Designers should consider the more conservative estimates of IS 875 Part 3 (2015) for higher safety margins in wind load design.
  - The octagonal shape proves to be the most effective in reducing wind-induced displacements, drifts, and base shear, suggesting a preferred shape for high-rise buildings in wind-prone areas.
  - Comparative results highlight the importance of choosing appropriate building shapes and standards to ensure both safety and cost-efficiency in structural design against dynamic wind effects

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WORD COUNT

8115 Words

CHARACTER COUNT

38011 Characters

PAGE COUNT

52 Pages

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