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COMPARATIVE ANALYSIS OF TWO DIFFERENT WIND SPEEDS FOR A MULTISTOREY BUILDING

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ABSTRACT
Every Civil Engineering structure or building is unique in nature unlike other engineering products which are produced in a massive scale using the same technique again and again. The present Project is an effort to analyze the multi storied building subjected to wind load by STAAD.Pro software.Consideration of site specific lateral loading due to wind along with vertical gravity loads is important for finding the behavior of the tall buildings. As the height of a building becomes taller, the amount of structural material required to resist lateral loads increases drastically.The wind load values were generated by STAAD.Pro considering the given wind intensities at different heights and strictly abiding by the specifications of IS 875 and compared it with the critical case condition.In the present study, the analysis of multi storied building is carried out in a routine fashion. So it helps in the investigation of the behavior of the structure under different loading conditions, its load deflection behavior

KEYWORDS: Tall buildings, wind loads.

INTRODUCTION
A large number of structures that are being constructed at present tend to be wind-sensitive because of their shapes, slenderness, flexibility, size and lightness. Added to these are the uses of materials which are stressed too much higher percentage of their ultimate strength than the in earlier days because of better assurance of quality of materials. In the social environment that is developing world over , the ancient philosophy of accepting continuing disasters due to wind by 'fate' and gods is giving place to demands for economical wind resistant. Updating of some international codes of practice, notably the British, Australian, Canadian, American and French has been effected fairly frequently over the last two decades and the present versions incorporate most of the advances made in understanding the wind characteristics and its effect on structures.

The new discoveries are such that it is clear mere issue of amendments to the earlier code IS 875:1964 will not be justifiable. The recently issued wind code of practice for design loads (other than earthquake) for buildings and structures IS875 (part 3):1987 differs in many ways from the previous code first issued in 1964 and attempts not only to rectify the shortfalls of the 1964 code but incorporates recent knowledge of wind effect on structures. The height up to which velocities are given has now been raised to 500m and the loadings on as many of the commonly encountered buildings and structures, for which there are no other Indian standards, have been included. Although not explicitly stated , the code recognizes the fact that most of the high winds in India occur due to short duration rotating winds like tropical cyclones along the coasts or tornadoes elsewhere, and nearly rectilinear winds of short duration like thunderstorms at many places.

In this respect, the high wind loading conditions in Indian are different from those of temperate zone countries like Europe and Canada. Much of the random response theories, which have been adopted in European/U.S. or Australian codes are based on these 'full developed pressure winds conditions and strictly cannot be applied in most parts of India. But their judicious use, in the absence of proper theories applicable to cyclones, tornadoes thunderstorms will give adequate safety margins and this is what the present IS 875 (part 3):1987 attempts to do.

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In India, success in satisfactory codification of wind loading on structures has remained elusive so far. In most cses, codification has followed, not preceded structural failures or distress. The wind maps given in the 1964 version of the code had been prepared mainly on the basis of extreme value wind data from storms which approached or crossed the Indian coasts during 1890 to 1960 together with the wind data available from about 10-20 continuously recording dynes pressure anemograph (DPA) stations which existed at that time, to get an overall picture for the country. However 3-cup anemometer readings were not much used in the preparation of wind maps because much of such data were synoptic.

The height of DPA instruments varied from 10m to 30m at different places. Therefore only one extreme value of wind was given up to 30m height from ground level without any variation in-between. Further ,1/10 power law had been adopted regardless of terrain conditions, for indicating variations of wind speed with height from 30m to 150m, for which there was no supportive evidence. The code gave two wind pressure maps (one giving winds of shorter duration <5 minutes and other excluding winds of shorter duration) and there was no clear guidance for using either or both of them.

With the publication of the recent revised wind code, IS 875(part 3):1987, an attempt has been made to remove these deficiencies and provide to Indian structural engineer adequate guidelines for arriving at more rational wind loading for design purposes.

STRUCTURAL MODELLING

GENERAL

A building frame model involves the assemblage of structural elements viz., beams, columns, slabs, walls, footing etc to represent the structural aspects of a typical frame in a building and exhibit its behavior under external loading. An analytical model must ideally represent its mass distribution, strength, stiffness and deformability through a full range of local and global displacements. This chapter deals with the modeling of the RC plane frames of G+11 stories of rectangular building.

MODELING ASPECTS

RC plane frames of G+11 stories containing with shape of rectangular building were modelled and analyzed by using STAAD pro. The numerical model represents all components that affect the strength, stiffness and the mass of the frame.

MATERIALS

The modulus of elasticity of reinforced concrete as per IS 456:2000 is given by

$$E_c = 5000\sqrt{f_{ck}}$$

For the steel rebar, the necessary information is yield stress, modulus of elasticity and ultimate strength. High yield strength deformed bars (HYSD) having yield strength 415 N/mm^2 is widely used in design practice and is adopted for the present study.

STRUCTURAL ELEMENTS

In this section, the details of the modeling adopted for various elements of the frame are given below.

a)BEAMS AND COLUMNS

Beams and columns were modeled as frame elements. The elements represent the strength, stiffness and deformation capacity of the members. While modeling the beams and columns, the properties to be assigned are cross sectional dimensions, reinforcement details and the type of material used.

b)BEAM-COLUMN JOINTS

The beam-column joints are assumed to be rigid. They were modeled by giving end offsets at the joints. This is intended to get the bending moments at the face of the beams and columns. A rigid zone factor of 1.0 was considered to ensure rigid connections of the beam and columns.

c) **FOUNDATION MODELING**

Fixed supports were provided at the ends of supporting columns.

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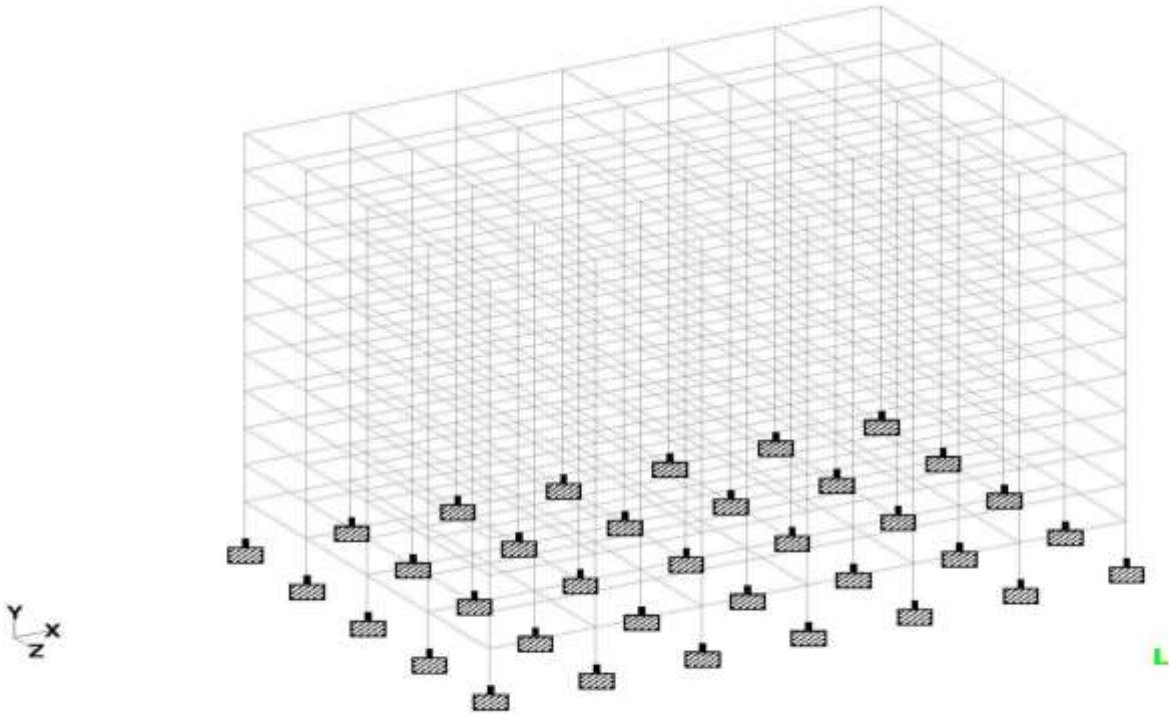

Fig. Showing Supports for Structural Modeling from Staad Pro.,

LOADS

All loads acting on the building except wind load were considered. These are

1. Dead Load
2. Live load
3. Lateral Load due to Wind load

It was assumed that earthquake load will not govern the demands on the members.

a)Dead Load

The dead load itself indicates self weight of the beams, columns, floors and slabs. The unit weights of some materials are given from Table-1, IS 875 (part-1):1987.

Dead load due to external walls = 0.23*3.2*20=14.72KN/m^2

Dead load due to internal walls = 0.16*3.2*20=10.24KN/m^2

Unit weight of Reinforced concrete, γ_c = 25.0 kN/m^3

Unit weight of standard brick = 20KN/ m^3

b) Live load on floors

Live load on floors= 3KN/m^2

Live load on roof slab= 2KN/m^2

c) Lateral loads due to Wind load

The lateral loads were calculated in X and Z-directions according to IS 875 (part -3):1987 and applied at the nodal points in directions considered. The lateral load along X and Z- directions is denoted as WLX and WLZ respectively.

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DESIGN WIND SPEED & WIND PRESSURE

a) Design Wind Pressure

$P_Z = 0.6 (V_Z^2)$

b) Design Wind Speed

$Vz = V_b*K_1*K_2*K_3$

Risk Coefficient Factor "K_1" = 1.08

(IS: 875-1987(part3),sec 5.3.1,Table -1)

Terrain & Height Factor " K_2" = varies with height (table 3.1)

(IS: 875 -1987(part3),sec 5.3.2,Table -2)

Topography Factor " K_3" =1.00 (IS:875-part-3,sec 5.3.3.1)

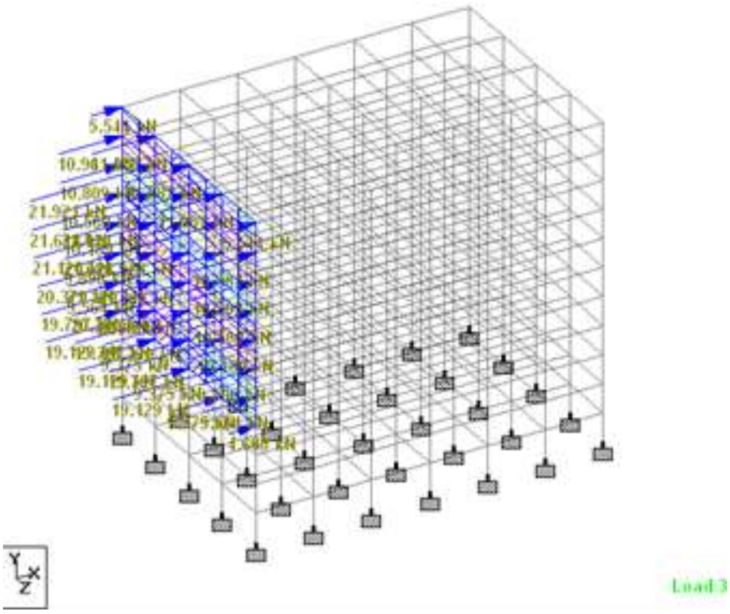

Fig: Wind Force acting in positive X-direction (from Staad pro)

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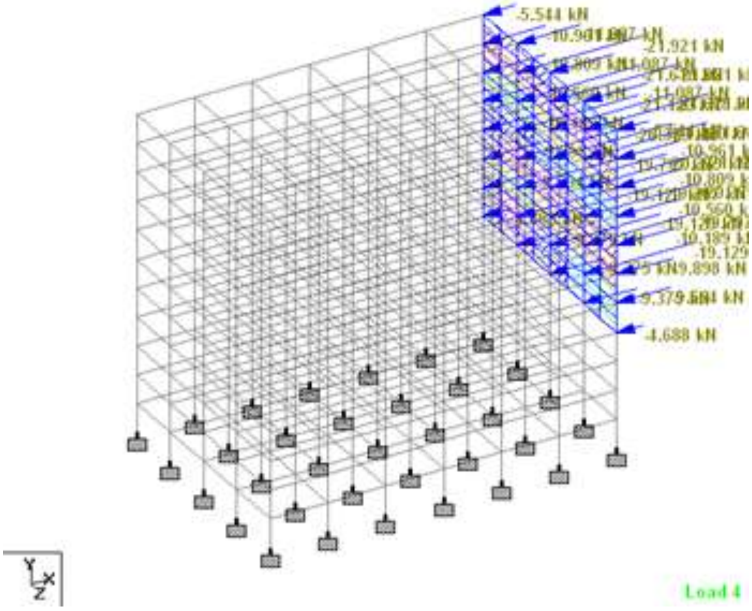

Fig: Wind Force acting in Negative X-direction (from Staad pro)

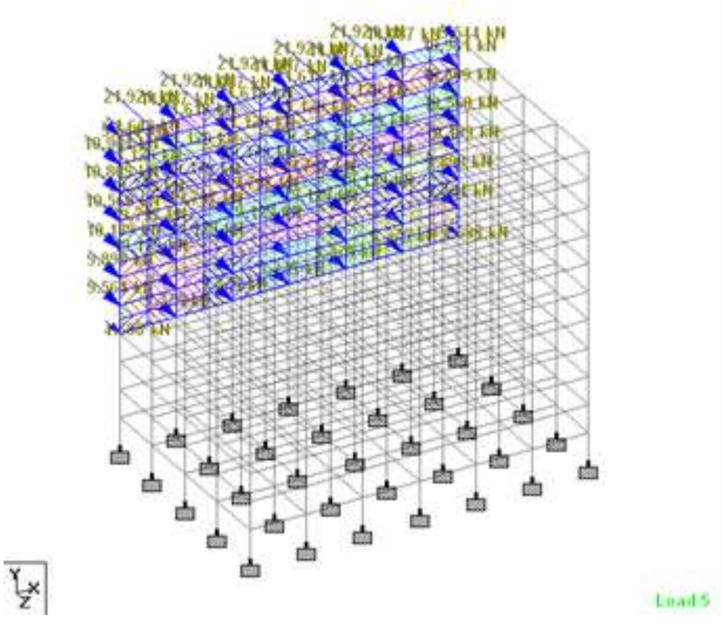

Fig: Wind Force acting in positive Z-direction (from Staad pro)

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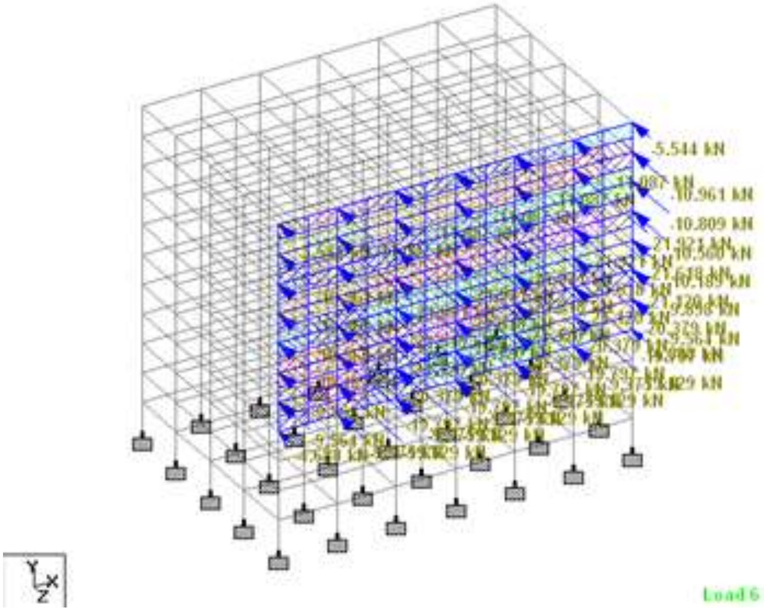

Fig: Wind Force acting in Negative Z-direction (from Staad pro)

RESULTS AND DISCUSSION

ANALYSIS OF MULTISTOREY BUILDING FOR DIFFERENT WIND SPEEDS: DESIGN OF WIND FORCE

Design wind speed (V_z) = $V_b.k_1.k_2.k_3$

Design wind pressure (P_z) =0.6 V_z^2

Wind Speed=50m/sec

Wind Load for Residential Building with a Height of 27.5m

HEIGHT IN METERS(FROM TOP)	INTENSITY(KN/m^2)
27.5	1.773980021
25	1.733440041
22.5	1.725379943
20	1.653749942
17.5	1.606840014
15	1.560600042
12.5	1.50
10	1.440600037

Wind Speed=58m/sec

Wind Load for Residential Building with a Height of 27.5m

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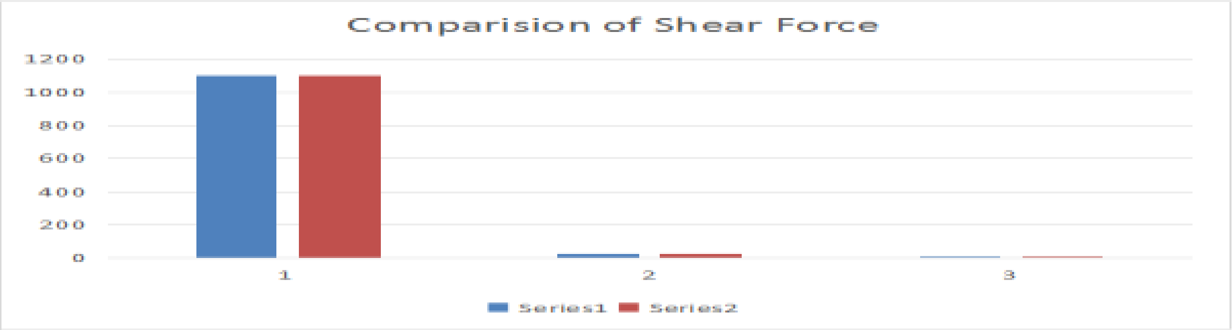
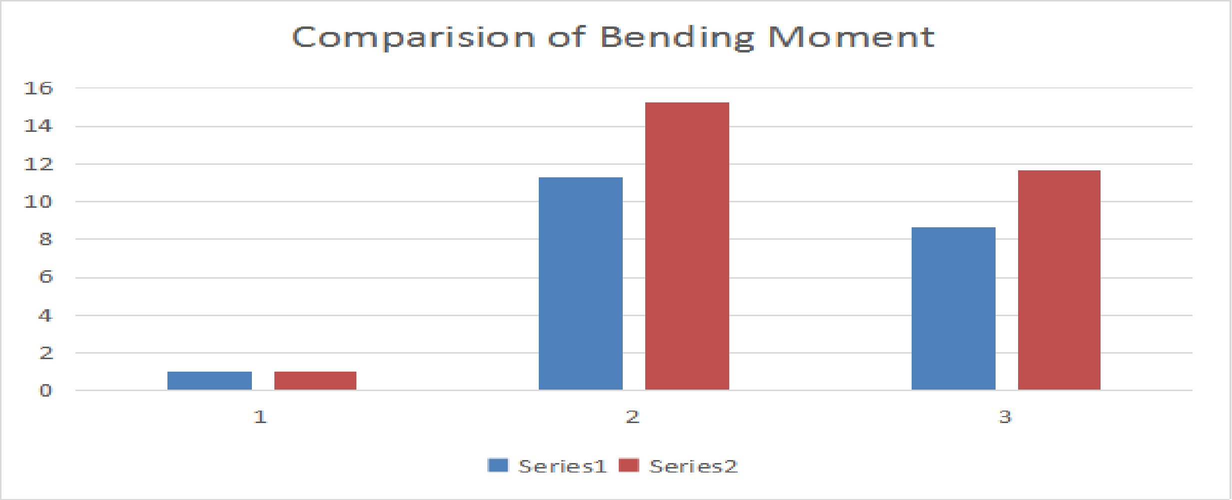
HEIGHT IN METERS(FROM TOP)	INTENSITY(KN/m^2)
27.5	1.938470005
25	2.018399953
22.5	2.099940061
20	2.162159919
17.5	2.225290060
15	2.321680068
12.5	2.332509994
10	2.387069940

Comparision of Shear Force for Wind Speeds 50 and 58 m/s (After providing shear wall):



Comparision of Bending Moment for Wind Speeds 50 and 58 m/s (After providing shear wall):



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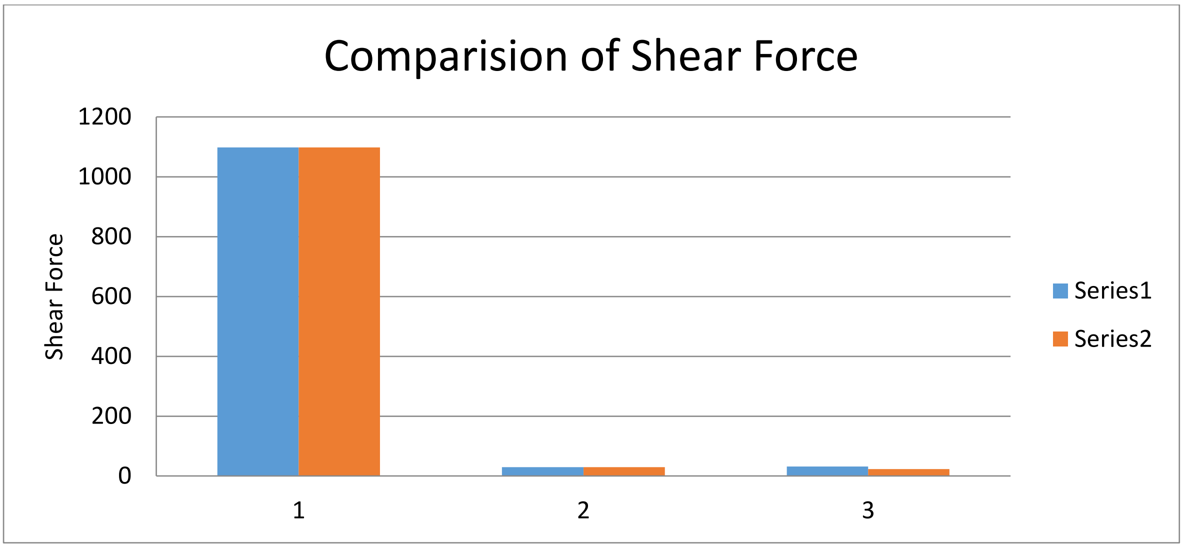
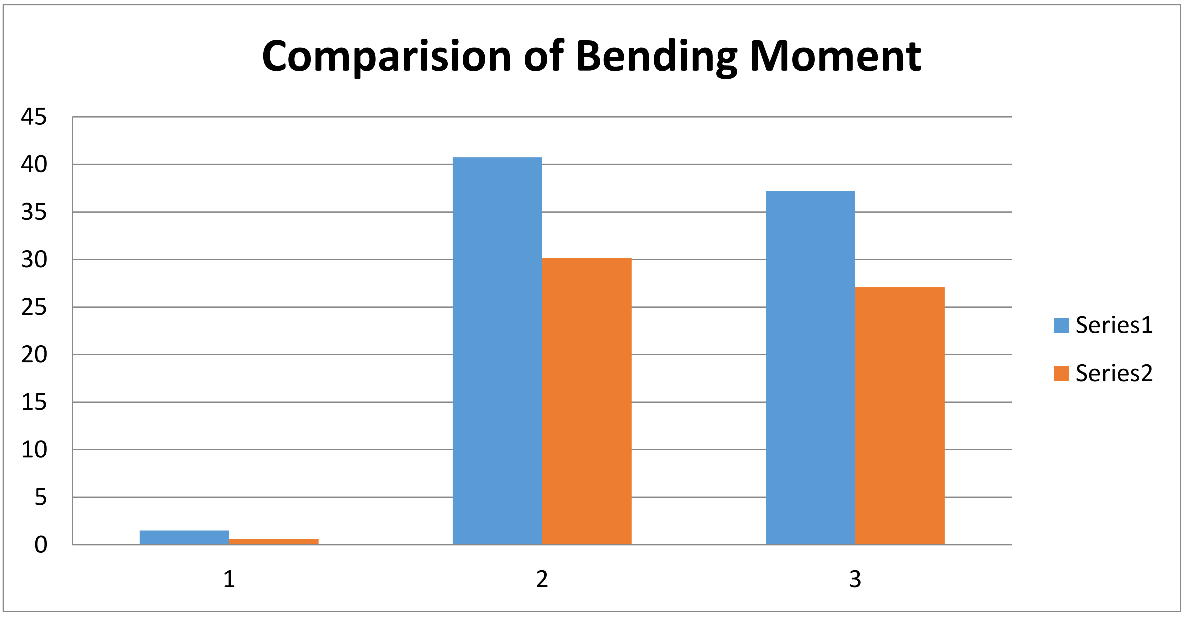
Comparision of Shear Force for Wind Speeds 50 and 58 m/s before and after providing shear wall



Comparision of Bending Moment for Wind Speeds 50 and 58 m/s before and after providing shear wall:



LATERAL DISPLACEMENTS:

	NODE	L/C	Maximum
X	400	2	0
Y	417	6	0
Z	388	2	0

% REDUCED BY COMPARING THE BM AND SF AFTER PROVIDING WITH SHEAR WALL WITH BM,SF OF CODAL WIND SPEED AND CRITICAL WIND SPEED:

	% REDUCED
F_X	0
F_Y	0
F_Z	26.4
M_X	60.39
M_Y	25.98
M_Z	27.19

% REDUCED IN LATERAL DISPLACEMENTS:

	% REDUCED
X	100
Y	100
Z	100

CONCLUSION

- By providing the shear wall on the negative Z direction the displacements,shear forces and bending moments are reduced.
- As by analyzing the building the bending moments and shear forces are increased by 25% in the critical case compared with codal wind speed results,so before designing the building should be checked for the worst condition also.
- The lateral displacement for beam 417 is 0.306mm is reduced to 0 after providing shear wall.
- By providing the shear wall lateral displacements are 100 % reduced.
- By providing the shear wall the bending moments are reduced by 60 % in X direction,25.98% in Y direction and 27.19 % in Z direction.
- By providing the shear wall the shear forces are reduced by 25 % in Z direction.

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