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Comparative Study on Tall Structures with Different Aerodynamic Modification Subjected to Wind Load Using ETABS

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ABSTRACT:High rise Structures are in demand due to scarcity of land in urban areas, economic growth, technological advancement, etc. Wind effect is very important for high rise structures and provides significant contribution to overall loading and serviceability. But as we go higher wind excitation becomes one of the most precarious force acting on the surface of the structure. So modifications to the structural geometry is one of the best idea to reduce the wind impact. In this paper different aerodynamic modification are applied to the G+40 square structure. Minor modification like round corner, recessed corner and major modification like setback, tapered were considered. Wind analysis for these models were done in ETABS software and the obtained results were compared with basic square model. Then the model having less impact for wind is concluded as the best modified structure

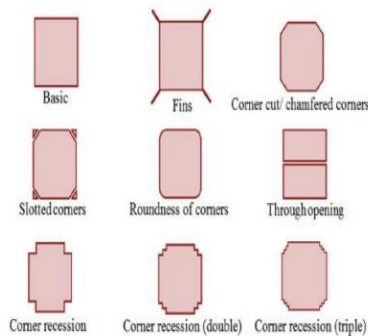
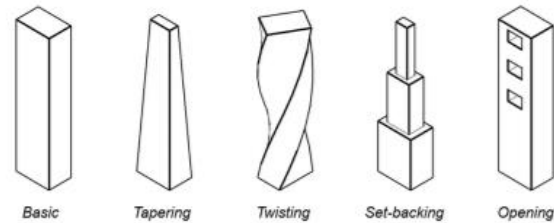
I. INTRODUCTION

Buildings are the structures used by the people for shelter purpose, working purpose or storage purpose. Day by day, the population in urban area is increasing and the space required for their residency is decreasing. Due to this, the demand for the high rise structure is quite popular these days. As we move higher and higher, we have to consider wind as the main point during structural design. Therefore for the design purpose, the structural engineers and architects mainly concentrate on the modifications for the structure which is going to reduce the wind effects.

Wind acts as lateral load on multistory buildings. As per IS 875 (part 3)1987, basic wind speed is specified for several zones. It mainly depends on the exposed area of buildings in opposite to the direction of wind flow. Wind pressure is exerted homogeneously on all the faces of the building. Higher the structure, greater will be the force. Often for shorter houses in dense locations, wind loads can be ignored while for high rise wind load calculation is must.

II. AERODYNAMIC FORMS AND MODIFICATIONS

Aerodynamic modifications are the practical approach to reduce the effects of wind on tall buildings. The effect of modification with wind forces has been widely investigated, so that aerodynamic modifications (which have been known as a minor architectural treatment) are thought to be efficient, including cross-sectional shapes (horizontally) such as polygons and corners, building forms(vertically) such as tapered, setbacks, helical or twisted, and openings. In this context, aerodynamic forms include setback models, helical and tapered, and composite models. Besides, aerodynamic forms include recessed corners, chamfer corners, and rounded corners. Using these types of techniques can ultimately increases the resistance of building facades against wind effects, and finally, the adverse effect of wind on tall buildings will be lower.

**Fig 1:** Minor aerodynamic forms**Fig 2:** Major aerodynamic forms

III. ETABS

ETABS stands for Extended Three dimensional Analysis of Building Systems. ETABS is commonly used to analyze: Skyscrapers, parking garages, steel & concrete structures, low and high rise buildings, and portal frame structures. The advantages are,

- Easy to use interface,
- Conformation with the Indian Standard Codes,
- Versatile nature of solving any type of problem,
- Accuracy of the solution.

Modelling of R.C.C. building is done in the ETABS software for analysis purpose. Structural analysis means determination of the general shape and all the specific dimensions of a particular structure so that it will perform the function will safely withstand the influences which will act on it throughout its lifetime. An attempt is made here to understand the behaviour of the building for wind force. Also a detailed study of the building with shear walls at different locations under wind pressure

IV. OBJECTIVES

- To model and analyse the different modified structures in ETABS
- To study the effect of wind on different structures.
- To evaluate the effect of corner modification on buildings to resist the wind load.
- To study the story displacement, story drift, base shear, moments for the opted modified structures.
- To predict the best shape and modification for the construction of tall structure.

V. METHODOLOGY

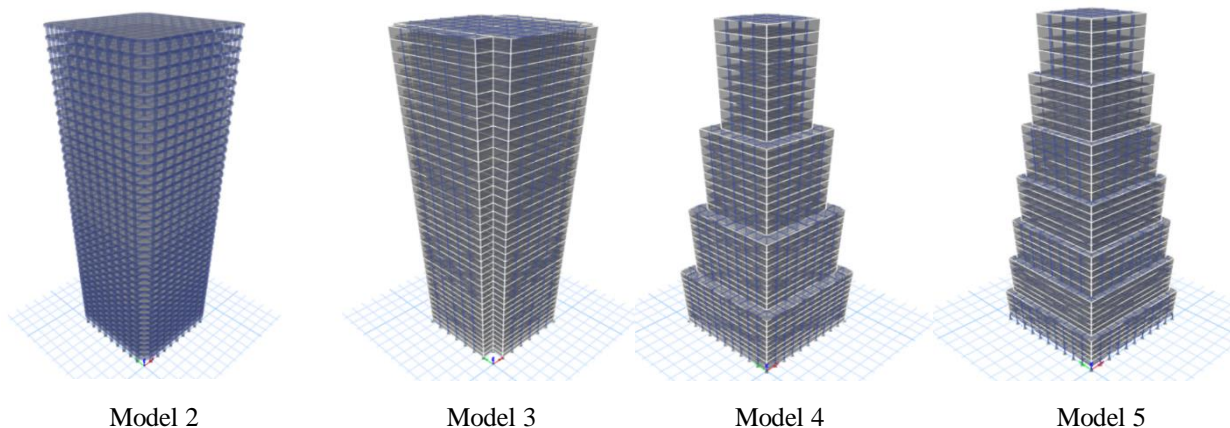
The modeling and design of the models were carried out in ETABS software. Model description and parameters were tabulated below.

| SL. NO | PARTICULARS | VALUES |
|--------|-------------------------|--------------------------------|
| 1 | No. of story | G+40 |
| 2 | Ground floor height | 3m |
| 3 | Story height | 3.5m |
| 4 | Plan area | 40m x 40m = 1600m ² |
| 5 | Thickness of slab | 0.2m |
| 6 | Thickness of shear wall | 0.23m |
| 7 | Grade of concrete | M40 M30 for slabs |

| | | |
|----|------------------------|----------------------------|
| 8 | Grade of steel | Fe550 |
| 9 | Basic Wind speed | 33m/s |
| 10 | Terrain category | 4 |
| 11 | Structure class | c |
| 12 | Risk coefficient (k1) | 1.05 |
| 13 | Topography factor (k3) | 1 |
| 14 | Wind coefficients | As per IS 875 (Part 3)1987 |
| 15 | Density of concrete | 25kN/m ³ |
| 16 | Density of solid brick | 20kN/m ³ |
| 17 | Density of Mortar | 20.4kN/m ³ |

Table 1: Parameters considered for the model

| Models | Structure | Plan area | Column size(m) | Beam size(m) | Modifications |
|---------|-----------------------------|-----------|--|--|--|
| Model 1 | Basic square | 40mx40m | 0.8x0.8 0.6x0.6 | 0.62x0.8 0.46x0.6 | - |
| Model 2 | Square with round corner | 40mx40m | 0.9x0.9 0.8x0.8 | 0.69x0.9 0.62x0.8 | Corner cut $(\frac{1}{10})B = \frac{1}{10} 40 = 4m$ |
| Model 3 | Square with recessed corner | 40mx40m | 0.9x0.9 0.8x0.8 | 0.69x0.9 0.62x0.8 | Corner cut $(\frac{1}{10})B = \frac{1}{10} 40 = 4m$ |
| Model 4 | Square setback model | 40mx40m | 1x1 0.85x0.85 0.75x0.75 0.65x0.65 | 0.75x1 0.65x0.85 0.55x0.75 0.5x0.65 | $(\frac{1}{10})B = 4m$ is reduced at all 4 sides for every 10 stories. |
| Model 5 | Square tapered model | 40mx40m | 1x1 0.85x0.85 0.75x0.75 0.65x0.65 | 0.75x1 0.65x0.85 0.55x0.75 0.5x0.65 | Plan area is reduced 16x16m i.e., $(\frac{2}{5})B$ |

Table 2: Description of models**Fig 3:** 3D view of the models in ETABS

VI. RESULT AND DISCUSSION

Maximum values of story displacement, story drift and Story shear were tabulated and graphs were plotted below

Story Displacement

| Story Displacement (mm) | | |
|-------------------------|--------|--------|
| Models | Wind X | Wind Y |
| Model 1 | 67.918 | 62.114 |
| Model 2 | 54.872 | 64.334 |
| Model 3 | 48.738 | 47.114 |
| Model 4 | 64.918 | 63.114 |
| Model 5 | 60.923 | 58.923 |

Table 3: Comparison of Displacement

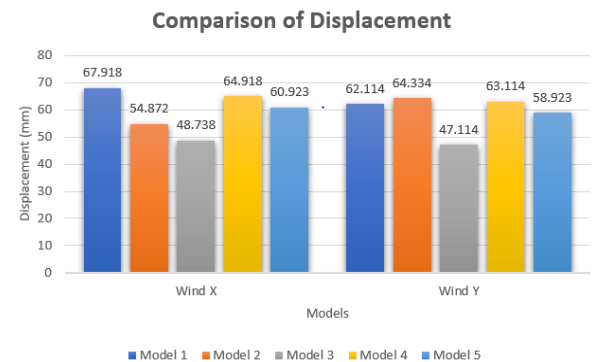


Chart 1: Comparison of Story Displacement in Wind X and Wind Y direction

Story Drift

| Story Drift (mm) | | |
|------------------|----------|----------|
| Model | Wind X | Wind Y |
| Model 1 | 0.000133 | 6.40E-05 |
| Model 2 | 6.90E-05 | 4.00E-05 |
| Model 3 | 0.000086 | 0.000046 |
| Model 4 | 0.000113 | 5.03E-05 |
| Model 5 | 0.000123 | 5.99E-05 |

Table 4: Comparison of Drift

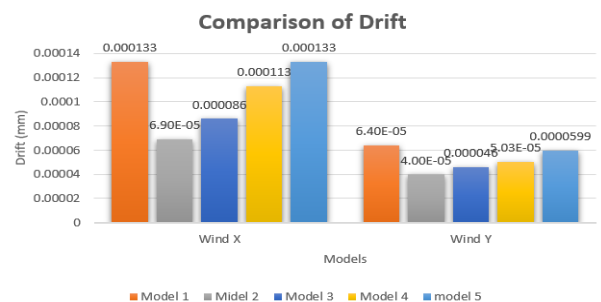


Chart 2: Comparison of Story Drift in Wind X and Wind Y direction

Story Shear

| Story Shear (kN) | | |
|------------------|----------|---------|
| Models | Wind X | Wind Y |
| Model 1 | 159.3656 | 119.207 |
| Model 2 | 81.8353 | 77.7529 |
| Model 3 | 71.5999 | 70.7636 |
| Model 4 | 128.9998 | 76.151 |
| Model 5 | 96.7499 | 73.7142 |

Table 5: Comparison of Story shear

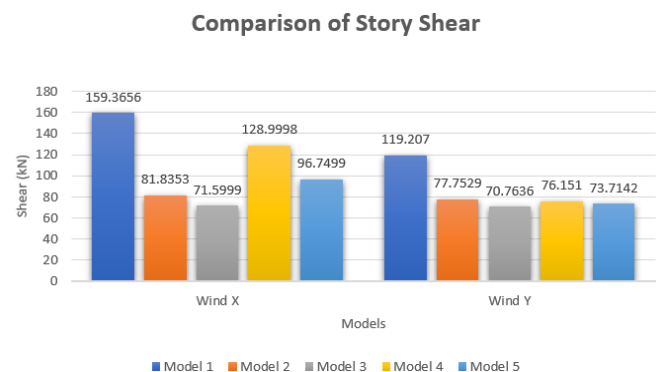


Chart 3: Comparison of Story Shear in Wind X and Wind Y direction



VII. CONCLUSION

In this study, different Aerodynamic modified structure like, round corner model. Recessed corner model, setback model and tapered models are compared with basic square model. Every model is analysed for wind force and different results like story displacement, story drift and story shear were compared and discussed here.

1. The maximum story displacement value is 19.3% and 3.46% reduced in Wind X and Wind Y direction respectively for model 2. And 28.3% and 24.15% is reduced in Wind X and Wind Y direction for model 3 when compared with model 1.
2. The maximum story displacement value is 4.5% and 2% reduced in Wind X and Wind Y direction respectively for model 4. And 10.3% and 5.15% is reduced in Wind X and Wind Y direction for model 5 when compared with model 1.
3. The maximum story drift value is 48.12% and 37.5% reduced in Wind X and Wind Y direction respectively for model 2. And 35.54% and 28.13% is reduced in Wind X and Wind Y direction for model 3 when compared with model 1.
4. The maximum story drift value is 15.04% and 21.4% reduced in Wind X and Wind Y direction respectively for model 4. And 7.5% and 6.4% is reduced in Wind X and Wind Y direction for model 5 when compared with model 1.
5. The maximum story shear value is 48.65% and 34.78% reduced in Wind X and Wind Y direction respectively for model 2. And 55.07% and 40.65% is reduced in Wind X and Wind Y direction for model 3 when compared with model 1.
6. The maximum story shear value is 19.05% and 36.11% reduced in Wind X and Wind Y direction respectively for model 4. And 39.29% and 38.16% is reduced in Wind X and Wind Y direction for model 5 when compared with model 1.
7. By observing above results, we can conclude that making modifications to the structural geometry reduces the wind pressure on the structure when compared to the regular/basic structure.
8. Minor aerodynamic modification i.e, structure with recessed corner and major modification i.e, tapered model reduces the wind impact than basic square model.

REFERENCES

1. Abdollah B. Daemei, AmiraslanaDarvish , Roya Aeinehvand , and AmiraliRazzaghipour. "Large-eddy simulation (LES) on the square and triangular tall buildings to measure drag force" (2021). <https://doi.org/10.1155/2021/6666895>
2. Abdollah BaghaeiDaemei, Elham MehrinejadKhotbehsara, ErfanMalekianNobarani, Payam Bahrami. "Study on wind aerodynamic and flow characteristics of triangular shaped tall buildings and cfd simulation in order to assess drag coefficient" (2019) <https://doi.org/10.1016/j.asej.2018.08.008>
3. Ahmed Elshaer, GirmaBitsuamlak, Ashraf El Damatty "Aerodynamic shape optimization of tall buildings using twisting and corner modifications" (2016) n Bluff Body Aerodynamics and Applications Northeastern University, Boston, Massachusetts, USA
4. Ameena M Ansary, M V Varkey, Jiji Thomas. "Aerodynamic modifications and shape optimization of tall buildings" (2017) (IRJET) e-ISSN: 2395 -0056 Volume: 04 Issue: 06 (www.irjet.net)
5. B. S. Yashaswini, A. B. S. Dadapeer "Comparative Study on Static and Dynamic Analysis of Multistoried Building Using ETABS" IJSRST | Volume 3 | Issue 6 | Print ISSN: 2395-6011
6. Bhumiika Pashine , V. D. Vaidya , Dr. D. P. Singh "Wind analysis of multistoried structure with T shape and L Shape geometry" (2016) IJEDR | Volume 4, Issue 3 | ISSN: 2321-9939 (www.ijedr.org)
7. Eswara Kumar Bandia,n , Yukio Tamura a , Akihito Yoshida a , Yong Chul Kima , Qingshan Yang "Experimental investigation on aerodynamic characteristics of various triangular-section high-rise buildings" (2013) / J. Wind Eng. Ind. Aerodyn. 122, 60–68
8. Hideyuki Tanaka, Yukio Tamura, Kazuo Ohtake, Masayoshi Nakai, Yong Chul Kim "Experimental investigation of aerodynamic forces and wind pressures acting on tall buildings with various unconventional configurations" (2012) H. Tanaka et al. / J. Wind Eng. Ind. Aero dyn. 107–108 (2012) 179–19.
9. K. C. S. Kwok, P. A. Wilhelm, B. G Wiikie "Effect of edge configuration on wind-induced response of tall buildings"
10. Kamlesh Mehta, Jigar Sevalia. "Effectiveness of cfd simulation of wind flow & its effect on tall structures with



- aerodynamic shapes” (2020) (IJARET) Volume 11, Issue 12 <http://www.iaeme.com/IJARET/index.asp>
11. Mohamad zaidchishty 1, Satya Veer Singh 2 “EFFECT OF WIND ON TALL STRUCTURES” (2019) IRJET e-ISSN: 2395-0056 Volume: 06 Issue: 05 www.irjet.net p-ISSN: 2395-0072
 12. Nasar Mohammed Naseer al azri, Sachin Kuckian, Himanshu Gaur. “Reducing the impact of wind load with shape of high rise buildings” (2020) ISSN: 2167-1907 (www.jofsr.org)
 13. Neethi B and Elsa Joby. “Aerodynamic modifications against wind excitation on tall buildings-shape optimization” (2018) (IJERT) ISSN: 2278-0181 Vol. 7 Issue 05 <http://www.ijert.org>
 14. P. V. Srivardhan, Dr. K. Harikrishna. “Deflection analysis of high rise concrete buildings for wind and seismic loads using bracing systems for plan irregularities using etabs” (2016) (IJLTEMAS) Volume V, Issue XI, November 2016 | ISSN 2278-2540
 15. Ravinder Ahlawat and Ashok K. Ahuja “Wind Loads on ‘T’ Plan Shape Tall Buildings” (2015) Journal of Academia and Industrial Research (JAIR) Volume 4, Issue 1 jairjp.com
 16. Thamanna Basheer P, Krishnachandran V N. “Study on wind flow on a hexagonal shaped tall building by mean of drag coefficients” (2020) IRJET)Volume: 07 Issue: 07 (www.irjet.net)
 17. IS 456:2000. “Plain and reinforced concrete code of practice”. Bureau of Indian standards, New Delhi.
 18. IS 875 (Part 3) 1987 “Indian standard code of practice for design of loads” (for wind loads), Bureau of Indian standards, New Delhi.



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