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Dynamic Analysis of Steel Frame Buildings Subjected To Wind Load

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Abstract: **Any Tall building can vibrate in both directions along wind and across wind caused by flow of wind, Modern Tall buildings area unit style to satisfy lateral drift necessities, still might oscillate to a fault for wind storm. These oscillations will cause some threats to the Tall building with additional and additional height becomes additional prone to oscillate for prime speed winds. typically these oscillations cause discomfort to the occupants even though it's not on a threatening position of structural harm. therefore associate degree correct assessment of building motion is important requirement for usableness. There area unit few approaches to search out out the Response of Tall buildings to Wind hundreds. An Analytical approach given by Davenport are mentioned in IS 875: part 3-1987 and other is Rayleigh factor method. In this paper four different level steel structure are considered with Vb= 44 m/s and storey of the structure is G+26, G+42, Analysis is done by two different methods namely gust factor method and Rayleigh factor method.**

Keywords: **Steel, Frame, Oscillations, Mass, Stiffness**

1. INTRODUCTION

The development of modern materials has result in the emergence of a new generation of structures that are often, to a degree unknown in past, remarkably flexible, low in damping, & light weight. Such structures generally exhibit increased susceptibility to an action of wind. Accordingly, it had become necessary to develop tools enabling the designer to estimate wind effects with greater level of confidence than required previously.

Under the action of wind, structures expertise mechanics forces that embody drag (along-wind) force acting in direction of wind, and the lift (across-wind) force acting perpendicular. The structural response induces by wind drag commonly referred to along wind response of the structure.

Xinzhong (2008) studied the frequency domain analysis for a long wind response to transient non-stationery winds. The Wind is that the development of nice complexness thanks to the flow things arising from the interaction of the wind at intervals structures. The Wind consists of the multitude of varied sizes and movement characteristics carried on normally stream of air moving relative to earth's surface. In In order to limit the response of a tall building beneath the action of the wind, lateral stiffness of tall building is also exaggerated, that successively decrease the amplitude of displacements, though it may not significantly diminish the accelerations.

By increasing a level of inherent damping, the acceleration response of the structure will be decreased, making it a structural property critical for meeting habitability criteria. Unfortunately, inherent damping can't be determine with a high degree of certainty in design and cannot be predicted in a structure, for example mass, stiffness, as mechanism is complex and, as of yet, not fully explained.

2. GENERAL

In case of static structures the flow interacts only with external shape of the structure. When the structure is stiff, deflections underneath wind masses won't be important, and also the structure is claimed to be "Static". just in case of dynamic structures, there's further interaction with the motion of the structure. once the structure is sufficiently versatile, the response to wind masses is important for style of the structure. the standard approach for the analysis of dynamic response of gently damped structures is resolve by the response into the natural modes of vibration, characterizing parameters for each mode: 1) Model shape, 2) Model mass, 3) Model stiffness and 4) Model damping. Using these parameters a frequency response function is generated that reflects the dynamic characteristics of the frame structure.
The wind load area unit most significant issue that determines the planning of all buildings over ten storeys. Buildings taller than ten storey's would typically need extra steel for lateral system. below the action of wind, gusts forces and alternative mechanics forces can unceasingly have an effect on the building. The structure will vibrate about a mean position and will oscillate continuously. Swami (1987) studied that if the wind energy that's absorbed by the structure is larger the energy dissipated by the structure damping, then the amplitude of oscillation will continue to increase and finally lead to destruction.
The frame becomes aerodynamically unstable. The structural forms used these days are more equipped in terms of flexibility combined with less damping, mass when compared to yesteryear structures. These factors have increased the

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importance of wind is consider in design. For estimations of the overall stability of a structure and local pressure distribution of the frame structure, records of maximum steadiness or time averaged wind loads is sufficient. For this purpose I.S codes signifies the importance of wind induced oscillations or excitations.

3. MODELLING PARAMETERS

3.1 Building Description:

S.No.	Description	Information	Remarks
1.	Plan size for 26 stories Plan size for 42 stories	25 m x 15m 35 m x25 m	----
2.	Building height	81 m and 129 m	----
3.	Number of storeys above ground	26 and 42	----
4.	Number of basements below ground	0	----
5.	Type of structure	Steel frame	----
6.	Grade of steel	Fe345	----
7.	Software used	STAAD PRO V8i	----
8.	Column size	ISMB 500D, ISMB 550D, ISMB 600D	
9.	Beam size	ISMB 500, ISMB 550, ISMB 600	
10.	Basic wind speed	44 m/s	
11.	Zone factor	0.36	
12.	Response reduction factor (R)	5	

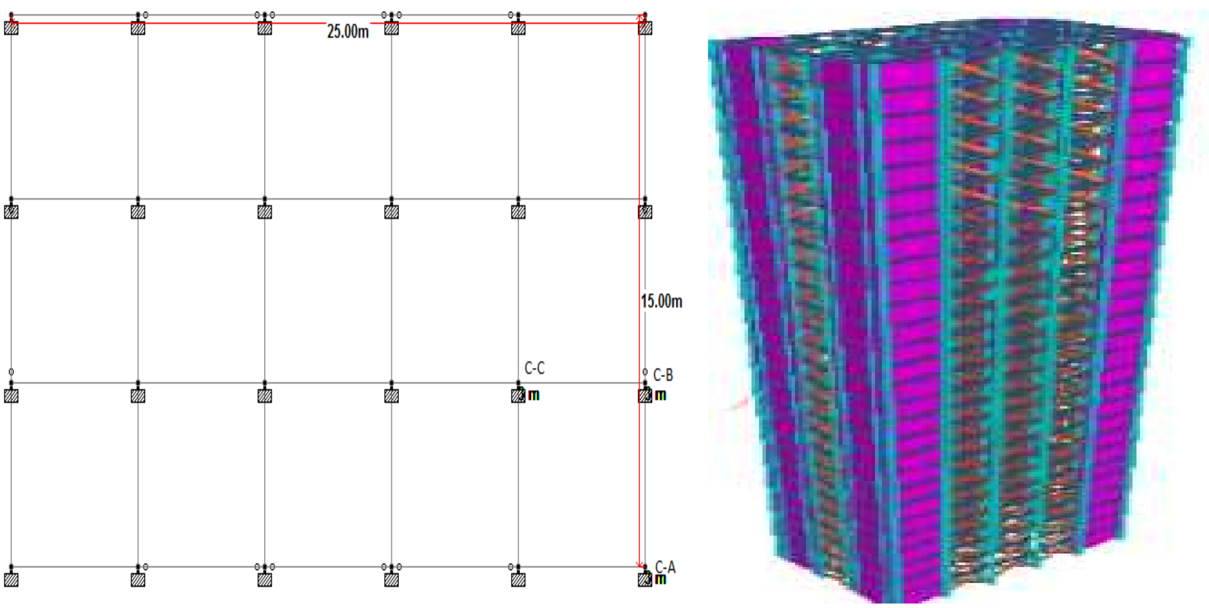

Fig 1: plan view and elevation view of 26 story building

4. RESULT AND DISCUSSION

1. FOR G+26 STORIES

No. of Storey	WL x-dirt Gust	WL x-dirt Rayleigh
26	37.292	40.671
23	36.173	39.442
20	34.224	37.287
17	31.5	34.26
14	28.159	30.564
11	24.31	26.345
8	19.812	21.446
5	14.581	15.768
2	8.453	9.134

No. of Storey	WL z-dirt Gust	WL z-dirt Rayleigh
26	135.754	149.67
23	123.48	136.09
20	110.077	121.262
17	95.098	104.697
14	78.504	86.365
11	60.635	66.656
8	42.242	46.402
5	24.621	27.026
2	9.809	10.76

Displacement (mm) on steel frame building G+2 due to wind load in x- direction and Y Direction

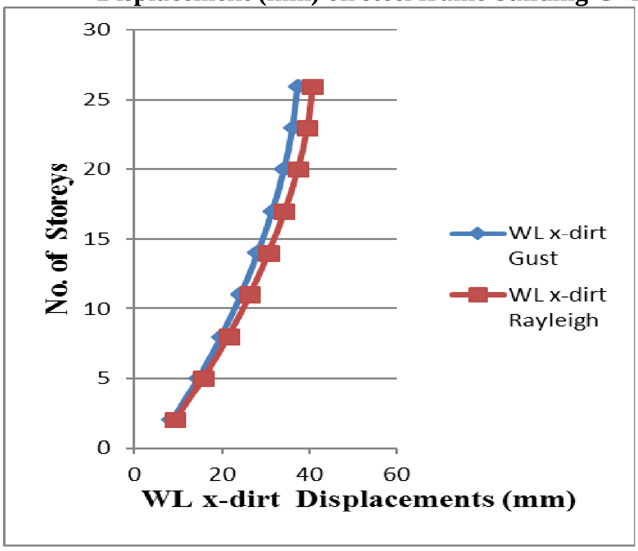

Fig 3

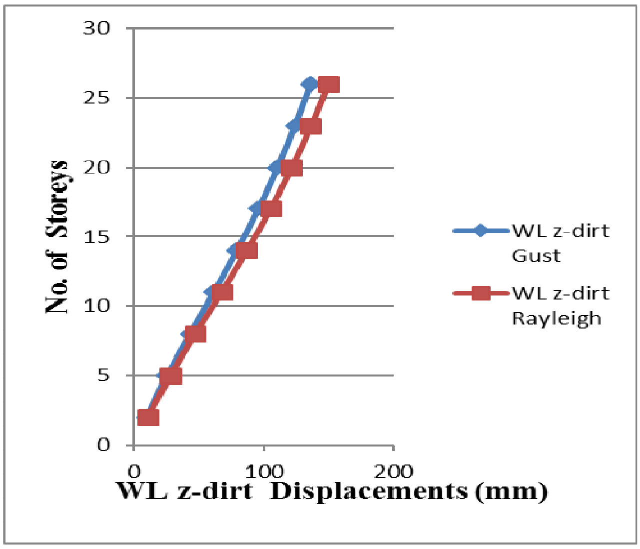

Fig 4

No. of Storeys	Column-A Gust	Column-A Rayleigh	Column-B Gust	Column-B Rayleigh	Column-C Gust	Column-C Rayleigh
26	0.422	0.457	0.218	0.239	2.092	2.284
23	6.329	6.897	0.865	0.933	10.035	10.951
20	1.077	1.233	3.994	4.418	17.516	19.107
17	14.857	16.376	17.027	18.735	27.031	26.915
14	34.088	37.413	36.208	39.72	33.82	34.444
11	58.629	64.155	60.963	66.697	39.877	41.374
8	88.97	97.153	92.439	100.925	44.524	47.04
5	125.479	136.807	134.519	146.629	46.986	50.639
2	175.421	191.006	190.445	207.325	46.35	51.155

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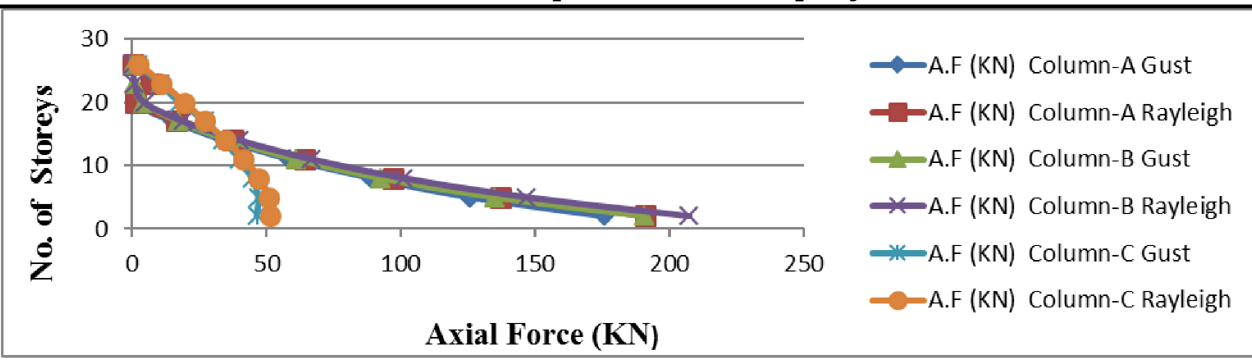
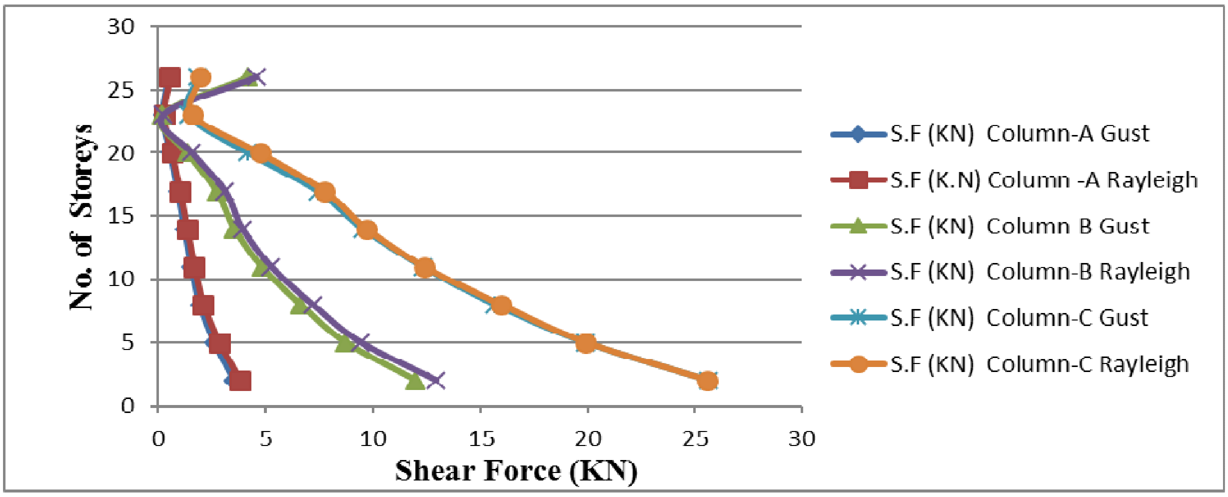


Comparison of Axial forces on columns (a, b, c) in X-direction by Gust factor method and Rayleigh factor method for G+26 (COLUMN-A =CORNER COLUMN, COLUMN-B =INTERMEDIATE COLUMN, COLUMN-C =INTERIOR COLUMN)

No. of Storeys	S.F (KN) Column-A Gust	S.F (K.N) Column -A Rayleigh	S.F (KN) Column-B Gust	S.F (KN) Column-B Rayleigh	S.F (KN) Column-C Gust	S.F (KN) Column-C Rayleigh
26	0.494	0.54	4.186	4.569	1.812	1.966
23	0.224	0.245	0.172	0.191	1.405	1.614
20	0.565	0.616	1.346	1.559	4.189	4.737
17	0.92	1.004	2.708	3.101	7.425	7.763
14	1.229	1.337	3.53	3.91	9.547	9.727
11	1.538	1.673	4.813	5.257	12.349	12.417
8	1.927	2.095	6.623	7.187	15.673	15.923
5	2.597	2.822	8.723	9.437	19.883	19.908
2	3.513	3.815	12.016	12.98	25.64	25.611



Comparison of Shear forces on columns (a, b, c) in X-direction by Gust factor method and Rayleigh factor method for G+26

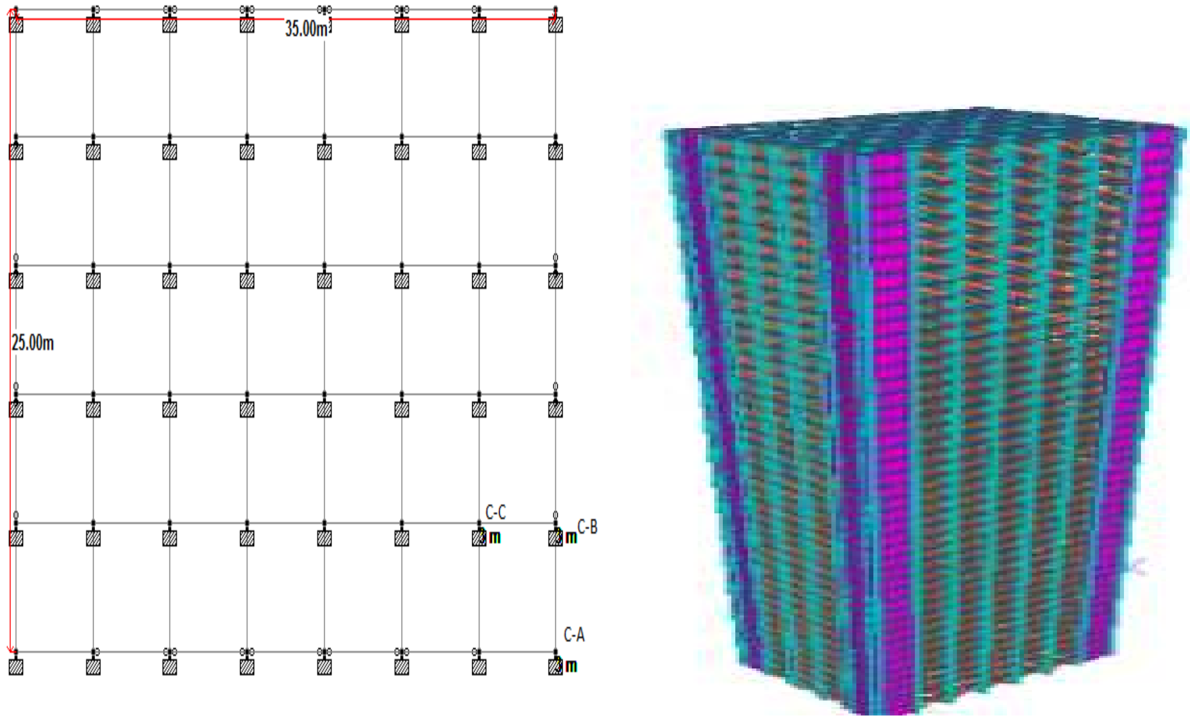


Fig 2: plan view and elevation view of 42 story building

2. FOR G+42 STORIES

No. of Storey	WL x-dirt Gust	WL x-dirt Rayleigh
42	129.226	156.263
37	122.991	148.67
32	114.148	137.827
27	102.77	123.809
22	89.278	107.256
17	74.028	88.733
12	56.792	67.945
7	37.394	44.667
2	15.886	18.95

No. of Storey	WL z-dirt Gust	WL z-dirt Rayleigh
42	270.914	334.523
37	249.524	307.933
32	224.755	277.108
27	195.716	240.966
22	162.393	199.594
17	125.347	153.795
12	85.713	104.995
7	46.117	56.408
2	12.813	15.65

Displacement (mm) on steel frame building G+42 due to wind load in x- direction and Y Direction

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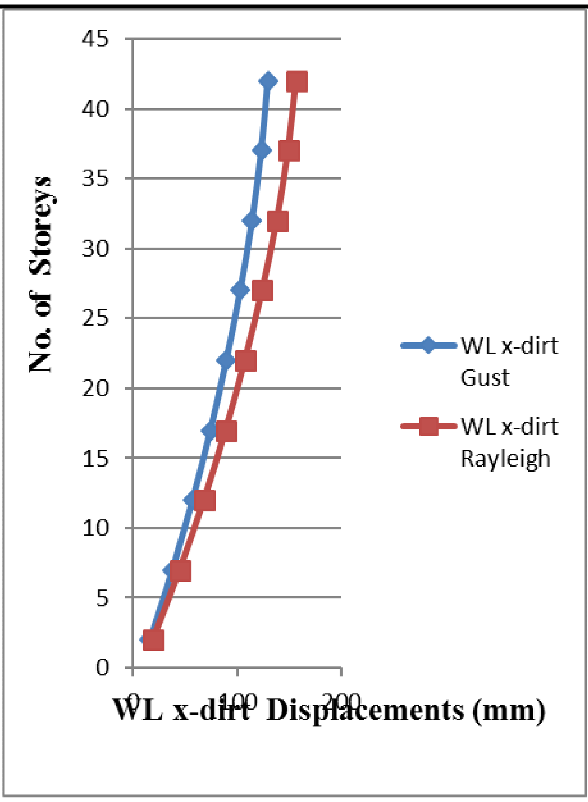


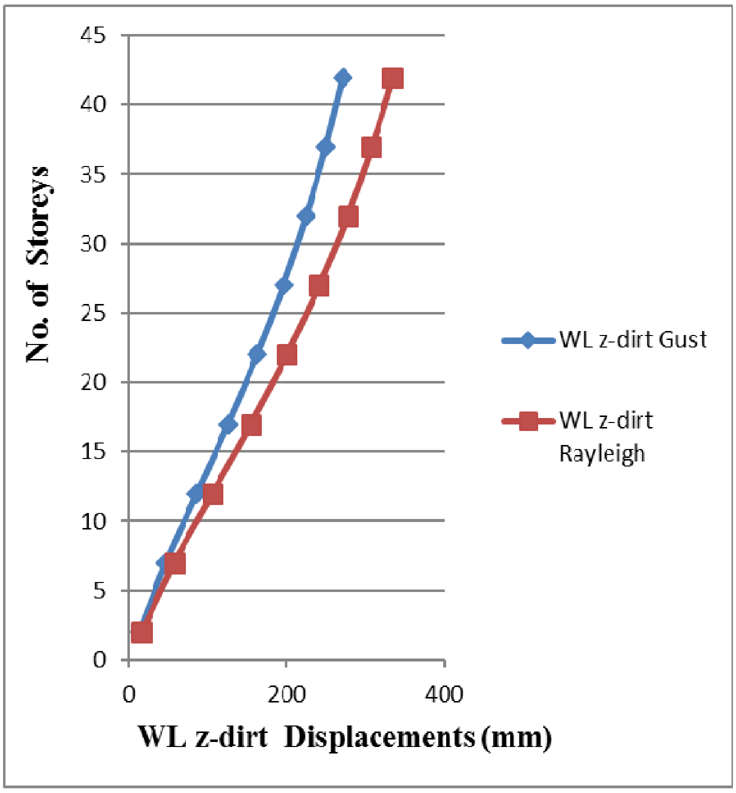
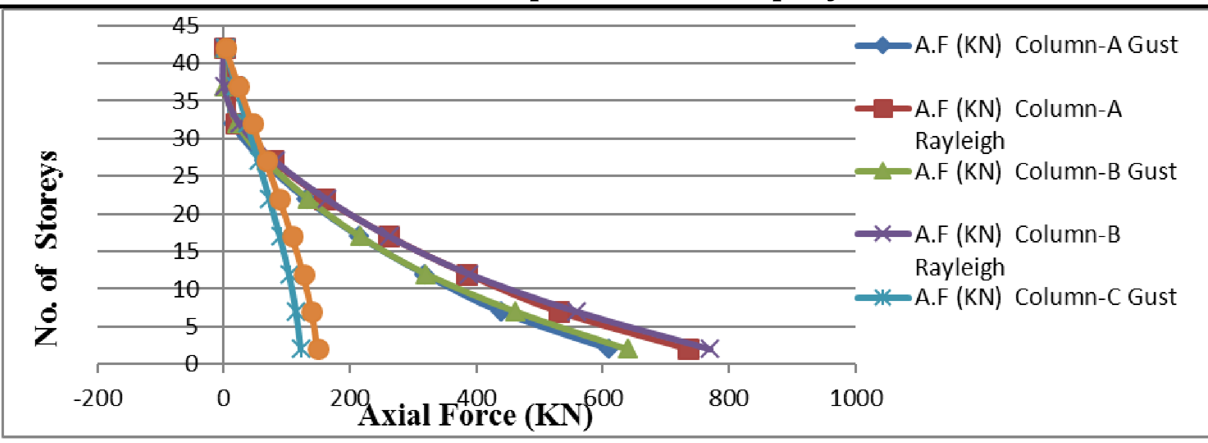


Fig 5

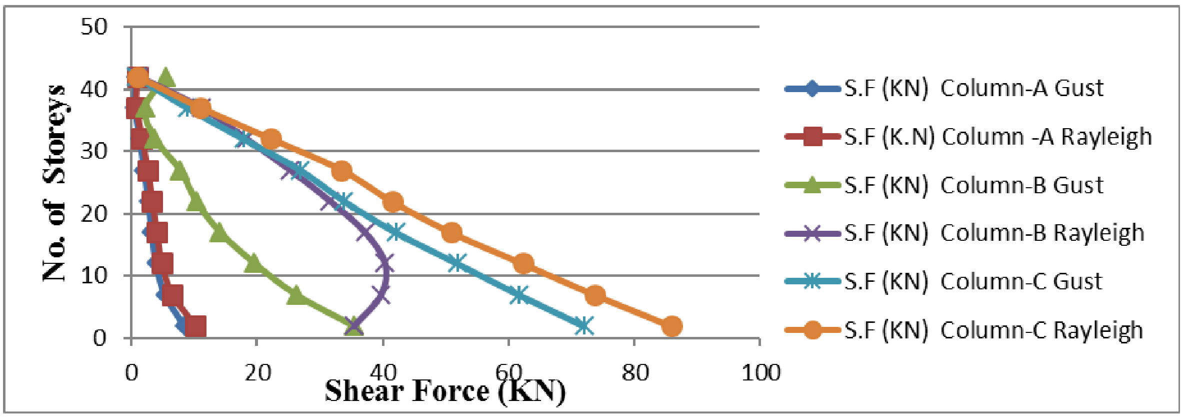
Fig 6

No. of Storeys	A.F (KN) Column-A Gust	A.F (KN) Column-A Rayleigh	A.F (KN) Column-B Gust	A.F (KN) Column-B Rayleigh	A.F (KN) Column-C Gust	A.F (KN) Column-C Rayleigh
42	1.322	1.595	1.227	1.412	2.633	3.188
37	11.032	13.257	0.733	1.108	20.18	24.434
32	16.001	19.779	20.906	25.379	37.849	45.83
27	64.01	78.433	67.452	82.697	55.647	67.37
22	130.736	159.507	132.959	162.666	73.222	88.634
17	215.086	261.426	215.477	262.396	89.796	108.669
12	317.832	385.154	320.601	388.896	104.273	126.155
7	438.501	530.139	462.241	558.907	115.508	139.712
2	609.648	735.556	638.9	770.395	123.032	148.773



Comparison of Axial forces on columns (a, b, c) in X-direction by Gust factor method and Rayleigh factor method for G+42

No. of Storeys	S.F (KN) Column-A Gust	S.F (K.N) Column -A Rayleigh	S.F (KN) Column-B Gust	S.F (KN) Column-B Rayleigh	S.F (KN) Column-C Gust	S.F (KN) Column-C Rayleigh
42	0.743	0.9	7.451	1.162	0.776	0.939
37	0.634	0.767	0.116	11.132	8.829	11.021
32	1.402	1.696	3.687	18.282	17.794	22.201
27	2.104	2.549	7.673	25.249	26.839	33.449
22	2.722	3.285	10.265	31.616	33.858	41.397
17	3.311	3.99	14.07	37.152	42.019	50.804
12	3.969	4.775	19.591	41.329	51.819	62.229
7	5.394	6.485	26.187	42.697	61.584	73.665
2	8.462	10.164	35.405	35.362	71.938	85.833



Comparison of Shear forces on columns (a, b, c) in X-direction by Gust factor method and Rayleigh factor method for G+42

CONCLUSION

- From maximum displacement table it is observe that the displacement value is higher in Rayleigh factor method when compare it to the value of displacement obtain by analyzing it by gust factor method and the result is same in both direction i.e. In X - direction and in Z – direction.
- And from the above mention tabular forms it is also observed that the displacement values for gust factor method is within the criteria i.e. it is lesser than H/500 (H=G+26*3,G+42*3) and for the Rayleigh factor method the values obtain is not under the safe criteria of H/500 for wind load in both X- direction and Z-direction.
- By comparing result of corner column it is observed that the values of A.X, S.F is higher in Rayleigh factor method when compare it to gust factor method in X – direction and Z-direction of steel frame building.
- By comparing result of intermediate column it is observed that the values of A.X, S.F is higher in Rayleigh factor method when compare it to gust factor method in X – direction and Z-direction of steel frame building
- By comparing result of interior column it is observed that the values of A.X, S.F is higher in Rayleigh factor method when compare it to gust factor method in X – direction and Z-direction of steel frame building

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