Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 11, November -2017

# *A Review on Eco skyscrape –Integration of Wind Turbines in Building*

Nilay S. Parekh[1],Grishma Thaker[2], Aditya Bhatt[3]

[1]*Civil Engineering Department, ChhotubhaiGopalbhai Patel Institute of Technology,*
*2Civil engineering Department, ChhotubhaiGopalbhai Patel Insttitue of Technology,*
*3Civil engineering Department, ChhotubhaiGopalbhai Patel Insttitue of Technology,*

**Abstract** —*This study comprises twin G+50 multistory building and the design features three horizontal axis wind turbines mounted between the towers, taking advantage of the prevailing onshore wind to generate electricity, which posed unique challenges that had to be overcome.This study includes time history analysis using ETABS for finding deflection of two towers,wind tunnel test using AUTODESK ROBOT STRUCTURAL ANALYSIS and design of sky bridges for connecting two buildings and for mounting wind turbines.Tube in tube structural system is used for twin tower. This study aims to get benefit from the wind energy and convert it into useful energy to be used in twin tower and showing how innovative ideas have come together to create this unique building.*

***Keywords***-*Eco-skyscraper, wind turbine, twin building, sky bridges, time history.*

## I. INTRODUCTION

The Thousands of years ago, human beings learned how to use wind as an energy source. The first usage of the wind power was to sail ships on the ocean. Then, it was been used to grind grains and pump water. In addition, due to the development in the world wind power has been used to generate electricity, because it offers pollution-free solutions, excellent supplement and it is renewable source. Today, large wind-power plants are supplying an economical clean power in many part of the world. Wind turbines are normally located far from people who use it. However, In this project aims to benefit from the wind energy and convert it into useful energy to be used in skyscrapers or commercial buildings.The BAHRAIN WORLD TRADE CENTRE is the only building which integrates wind turbines in multi-storey building and located on connecting skydecks.For establishment of this type of project the best location would be MUMBAI, MAHARASTRA. Location must be require enough wind speed for the success of the project so Mumbai is one of the best place for this kind of project.This report covers the design aspect of two multi-storey building linked with skybridges.It will describe the details of the building location, physical characteristics and performance of wind power system showing how innovative ideas have come together to create this unique building.

The twin tower is analysed and planned as per referenceof various literature paper. The time history analysis is done by ETABS software. For this kind of project wind tunnel test is necessary so its is done by AUTODESK ROBOT STRUCTURAL ANALYSIS and the sky bridges will located at 17$^{th}$,27$^{th}$ and 37$^{th}$ floor respectively.

## II. LITERATURE REVIEW

### A. Design of Tall Buildings Preliminary Design and Optimization,Worcester Polytechnic Institute, Worcester, Massachusetts, 01609, USA

**P. Jayachandran**has studied on tall building structural system and characteristics and gives information about how to decide structural system. The design issues for preliminary design and optimization have been briefly summarized, and a rational methodology of design was shown. This enables optimization of initial structural systems for drift and stresses, based on gravity and lateral loads. Some insight into the design of many types of tall building structural systems and their subsystems was provided based on past experience in tall building design. The design issues are efficiency of systems, stiffness, member depths, balance between sizes of beam and column, bracings, as well as spacing of columns, and girders, and areas and inertias of members. Drift and accelerations should be kept within limits. Good preliminary design and optimization leads to better fabrication and erection costs, and better construction. The cost of systems depends on their structure weight. This depends on efficient initial design. Efficient structural design also leads to a better foundation design, even in difficult soil conditions. The structural steel weight is shown to be an important parameter for the architects, construction engineers and for fabrication and assembly.

 

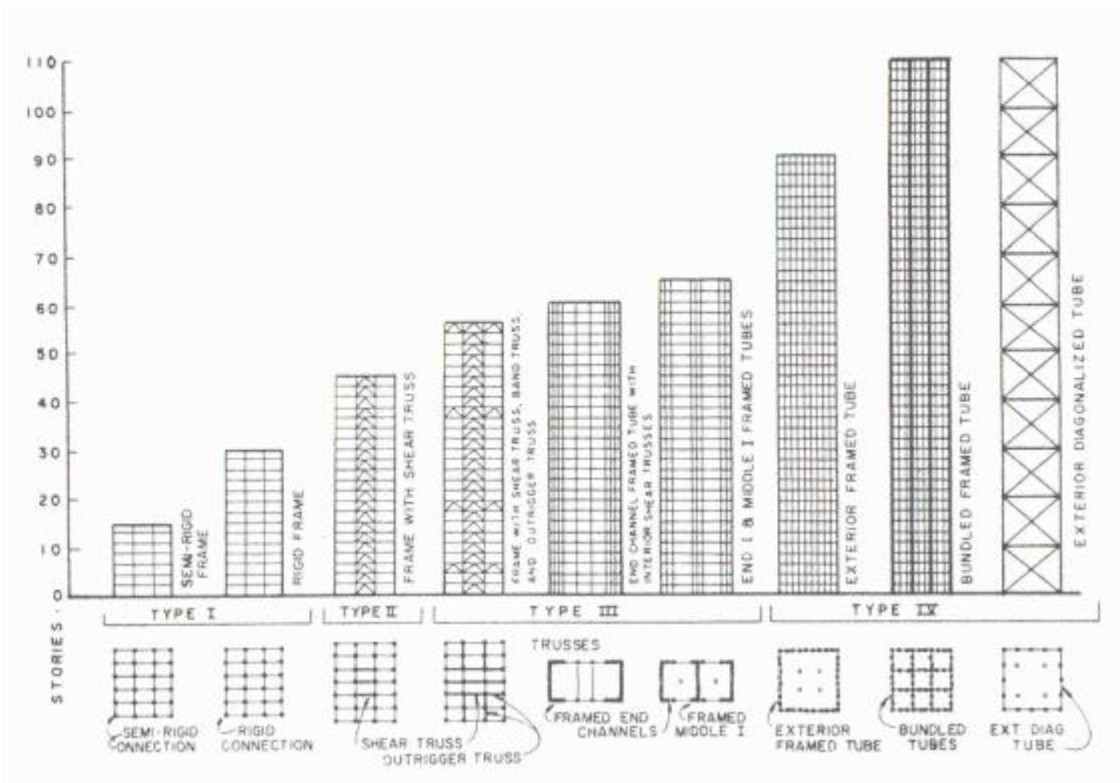


***Figure1:Structural Systems***

## B. Time history analysis of multistoried RCC buildings for different seismic intensities

**A S Patil and P D Kumbhar**have studied nonlinear dynamic analysis of Ten storied RCC building considering different seismic intensities is carried out and seismic responses of such building are studied.The building under consideration is modeled with the help of SAP2000-15 software. Five different time histories have been used considering seismic intensities V, VI, VII, VIII, IX and X on Modified Mercalli's Intensity scale (MMI) for establishment of relationship between seismic intensities and seismic responses. The results of the study show similar variation patterns in seismic responses such as base shear and storey displacements with intensities V to X. From the study it is recommended that analysis of multistoried RCC building using Time History method becomes necessary to ensure safety against earthquake force.

The values of base shear, storey displacements and storey drifts (X and Y directions) for seismic intensities of VI, VII, VIII, IX and X [table 2, 3, 4, 5, 6] are found to be more by 1.85, 3.56, 7.86, 15.1, and 17.15 times [fig.2, 3, 4, 5] , respectively as compared to seismic intensity of V for both the models (i.e., with and without soft story) and for all the time histories. As Time History is realistic method, used for seismic analysis, it provides a better check to the safety of structures analyzed and designed by method specified by IS code.

**Table 1: Different Time Histories Considered for Study**

| S. No. | EQ | Date | Magnitude Richter Scale | P.G.A.g |
|---|---|---|---|---|
| 1. | Bhuj, India | Jan 26, 2001 | 6.9 | 0.110 |
| 2. | Koyana, India | Dec 11, 1964 | 6.5 | 0.489 |
| 3. | Anza, USA | Feb 25, 1980 | 4.7 | 0.110 |
| 4. | Nahanni, Canada | Dec 23, 1985 | 6.9 | 0.489 |
| 5. | Northridge, USA | Jan 17, 1994 | 6.7 | 0.489 |

 

**Table 2: Different Seismic Intensities Considered for Study**

| S. No. | Intensity MMI | PGA g | Seismic Zones as per IS:1893-2002 |
|---|---|---|---|
| 1. | V | 0.03-0.04 | - |
| 2. | VI | 0.06-0.07 | II (second) |
| 3. | VII | 0.10-0.15 | III(third) |
| 4. | VIII | 0.25-0.30 | IV(fourth) |
| 5. | IX | 0.50-0.55 | V(fifth) |
| 6. | X | >0.60 | - |

**Table 3: Variations in Base Shears for X Direction**

| S. No. | Intensity MMI | Base Shears kN | | | | |
|---|---|---|---|---|---|---|
| | | Bhuj | Koyana | Anza | Nahanni | Northridge |
| 1. | V | 40.268 | 56.87 | 96.479 | 145.774 | 106.544 |
| 2. | VI | 74.786 | 105.615 | 179.153 | 270.746 | 197.897 |
| 3. | VII | 143.801 | 203.112 | 344.554 | 520.643 | 380.542 |
| 4. | VIII | 316.37 | 446.84 | 757.985 | 1145.45 | 837.214 |
| 5. | IX | 603.975 | 853.056 | 1447.07 | 2186.74 | 1598.34 |
| 6. | X | 690.247 | 974.926 | 1653.8 | 2499.11 | 1826.66 |

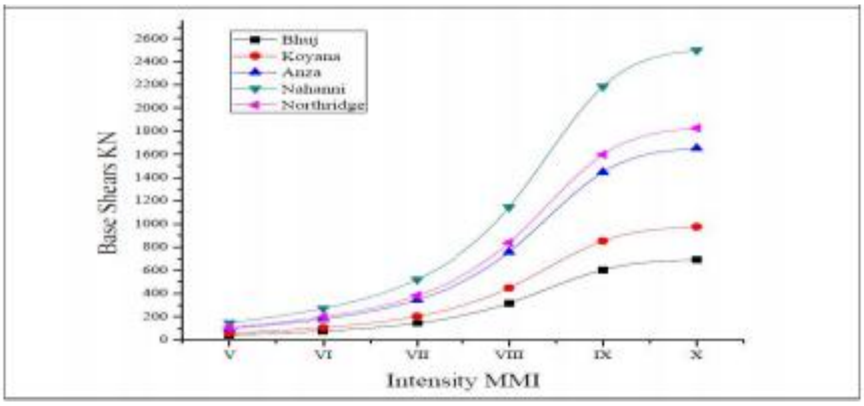


*Figure 2: Variations in Base Shears for X Directions*

**Table 4: Variations in Base Shears for X Direction**

| S. No. | Intensity MMI | Base Shears kN | | | | |
|---|---|---|---|---|---|---|
| | | Bhuj | Koyana | Anza | Nahanni | Northridge |
| 1. | V | 47.932 | 54.299 | 124.994 | 71.536 | 79.959 |
| 2. | VI | 89.028 | 100.874 | 232.111 | 132.834 | 148.504 |
| 3. | VII | 171.182 | 139.969 | 446.395 | 255.429 | 285.609 |
| 4. | VIII | 376.609 | 426.722 | 982.029 | 561.973 | 628.304 |
| 5. | IX | 718.996 | 817.659 | 1874.78 | 1072.83 | 1199.49 |
| 6. | X | 821.7 | 931.041 | 2142.61 | 1226.1 | 1370.82 |

 

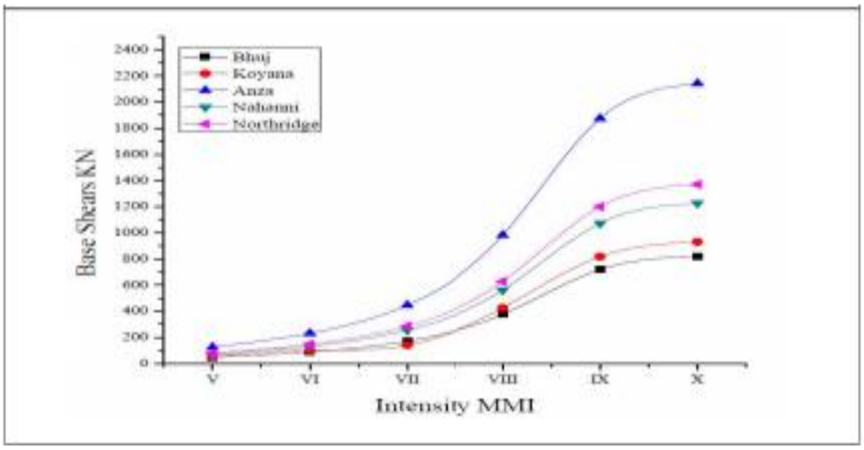


*Figure 3: Variations in Base Shears for Y Directions*

**Table 5: Variations in Roof Displacements for X Direction**

| S.No. | Intensity MMI | Displacements mm | | | | |
|---|---|---|---|---|---|---|
| | | Bhuj | Koyana | Anza | Nahanni | Northridge |
| 1. | V | 0.027 | 0.031 | 0.044 | 0.052 | 0.05 |
| 2. | VI | 0.05 | 0.058 | 0.082 | 0.097 | 0.093 |
| 3. | VII | 0.097 | 0.111 | 0.159 | 0.186 | 0.18 |
| 4. | VIII | 0.213 | 0.245 | 0.349 | 0.41 | 0.395 |
| 5. | IX | 0.407 | 0.467 | 0.666 | 0.782 | 0.755 |
| 6. | X | 0.465 | 0.534 | 0.762 | 0.894 | 0.863 |

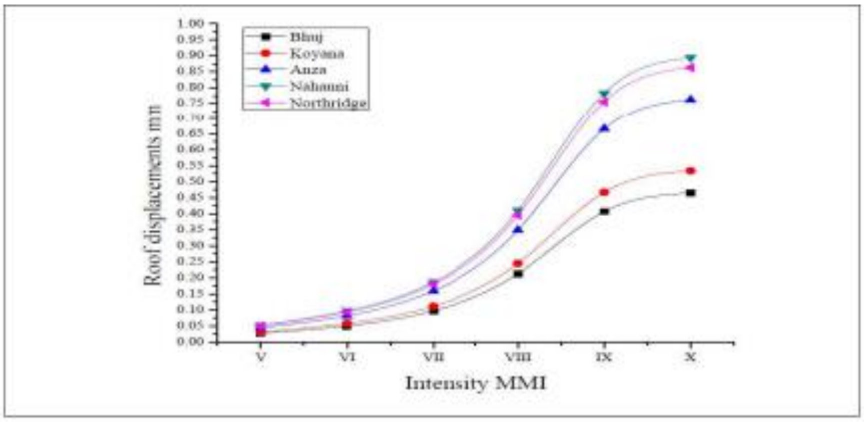


*Figure 4: Variations in Roof Displacements for X Directions*

**Table 6: Variations in Roof Displacements for Y direction**

| S.No. | Intensity MMI | Displacements mm | | | | |
|---|---|---|---|---|---|---|
| | | Bhuj | Koyana | Anza | Nahanni | Northridge |
| 1. | V | 0.056 | 0.073 | 0.162 | 0.1 | 0.076 |
| 2. | VI | 0.104 | 0.135 | 0.3 | 0.186 | 0.141 |
| 3. | VII | 0.201 | 0.259 | 0.578 | 0.357 | 0.272 |
| 4. | VIII | 0.442 | 0.57 | 1.271 | 0.786 | 0.598 |
| 5. | IX | 0.843 | 1.088 | 2.426 | 1.5 | 1.141 |
| 6. | X | 0.963 | 1.244 | 2.772 | 1.715 | 1.304 |

 

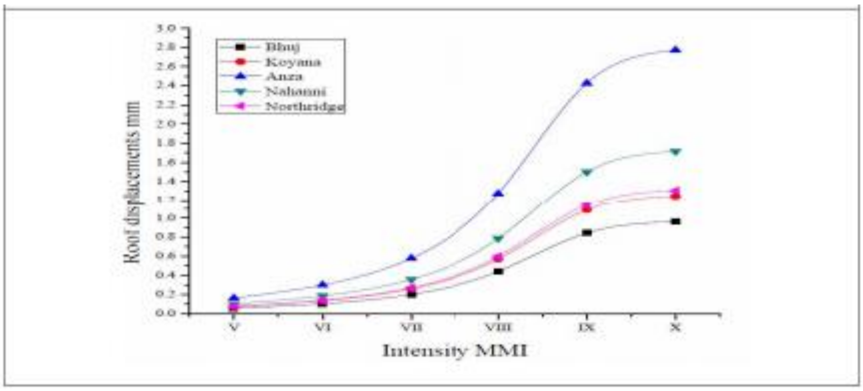


*Figure 5: Variations in Roof Displacements for X Directions*

## C. Technical journal-bahrain world trade

**SarthiArshad khan, martin halford**give informationbuildings floor plan,ground condition,foundation solution and analysis which is very useful in this study.

The Bahrain World Trade Centre is the world's first large-scale integration of wind turbines into a building [fig.6]. This integration was one of the principal challenges on the project. The turbines were commissioned in April 2007, and global interest was received from environmental and architectural bodies, media and private institutions across the world. Other challenges on the project included the 'fast-track' approach adopted for design and construction, the sheer scale and complexity of the project and the integration of the reinforced concrete, structural steelwork and cladding elements of the design. With their distinctive instantly recognizable design and utilization of wind power, the twin towers are likely to become well known worldwide and contribute to developing Bahrain's reputation as an appealing destination.

*Figure6: BAHRAIN WORLD TRADE CENTRE*

## D. Effects of shape on the wind-instigate response of high rise buildings

**M. R. Wakchaure,sayaligawali**have calculated wind load effect on various shape of building using gust factor method. The percentage reduction in peak intensity of wind for circular building is 4.471 %, 68.392 % for elliptical building and it is more by 15 % for rectangular building when compared with square building with gust factor.[table : 7,8]

The percentage reduction in peak storey shear is 30.57 % in rectangular building,4.40 % in elliptical building and 68.37% in circular building with gust factor in longitudinal direction when compared with square building. The percentage reduction in peak drift is decreased by 70.86 % in elliptical building; it is more by 14 % in rectangular, 1.27 % in circular building when compared with square building with gust factor in transverse direction

From the above results, with the change in shape of building from square to elliptical the wind intensity, storey drifts, the lateral displacements, storey shear of the building decreased. Hence it is conclude that wind load is reduced by maximum percentage with an elliptical plan.

**Table 7: Comparison of Wind forces with gust factor (X-direction) (kN)**

| Storey No. | Height m | Square | Rectangular | | Circular | | Elliptical | |
|---|---|---|---|---|---|---|---|---|
| | | Wind intensity (kN) | Wind intensity (kN) | % Decrease | Wind intensity (kN) | % Decrease | Wind intensity (kN) | % Decrease |
| 0 | 0 | 96.457 | 116.566 | -20.847 | 94.773 | 1.746 | 30.172 | 68.719 |
| 10 | 30 | 136.446 | 162.674 | -19.223 | 132.902 | 2.597 | 42.915 | 68.548 |
| 20 | 60 | 165.272 | 194.964 | -17.965 | 160.494 | 2.891 | 52.061 | 68.500 |
| 30 | 90 | 183.979 | 214.612 | -16.651 | 177.101 | 3.738 | 57.981 | 68.485 |
| 40 | 120 | 197.028 | 229.230 | -16.344 | 189.554 | 3.793 | 62.695 | 68.180 |
| 50 | 150 | 209.786 | 241.265 | -15.006 | 200.406 | 4.471 | 66.310 | 68.392 |

**Table 8: Comparison of Wind forces with gust factor (Y-direction) (kN)**

| Storey No. | Height m | Square | Rectangular | | Circular | | Elliptical | |
|---|---|---|---|---|---|---|---|---|
| | | Wind intensity (KN) | Wind intensity (KN) | % Decrease | Wind intensity (KN) | % Decrease | Wind intensity (KN) | % Decrease |
| 0 | 0 | 96.457 | 67.265 | 30.265 | 94.773 | 1.746 | 29.222 | 69.704 |
| 10 | 30 | 136.446 | 95.846 | 29.755 | 132.902 | 2.597 | 40.803 | 70.096 |
| 20 | 60 | 165.272 | 116.165 | 29.713 | 160.494 | 2.891 | 49.174 | 70.247 |
| 30 | 90 | 183.979 | 128.604 | 30.099 | 177.101 | 3.738 | 54.235 | 70.521 |
| 40 | 120 | 197.028 | 137.912 | 30.004 | 189.554 | 3.793 | 57.959 | 70.583 |
| 50 | 150 | 209.786 | 145.574 | 30.608 | 200.406 | 4.471 | 61.101 | 70.875 |

**E. Dynamic characteristics of wind excited linked twin buildings based on a 3-dimensional analytical model**

**JieSong , K.T. Tse**have studied on dynamic characteristics of twin building and The present work investigates the effects of structural links on the modal properties and wind-induced responses of a linked building system (LBS) by using an advanced three-dimensional analytical model. The LBS in this study refers to a system consisting of twin buildings horizontally connected by structural links such as skybridges and skygardens. The proposed analytical model of the LBS is derived by assembling the structural-property matrices of a rigid floor diaphragm model of the buildings and those of a beam model of each link. The accuracy of the analytical model is then compared with and validated by a detailed finite element method (FEM) model [fig.8,9]. By employing the analytical model together with the layer-by-layer wind force time histories measured in a wind tunnel, the modal properties and windinduced dynamic responses are computed for LBSs with different link properties.

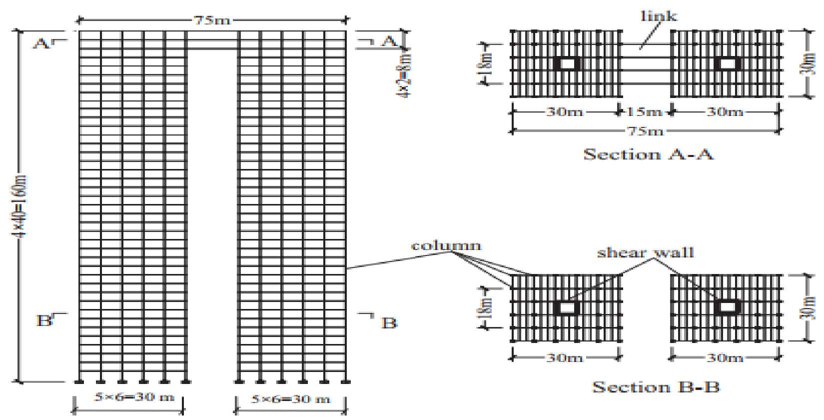


*Figure7: Structural system of a LBS*

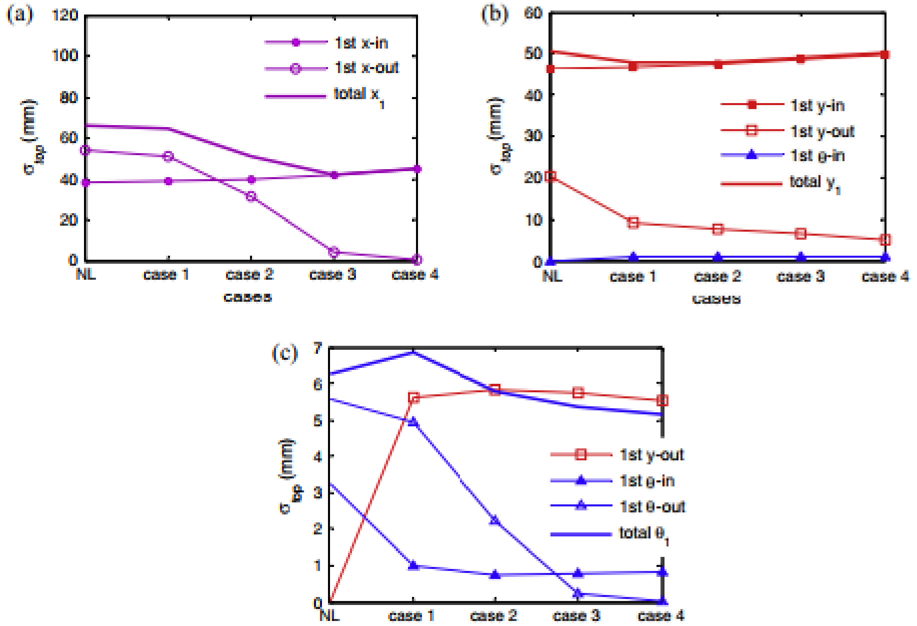


*Figure 8: Variation of standard deviation of rooftop displacement responses for a = 0: (a) x direction; (b) y direction; (c) h direction.*

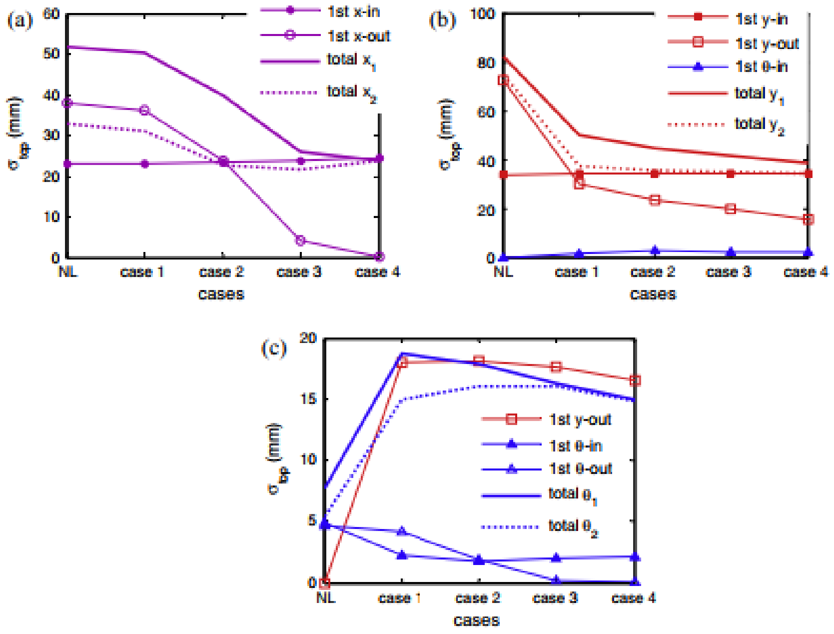


*Figure 9: Variation of standard deviation of rooftop displacement responses for a = 90: (a) x direction; (b) y direction; (c) h direction*

## III. CONCLUSION

From all this we have concluded that to construct this type of structure; we have to understand the behavior and characteristics of the structures. We have to analyze the structure in terms of wind effect on different shape of building, proper structural analysis, and analysis and design aspect for inter connected sky bridge or sky deck. To integrate large scale wind turbines into a tall building involves extensive research.In addition, it should be appreciate and understand this type of project as a pioneering step toward sustainability design through the potentials of modern engineering and architecture.

 

**REFRENCES**

[1] Prof. M. R. Wakchaure , SayaliGawali, Effects Of Shape On Wind Forces Of High Rise Buildings Using Gust Factor Approach, International Journal Of Science, Engineering And Technology Research (Ijsetr), Volume 4, Issue 8, August 2015

[2] Jie Song , K.T. Tse,Dynamic Characteristics Of Wind-Excited Linked Twin Buildings Based On A 3-Dimensional Analytical Model,Department Of Civil And Environmental Engineering, The Hong Kong University Of Science And Technology, Hong Kong, China.

[3] Prof. M. R. Wakchaure , SayaliGawali, Effects Of Shape On Wind Forces Of High Rise Buildings Using Gust Factor Approach, International Journal Of Science, Engineering And Technology Research (Ijsetr), Volume 4, Issue 8, August 2015

[4] M. R. Wakchaure , SayaliGawali, Effects Of Shape On The Wind-Instigate Response Of High Rise Buildings, Professor, Civil Engineering Department, Amrutvahini College Of Engineering Sangamner, Maharashtra, India 2post Graduate Student, Civil Engineering Department, Amrutvahini College Of Engineering Sangamner, Maharashtra, India

[5] A S Patil, P D Kumbhar, Time History Analysis Of Multistoried Rcc Buildings For Different Seismic Intensities, Issn 2319 – 6009 Www.Ijscer.Com Vol. 2, No. 3, August 2013 © 2013 Ijscer.

[6] "Bis Is 456 : Plain And Reinforced Concrete-Code Of Practice.New Delhi(India) : Bureau Of Indian Standards;2000."

[7] "Ced 38 (10639)Wc -Tall Building Code,New Delhi(India):Bureau Of Indian Standards."

[8] Bis Is 875:Wind Loads For Building And Structures,New Delhi(India):Bureau Of Indian Standards."

[9] "Bis Is 1893: Criteria For Earthquake Resistant Design Of Structure,Part 1.New Delhi(India):Burreau Of Indian Standard;2002.

 