COMPARITIVE STUDY ON STURUCTURES HAVING VERTICAL AND STIFFNESS IRREGULARITIES UNDER WIND LOAD

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Abstract - Urbanization has led to housing problems. This has resulted in the rise of several Multi-storey and High rise buildings. Hence Structural Dynamics study has been steadily increasing over the years. The present study describes the effect of wind of speed 50 m/sec on 4 buildings of G+10 multi storied framed structure for different irregularities. The 4 structures considered are Regular building, Stiffness irregular, Vertical irregular, vertical and stiffness irregular buildings. The results were tabulated by performing analysis using STAAD Pro in the form of bending moment, shear force, axial force and storey displacements.

KEYWORDS : axial force, bending moment, deflection, shear force, Staad pro., stiffness irregularity, vertical irregularity, wind analysis.

I. INTRODUCTION

Buildings are defined as structures utilized by the people as shelter for living, working or storage. In 21ST century due to huge population the number of areas in units is decreasing day by day. In high rise buildings we should consider all the forces that act on the building. The beam, column reinforcements and joint detailing should be good enough to counteract these forces successfully. Wind is a phenomenon of great complexity because of the many flow situations arising from the interaction of wind with structures.

Wind in general has two main effects on the tall buildings.

1. It exerts forces and moments on the structure and its cladding.
2. It distributes the air in and around the building mainly termed as wind pressure. Sometimes because of unpredictable nature of wind it takes so devastating form during some wind storms that it can upset the internal ventilation system when it passes into the building.

Analytical method given in the code IS 875 part 3-1987 is followed. The analytical method is usually acceptable for a building with regular shape and size.A structure can be classified as irregular if the structure exceeds the limits as prescribed by different design codes. Generally multi storey building are of two types.

Regular multi storey building: It has all the loads, mass, stiffness etc., distributed equally along the columns, beams, slab. The chance of collapse of the regular building is less.

Irregular multi storey building: The multi storey building having some structural irregularities like horizontal, vertical, stiffness and mass. The chance of collapse of building is more than a regular building

II. METHOD OF ANALYSIS

Code based procedure for wind analysis:

The basic wind speed for any site shall be obtained from Fig 3.1 and shall be modified to include the following effects to get design wind speed, V_z 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 can be mathematically expressed as follows:

$V_z = V_b k_1 k_2 k_3 k_4$.

Where,

V_z = design wind speed at any height z in m/s

k_1 = probability factor (risk coefficient)

k_2 = terrain roughness and height factor

k_3 = topography factor

NOTE: The wind speed may be taken as constant up to a height of 10 m. However, pressures for buildings less than 10m high may be reduced by 20% for stability and design of the framing.

III. MODELLING AND ANALYSIS

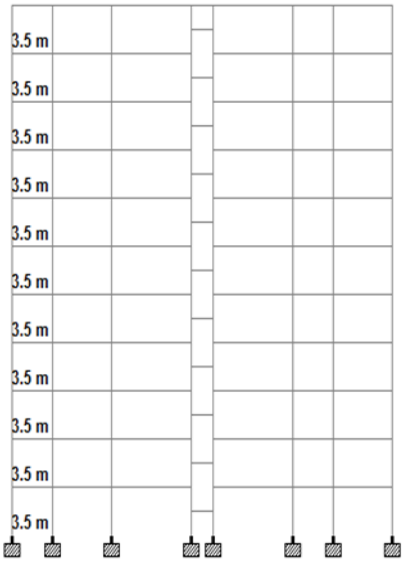
An RCC framed structure is basically an assembly of slabs, beams, columns and foundation inter-connected to each other as a unit. The load transfer mechanism in these structures is from slabs to beams, from beams to columns, and then ultimately from columns to the foundation, which in turn passes the load to the soil.
In this structural analysis study, we have adopted 4 cases by considering different irregularities for the same structure, as explained below.

1. Regular
2. Stiffness Irregularity
3. Vertical Irregularity
4. Vertical and Stiffness Irregularity

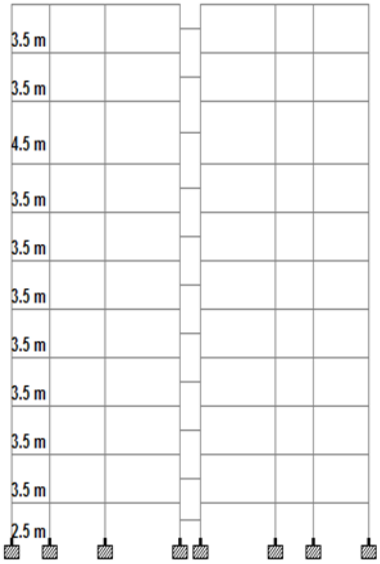
Design characteristic:- The following design characteristic are considered for multi-storey structure

TABLE 1 DESIGN DATA OF RCC FRAME STRUCTURES

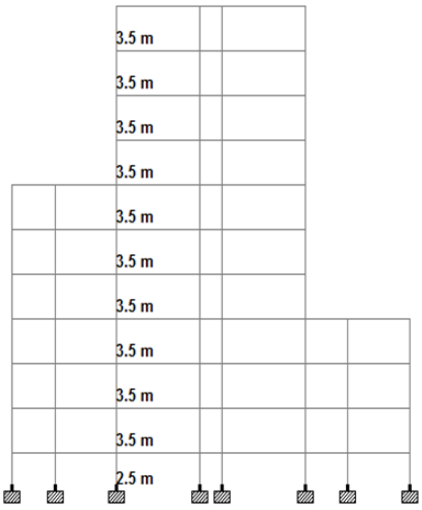
S.NO	PARTICULARS	DIMENSION/SIZE/ VALUE
1	MODEL	G+10
2	Wind Speed	50m/s
3	FLOOR HEIGHT	3.5 m
4	PLAN SIZE	35.77m x 24.42 m
5	SIZE OF COLUMNS	0.60 x 0.30 m
6	SIZE OF BEAMS	0.45 x 0.3 m
7	WALLS	1) EXTERNAL WALL =0.23 m 2) INTERNAL WALL =0.15 m
8	THICKNESS OF SLAB	125 mm
9	TYPE OF SOIL	TYPE-II,MEDIUM SOIL AS PER IS-1893
10	MATERIAL USED	CONCRETE M-25 AND REINFORCEMENT F -415 e
11	PLACE	VISAKHAPATNAM
12	SOFTWARE USED	STAAD Pro FOR STATIC ANALYSIS



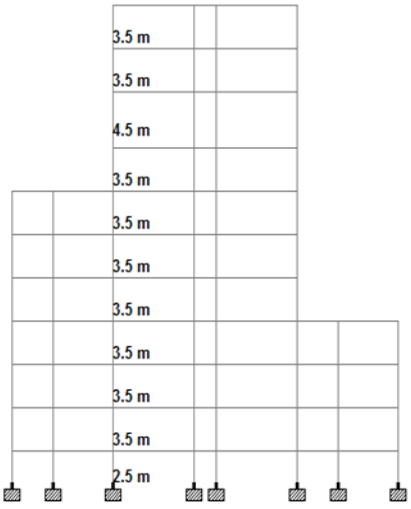
a) Regular building



b) stiffness irregular building



c)Vertical irregular building



d) vertical and stiffness irregular building

Fig:- 1 Elevations of the buildings

LOADS CALCULATIONS

Dead load on Floors:

Weight Of The Slab = Thickness of slab x unit weight of RC
= 0.125 × 25= 3.625KN/m^2
Floor Finish = 1 *KN/*m^2
Partitions = 1 *KN/m*
TOTAL =5.625 KN/m^2
Weight Of External Walls (230mm thick) = 3.05 x 0.23x 20
=14.03*KN/m*
Weight Of Internal Walls (150mm thick) = 3.05x 0.15x 20
=9.15KN/*m*
Self weight of beam = 25×0.25×(0.45-0.15) = 1.875KN/m

Dead load on Roof:
Weight of the roof slab =0.125 × 25 = 3.625KN/m^2
Weight of the water tank = 10KN/m^2
Weight of floor finish + partitions = 2KN/m^2
Total = 15 KN/m^2

LIVE LOAD:
On Roof = 2 *KN/m^2*
internal rooms = 3 *KN/m^2*
Lobby Including Stair Case & Lifts= 4 *KN/m^2*

WIND LOAD
Wind speed $\mathbf{V_z=V_bK_1K_2K_3}$
Wind pressure $\mathbf{P_z=0.6V_z^2}$
Force coefficients $\mathbf{F=C_fA_ep_d}$
where

V_z= design wind speed at any height z in m/s;

K_1= probability factor (risk coefficient);

K_2= terrain, height and structure size factor;

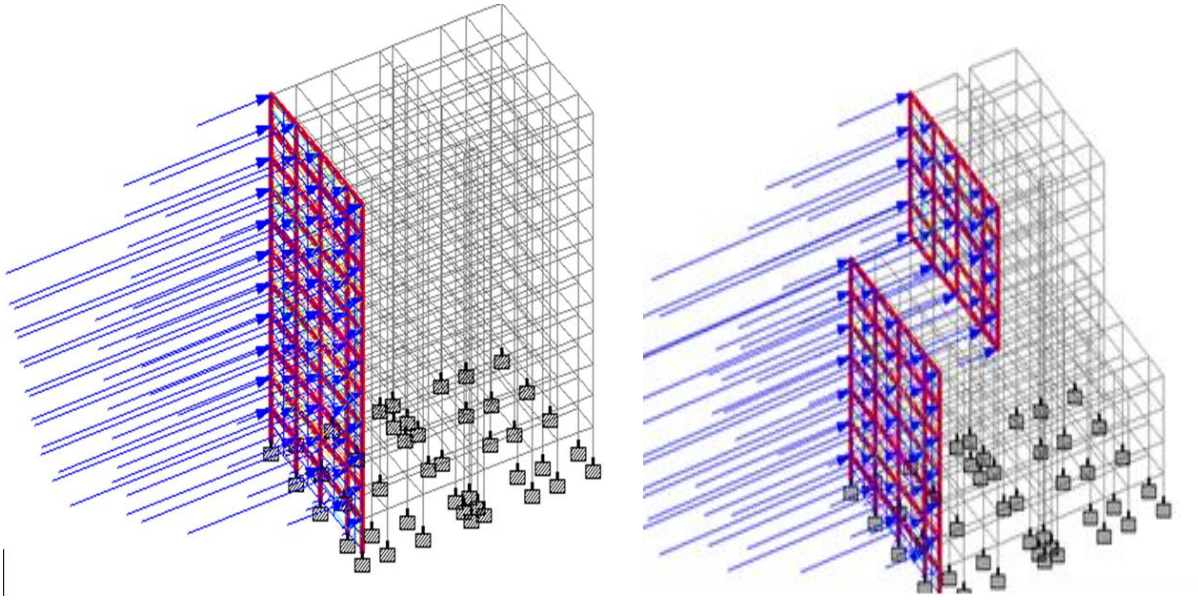
K_3= topography factor;

P_z= design wind pressure in N/m^2 at height z;

F = force acting in the direction specified

Table 2 Values of K_2,V_z, P_z at Respective Floor Height

FLOOR NO.	HEIGHT(m)	K_2	V_Z(m/s)	P_Z(KN/m^2)
G	2.5	0.258	12.9	0.099
1	6	0.618	30.9	0.572
2	9.5	0.978	48.9	1.434
3	13	1.054	52.7	1.666
4	16.5	1.079	53.95	1.746
5	20	1.10	55	1.815
6	23.5	1.110	55.5	1.848
7	27	1.121	56.05	1.884
8	30.5	1.131	56.55	1.918
9	34	1.141	57.05	1.952
10	37.5	1.148	57.4	1.976



a) Wind load on regular building b) wind load on vertical irregular building

Fig 2. Wind load

IV. RESULTS AND GRAPHS

Bending moment:

Table 3 Maximum Bending moment (KN-m) of Beams at different floors

Storey No.	Regular structure	Stiffness Irregular structure	Vertical Irregular structure	Vertical & stiffness Irregular structure
1	330.81	343.01	358.70	344.32
3	322.24	334.02	380.66	341.65
5	301.11	334.11	371.161	236.41
7	279.35	339.74	354.59	276.96
8	270.36	320.56	346.46	264.35
9	260.62	340.78	334.28	303.91
10	375.79	401.25	392.218	383.67

Table 4. Maximum Bending moment (KN-m) of Columns at different floor

Shear force

Storey No.	Regular structure	Stiffness Irregular structure	Vertical Irregular structure	Vertical & Stiffness Irregular structure
1	206.03	235.05	235.17	267.73
3	168.48	200.69	201.86	236.61
5	145.77	188.57	205.57	239.50
7	130.43	165.66	209.37	244.87
8	126.98	176.36	178.36	264.86
9	146.05	152.31	127.98	236.91
10	229.33	284.21	227.82	265.35

Table 5 Maximum Shear Force (KN) of Beams at different floors

Storey No.	Regular structure	Stiffness Irregular structure	Vertical Irregular structure	Vertical & Stiffness Irregular structure
1	109.968	126.49	124.46	93.02
3	98.362	115.26	115.20	131.56
5	87.038	99.48	110.21	119.36
7	71.22	100.66	107.35	117.35
8	68.56	96.48	95.67	86.59
9	52.209	83.03	70.79	71.94
10	154.74	175.79	189.93	127.40

Table 6 Maximum Shear Force (KN) of Columns at different floors Axial force

Storey No.	Regular structure	Stiffness Irregular structure	Vertical Irregular structure	Vertical & Stiffness Irregular structure
1	115.64	116.37	124.83	114.57
3	113.38	110.02	130.54	110.29
5	108.76	127.69	127.32	101.02
7	103.74	139.08	123.54	183.7
8	99.68	126.35	128.69	156.46
9	100.093	113.1	116.31	101.79
10	265.30	240.38	237.49	277.25

Table 7 Maximum Axial Force (KN) of Columns at different floors

Storey No.	Regular structure	Stiffness Irregular structure	Vertical Irregular structure	Vertical & Stiffness Irregular structure
1	8328.42	9680.82	8038.82	8328.11
3	6772.18	7796.38	6733.25	7032.84
5	5230.93	5939.28	5148.36	5648.98
7	3923.37	4103.49	3622.68	3436.73
9	2275.05	2365.03	2019.55	2064.23
10	1477.53	1511.38	1222.60	1319.34

Table 8 Comparison of B.M, S.F, Deflection of Frames in Vertical Irregular Building

	Frame C			Frame F		
Storey No.	**B.M (KN-m)**	**S.F (KN)**	**Deflection (mm)**	**B.M (KN-m)**	**S.F (KN)**	**Deflection (mm)**
1	366.81	237.74	18.25	329.65	222.88	9.55
3	357.83	238.03	49.22	342.82	227.57	37.63
5	342.45	234.43	66.68	261.90	172.27	59.42
7	240.45	166.84	78.87	241.26	167.27	76.76
9	222.09	161.69	89.49	223.07	161.78	87.92
10	428.44	236.73	96.38	420.12	236.73	90.63

V. Conclusion

- Bending Moment and shear force for structural elements in a structure decreases as height increases in Regular building and Stiffness Irregular building. It decreases in Vertical irregular and Vertical & Stiffness irregular building till the vertical irregularity point and at the floor it increases and then again decreases till top expect last floor due to water tank load.
- Displacement of the structural elements increases as the height of structure increases irrespective of the irregularities present.
- Axial force of the structural elements decreases as the height of structure increases irrespective of the irregularities present.
- When Regular building is compared with other Irregular Buildings the Bending moment and Shear force are less in regular building
- When displacement is compared Regular building has more than the other Irregular buildings.
- Stiffness Irregular building has more bending forces than without stiffness irregularity building.
- The maximum displacement for all structures is observed under the load case 1.2D.L+1.2L.L+1.2W.L(Z).

- Frames C and F of Vertical Irregular Building when compared the Bending moment, Shear force and displacement are more for Frame C. means the continuous frame has more forces.
- The bending moment and shear force on the floors 1,2 and 3 in structures without vertical irregular has less values than the structures having vertical irregularities values.

VI References

1. *ASCE 7-98: Minimum design loads for buildings and other structures, Revision of ANSI/ASCE 7-95, 2000*
2. *Building planning and design by Kumara swamy*
3. *Design of steel structures by Subramanian*
4. *International Journal of Engineering Research & Technology (IJERT)*
5. *International Journal of u- and e- Service, Science and Technology*
6. *IS 456 : 2000, Indian standard code for practice of plain and Reinforced concrete design.*
7. *IS 875 : 1987 (part - 1), (part -2), (part-3) code of practice for design loads (other than earth quake) for buildings and structures*
8. *Reinforced concrete limit state design by A.K. Jain*
9. *Text book of concrete technology by S.K.Duggal*
10. *Text book of reinforced concrete design by Ramamurtham*