iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** X **Month of publication:** October 2021

DOI: https://doi.org/10.22214/ijraset.2021.38463

Analysis of Wind Load Effect on C-Shape Tall Building with and Without Shear Wall

Mr. Ankur Srivastava[1], Mr. Vinayak Mishra[2]
[1]M. Tech Structural Engineering, [2]Assistant Professor, Department of Civil Engineering, Institute of Engineering and Technology, Lucknow, Uttar Pradesh, INDIA

Abstract: Since land is scarce in metropolitan locations, it's common for tall building to be erected in C form. With the use of software ETABS 2019, this study examines the features of wind-induced story displacement and story drift operating on tall C-shaped models, with and without shear wall. Also, empirical formulae are used for manual calculations and to obtain the wind force and designed wind pressure on C-shaped tall building using codal provisions of IS 875 (Part 3) : 2015, also its applicability has been validated by a case study. For tall C-shaped buildings, this study gives a comparative result on the effect of wind load on building, with & without shear wall on behalf of maximum story displacement and story drift.
Keywords: Plan irregularity, shear wall, wind load, ETABS 19

I. INTRODUCTION

In recent years, large number of irregular shaped tall structures have been constructed because of shortage of land in metropolitan areas. The structures' uneven forms is more responsive to wind stimulation. In the occurance of wind load, lateral displacement play a significant role in the buildings that soar to a great height. When the centre of mass and the centre of stiffness do not coincide, eccentricities occur in the structures, causing torsion.

It's crucial for structural engineers to analyse loads operating on a structure rationally and effectively, including wind load during design. There are a variety of C-type buildings that have plan anomalies. Seismic loading is made more difficult by the uneven design of the building. In recent years, high-rise constructions have become an essential element of the construction industry. Construction technological advances have led to the transformation of classic rectangular sky scrapers into unusually shaped towers. High-rise buildings face the same vertical pressures as conventional structures, but the lateral loads caused by wind and earthquakes have a higher influence. As a result of its restricted reach in terms of building height and design, its trustworthiness has been questioned.

High-rise structures are affected by both longitudinal and transverse wind forces, and in order to resist the building from transverse wind forces, Shear walls are provided in the structure. Shear wall is the structural panels that can bear lateral forces. Lateral forces are those that run perpendicular to the plane of the wall. Examples of dynamic loadings include wind load, earthquake and other factors. In the absence of perpendicular shear walls, side forces might topple parallel structural panels.

II. METHODOLOGY

Here certain parameters have been taken into account and graphical depiction of the structure's parameter are illustrated in this technique. The Story displacement and Story Drift parameters are taken into account. These parameters are computed with ETABS Program and the data is obtained via the execution of loadings in the software.

Structures examined for graphical depiction are C type Building with and without shear walls. Each time, the wind blows in the X direction at a velocity of 50 m/sec, the story displacement and story drift value is calculated. And the outcome is displayed in Global X. The results are presented in tabular and graphical formats. Story Height will be graphed against its many characteristics. Take, for example.

Story height vs storey displacement (or) storey drift. In this case, the comparison was carried out by taking into account the highest output of the specific condition.

Also by the help of manual calculation various results are obtained such as designed wind pressure and wind force using IS 875 (Part 3) – 2015. All the result for each story has been shown in the graphical manner. C type structure is the structure having plan shape of "C" shape or it can also be known as rotated "U" shape structure.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue X Oct 2021- Available at www.ijraset.com

III. MODELLING

A. Descriptions

S. No	Structure Part	Dimension
1	Locality	Eastern coast of India
2	Building type	Residential G+30
3	Structure Shape	C Shape RC Tall Building
4	No. of Spans in X-Direction	40m
5	No. of Spans in Y – Direction	35m
6	Number of bays in X- Direction	8 Nos.@ 4m
7	Number of bays in Y- Direction	7 Nos. @ 4m
8	Each story height	3m
9	Complete height of building	90m
10	Slab Thickness	140mm
11	Size of column	600*600mm
12	Beam	300*600mm

Table 1

S. No	Material	Grade
1	Concrete	M 30
2	Steel Section	Fe 250
3	Rebar	HYSD 500
4	Density of Steel	7850 kg/m cube
5	Youngs Modulus (E)	2.1 X 10^5 N/mm^2
6	Shear Modulus	80000 N/mm^2
7	Poisson's Ratio	0.3

Table 2

S No.	Parameters	Value
1	Basic Wind speed	50 m/ sec
2	Risk Co-efficient (K1)	1.0 (Clause 6.3.1)
3	Terrain Category (K2)	1.2344 Category 2 (Clause 6.3.2)
4	Topography factor (K3)	1 (Clause 6.3.3)
5	Importance Factor (K4)	1.0
6	Wind directionality factor (Kd)	1
7	Area averaging factor (Ka)	0.8
8	Combination Factor (Kc)	0.9
9	Class of Building	Class-B
10	Windward Co-efficient	0.8
11	Leeward Co-efficient	0.5
12	Pressure coefficient [External] (Cpe)	0.8
13	Pressure coefficient [Internal] (Cpi)	0.5

Table 3

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue X Oct 2021- Available at www.ijraset.com

B. Models

Below shown is the building which is not having shear wall and it's plan having shape "C" . It is the type of irregular structure having the plan irregularities. Here the wind is blowing in X direction and total no. of bays in X direction is 8 and that in Y direction is 7. Building is having height of 90m and the range of projection is within 15-20%.

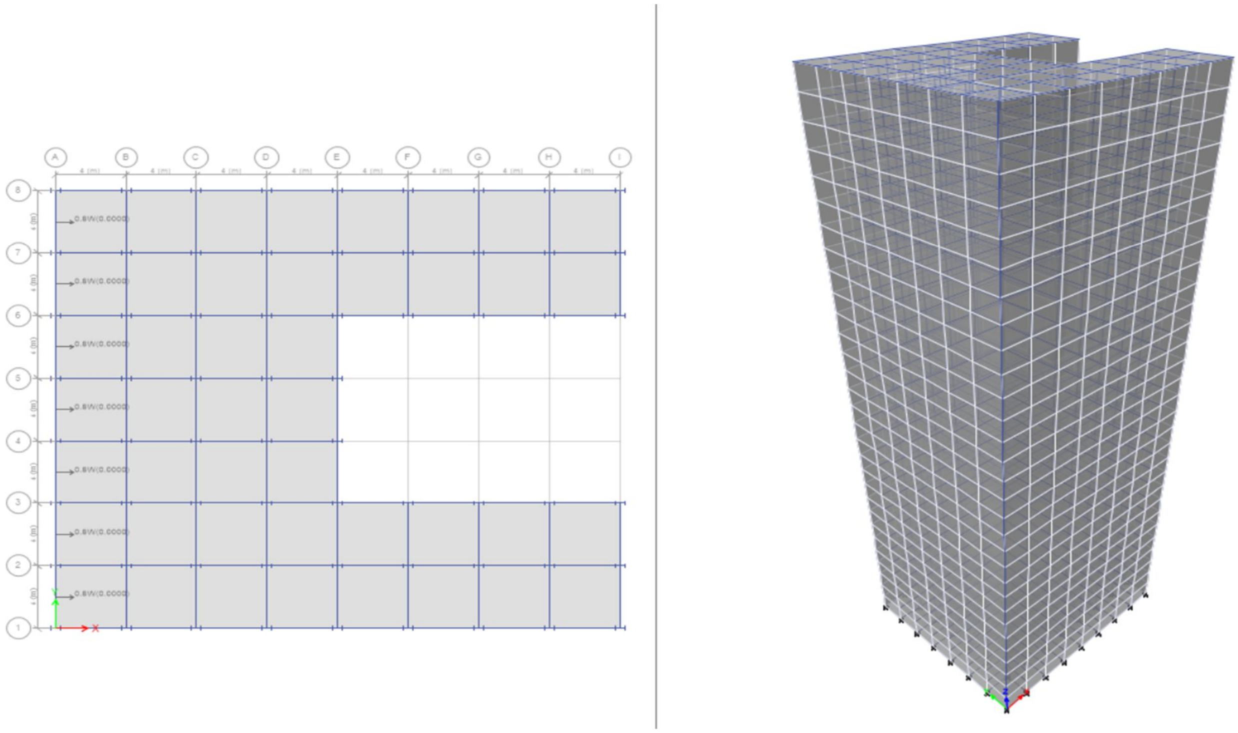

Fig. 1 Showing building without shear wall

The shear wall is placed at each of the building's eight corners and the building is having plan irregularity of C-shape. The wind is blowing in the direction of X. Clause 4.4.4 of IS 4326 -1993 specifies that the length of its projection must be within 15 to 20 percent range in order to be considered irregular and this building satisfies that condition. The building's total height is 90m, hence it comes under the category of tall buildings.

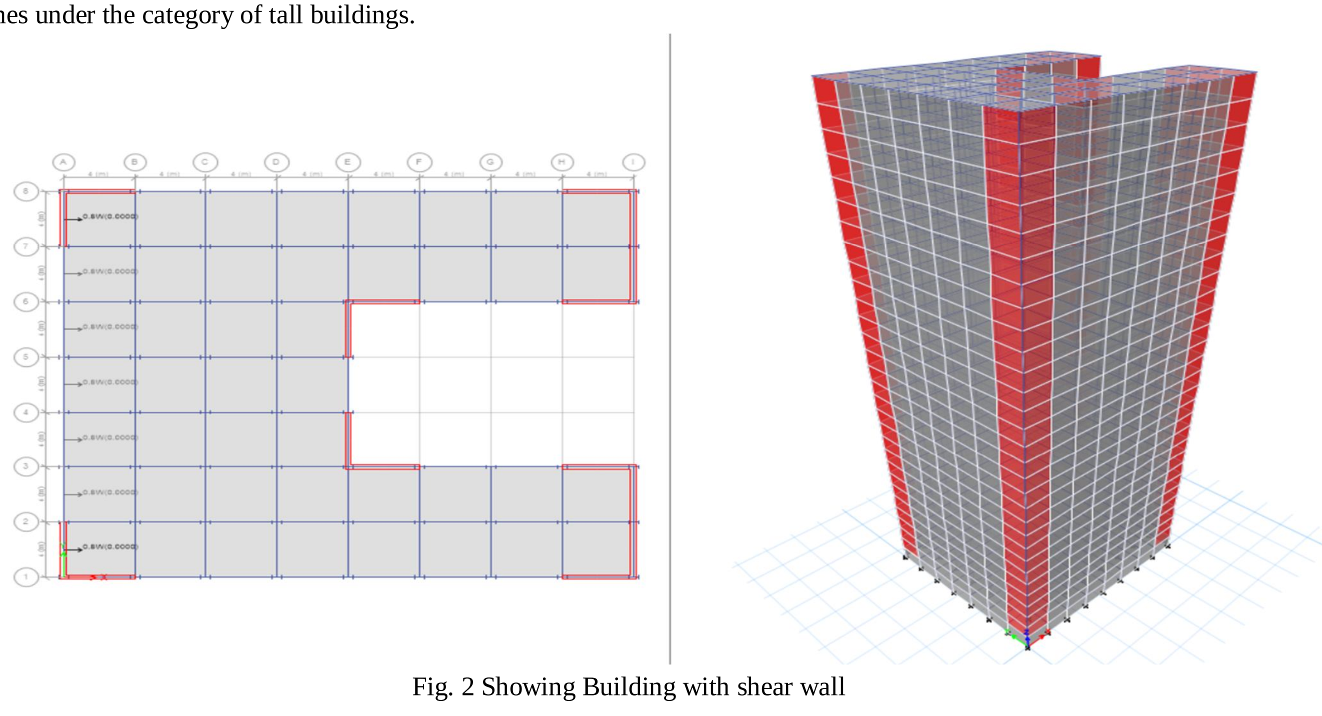

Fig. 2 Showing Building with shear wall

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue X Oct 2021- Available at www.ijraset.com

IV. ANALYSIS

A. Manual Calculations

Here It can be observed from Fig. 3 that as the height of building increases, the effect of wind force is also increased. This result is on the building of genaralised form, where no regularity or irregularity has been considered, only height, terrain category and other various factors has been taken into consideration for the manual calculation. So it gives the general idea about how the wind of particular velocity will effect the entire building while assuming certain parameters. And by using building of fixed shape and dimension, this analysis is to be carried outusing the software (Pd – Designed wind load, F – Wind Force). Here the maximum value of Design wind pressure is 1633.932N/m2 and Wind force is 1235.25x 10^3 N which is at storey 30.

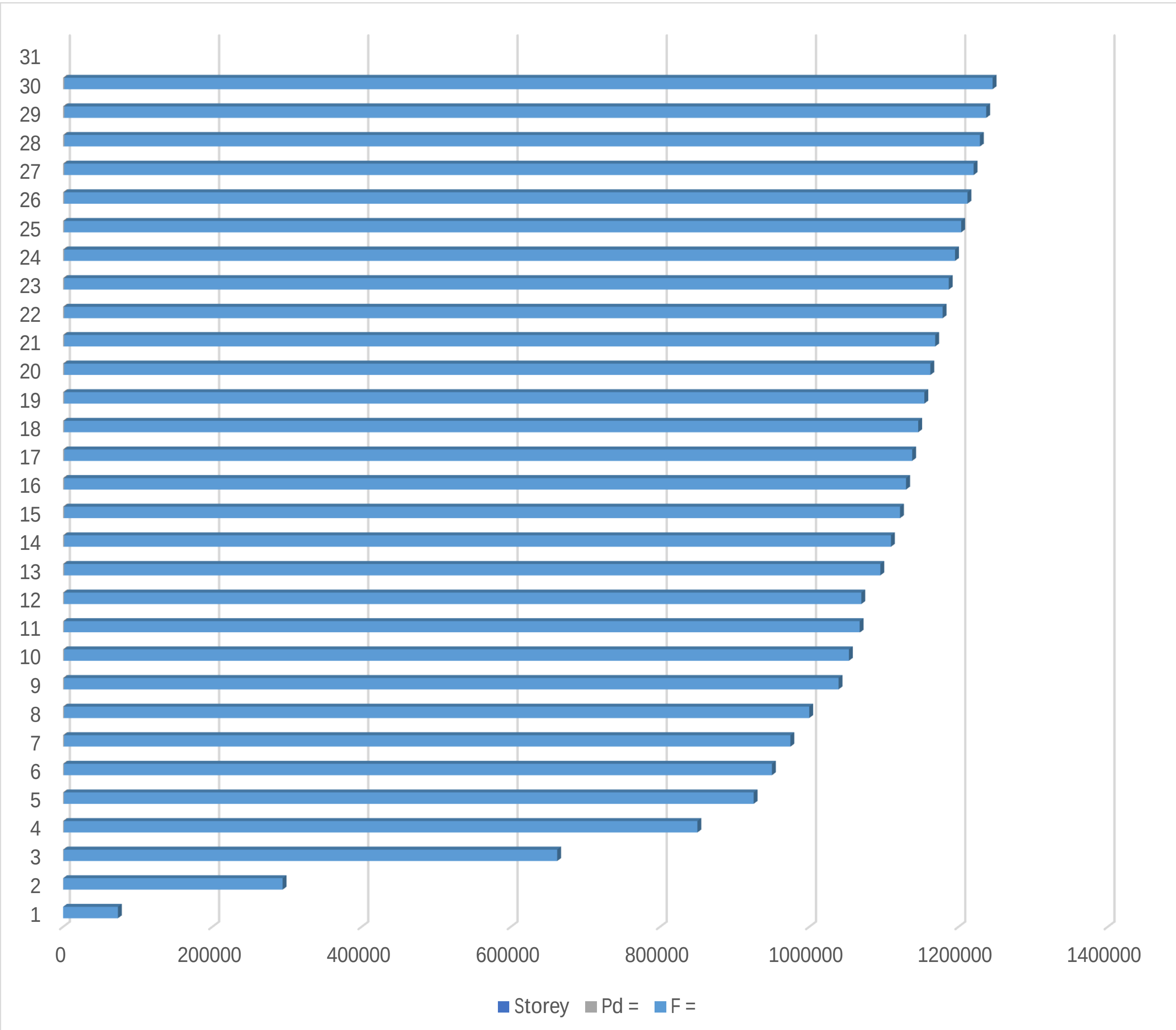

Fig 3. Graphical representation of wind force and designed wind pressure

B. Calculations using ETABS 19

Note: Comb1 is 1.5 (DL + IL) ,Comb2 is 1.2[DL + IL + WLx], Comb3 is 1.2[DL + IL + WLy], Comb4 is 0.9[DL+ IL+ WLx] and Comb5 is 0.9[DL + IL+ Wly] .

Where, DL = Dead loading, IL = Imposed loading, WLx = Wind loading in X-direction, WLy = Wind loading in Y-direction.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue X Oct 2021- Available at www.ijraset.com

1) *Story Drifts in X-direction for Absence and Presence of Shear Wall:* The following are graphs shown in Fig. 4 and Fig. 5 that were created based on the existence of a shear wall. From study on the building with shear wall it has been obtained that in Comb 1 maximum value of story drift is 0.000198, for Comb 2 maximum story drift is 0.001239, Comb 3 maximum story drift is 0.001326, Comb 4 has maximum story drift 0.000929 and Comb 5 has 0.000995 as the highest maximum drift value. The entire value has been plotted on the graph and out of these, maximum value of the story drift is 0.001326 for story 7 in load combination 3 for building without shear wall.

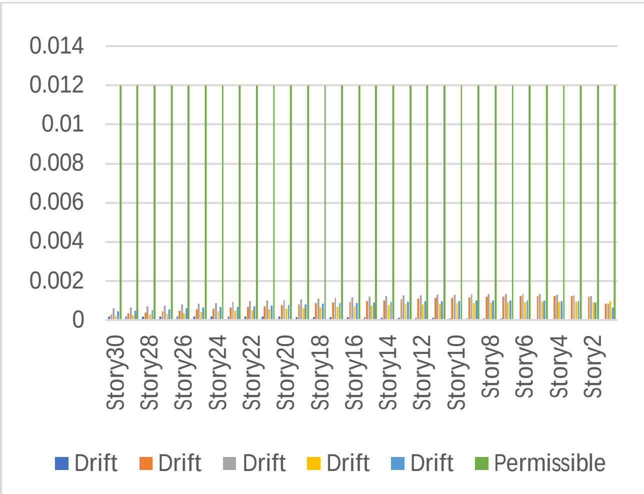

Fig 4. Story drifts for building without shear wall

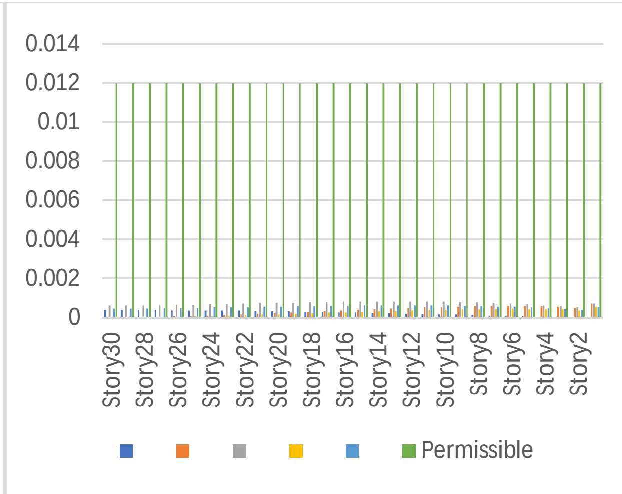

Fig. 5 Story drifts for building with shear wall

On the other hand, in the case when there is presence of shear wall, the value is significantly less. Maximum story drifts for the load combinations 1,2,3,4 and 5 are 0.000386,0.000732, 0.000823,0.000549 and 0.000617 respectively. Drifts are reduced when there is a shear wall present and the maximum permissible value is 0.0012. From this study it has been obtained that the maximum of the maximum value of story drift is on Story 13 or 12 i.e. 0.000823 for a building with a shear wall.

2) *Story Displacement in X-direction for Absence and Presence of Shear Wall:* X-axis displacement on C-shape building with and without the shear wall: graphs below show displacement generated depending on the presence of a shear wall, such the ones below. According to research done on a building with a shear wall, the maximum story displacement value in Comb 1 is 11.665mm , the maximum story displacemnt value in Comb 2 is 78.813mm , the maximum story displacement value in Comb 3 is 97.477mm, the maximum story displacement value in Comb 4 is 59.109mm, and the maximum story displacement value in Comb 5 is 73.108mm. Fig. 5 depicts the total value as a bar graph. Building without shear wall has the highest-maximum value of story displacement i.e. 97.477mm for story 30 in load combination 3.

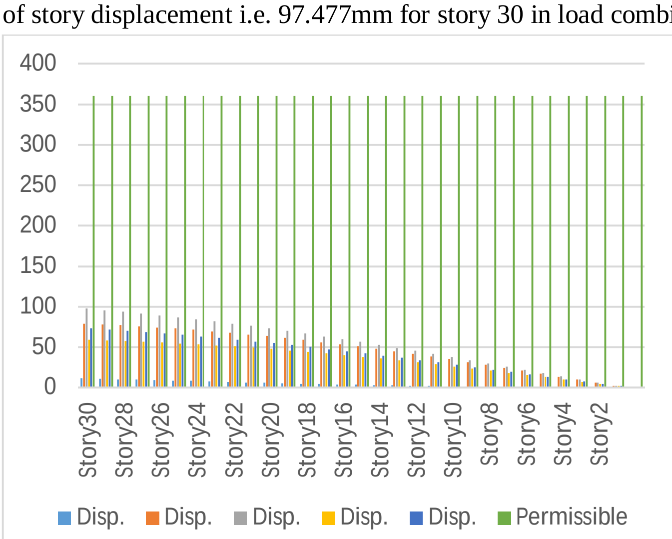

Fig. 6 Story displacement for building without shear wall

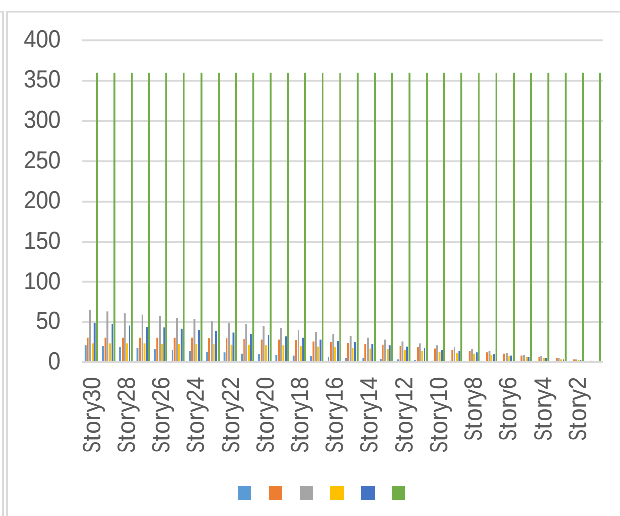

Fig.7 Story displacement for building with shear wall

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue X Oct 2021- Available at www.ijraset.com

Secondly for building having shear wall, the value is comparatively less. Maximum displacement for the load combinations 1,2,3,4 and 5 are 21.261mm,31.033,65.012mm,23.248mm and 48.759mm respectively. Displacements are decreased when there is a shear wall present. For another thing, 360mm is inside the permissible range. From study it has been obtained that the maximum of the maximum value of story drift is on Story 30 i.e. 65.012mm for a building with shear wall present.

V. RESULTS

Highest value of story displacement for the building not having shear wall is 97.4770 mm. Highest story displacement for the building with shear wall is 65.012mm.

Highest story drift for the building not having shear wall is 0.001326. Highest story drift for the building with shear wall is 0.000823.

Maximum wind force 1235.25x 10^3 N which is at 30th storey and the Design wind pressure (Pd) is 1633.932N/m2 at that point.

Note:

According to IS 1893 (part 1) 2016, the maximum story displacement value is H/250 [where H is the total construction height].

According to IS 1893 (part 1) 2016,maximum story drift is 0.004h [where h represents the height of one story] (Clause 7.11.1.1)

The results obtained are shown in tabular form as follows:

S. no.	Parameters	Permissible Value	Building type	Wall Condition	Obtained Values
1 a)	Designed Wind pressure	nil	C-Type	Irrespective of wall condition	1633.93 N/m^2
b)	Wind Force	nil	C-Type	Irrespective of wall condition	1235.25x10^3 N
2 a)	Maximum story Displacement	H/250 i.e. 360mm	C-Type	Non-Existence in X- direction	97.4770 mm
b)	Maximum story Displacement	H/250 i.e. 360mm	C-Type	Existence in X- direction	65.012 mm
3 a)	Maximum Story drift	0.004xh i.e. 0.012	C-Type	Non-Existence in X- direction	0.001326
b)	Maximum Story drift	0.004xh i.e. 0.012	C-Type	Existence in X- direction	0.000823

Table 4

VI. CONCLUSIONS

From analysis it is observed that the story drift and story displacement is maximum for the case when there is no shear wall. And also the value of story drift and displacement is comparatively less for the case in which shear wall is present. Hence purpose of installation of shear wall is fulfilled as it is reducing the effect of wind load.

It is also observed that maximum story drift without shear wall is 37.93% more than that in case of building with shear wall. And the Story displacement without shear wall is 33.30% more than that in case of with shear wall.

Maximum designed wind pressure, wind force and story displacement is coming at top of the building. Hence, it verifies the fact that wind pressure and wind force is maximum at the top of the structure. By performing this study, it has also been observed that shear wall is necessary in every corner; So that it can withstand the lateral load and keep the structure safe and durable.

REFERENCES

[1] Mr. S.Mahesh, Mr. Dr.B.Panduranga Rao "Comparison of analysis and design of regular and irregular configuration of multi Story building in various seismic zones and various types of soils using ETABS and STAAD" ISSN: 2320-334X, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) Volume 11, Issue 6 Ver. 1 (Nov-Dec 2014), PP 45-52

[2] Souvik Chakraborty, Sujit Kumar Daluiand and Ashok Kumar Ahuja (2014) "Wind load on irregular plan shaped tall building – a case study " ISSN: 1598-6225 Wind and Structures, Vol. 19, No. 1 (2014) 59-73

[3] K Venu Manikanta , Dr. Dumpa Venkateswarlu (2016) "Comparative Study On Design Results Of A Multi-Storied Building Using Staad Pro And Etabs For Regular And Irregular Plan Configuration" ISSN : 2319-6106 International Journal of Research Sciences and Advanced Engineering Vol.2(15), Sep' 2016

[4] Naveen G.M. , Chaya. S (2016) "STUDY ON REGULAR AND IRREGULAR BUILDING STRUCTURES DURING AN EARTHQUAKE" ISSN: 2455-7137, International Journal of Latest Engineering Research and Applications Volume 01, Issue 08, November 2016

[5] Yi Li , Q.S. Li , Fubin Chen (2017) "Wind tunnel study of wind-induced torques on L-shaped tall buildings", Journal of Wind Engineering & Industrial Aerodynamics 167 (2017) 41-50

[6] Mariyam, Sagar Jamle (2019) "Wind Analysis over Multistorey Building Having Flat Slab-Shear Wall Interaction" ISSN: 2456-1908 International Journal of Advanced Engineering Research and Science (IJAERS) Vol-6, Issue-5, May- 2019

[7] Pranali U. Meshram, Ms. Deepa Telang (2020) "Analysis of wind on tall structure" ISSN : 0731-6755, JAC : A Journal Of Composition Theory Volume XIII, Issue VI, JUNE 2020

[8] IS 875 (Part 1) : 1987, IS 875 (Part 2) : 1987, IS 875 (Part 3) : 2015

[9] IS 800 : 2007 "Code of practice for design load (other than earthquake) for buildings and structures."

[10] IS 4326 : 1993 "Earthquake resistant design and construction of buildings – code of practice"

[11] IS 456 : 2000 "Plain and reinforced concrete – code of practice"

[12] IS 1893 (part 1) : 2016 "" Criteria for earthquake resistant design of structures"