International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 02, February-2021

# Interrealtion Between Geometric Ratios of Steel Chimney and Deflection by Static and Dynamic Analysis

[1]Shubham Patidar, [2]Vijay Rode, [3] Kanhaiya Kumar Yadav, [4]Mahesh Chandra
[1] M.E (Structural Engineering),SGSITS, Indore
[2] Professor, CE & AMD, SGSITS, Indore
[3] Asst. professor, CE & AMD, SGSITS, Indore
[4] Asst. professor, CE & AMD, SGSITS, Indore

***Abstract* - Most of the industrial steel chimneys are tall structures with circular cross section. Tall chimney plays pivotal role in proper functioning of most of industrial facilities, in this thesis we are considering chimney used for de-dusting system. The basic dimension of industrial self-supporting steel chimney such as height diameter at entry, diameter at exit etc. are taken hypothetically for the study purpose. For comparison analysis, area is proposed for the design of structural self-supporting steel chimney at Indore (plain terrain), certain terrain conditions, wind pressure is calculated as per IS-875 (part 3), and Maximum bending moment and stress for all the chimneys were calculated by using the M S Excel sheet.For static wind load calculations reference is made of design of steel structure by Dr.B.C. Punmia and dynamic wind load calculation as per the procedure given in IS 6533: 1989 (Part 2) .By comparing the three design results like self-supporting chimney stresses, thickness of shells, an effort has been made to arrive at possible/probable cost effective recommendation toward design parameters.**

***Keywords: - Self-supporting chimney, Height 75 m, of different Top and Bottom Diameter, Static Wind pressure, Dynamic wind pressure, Structural Design, Mode shape, Staad pro., Deflection.***

## I INTRODUCTION

Chimneys or stacks are very important industrial structures for emitting toxic gases to a height of so that the gases do not contaminate the surrounding atmosphere. These structures are tall, slender and generally with circular cross sections. Different building materials, such as concrete, steel or masonry, are used to build chimneys. Steel chimneys are ideal for process jobs where a short warm-up period and low thermal capacity are required. In addition, the steel chimneys are economical for heights up to 45 m.

With large-scale industrial developments taking place everywhere, a large number of tall chimneys would need to be built every year. Building chimneys this tall requires a better understanding of the loads acting on them and their structure. Proper design and construction of such chimneys creates self-contained structures that can withstand wind loads and other forces acting on them. Chimneys are more susceptible to wind and earthquake loads, which can cause serious problems in power plants and large industries. Numerous standards are available for the construction of self-supporting industrial steel chimneys one of which is Indian Standard IS 6533: 1989 (Part-1 and Part-2). The geometry of a self-supporting steel chimney plays an important role in its structural behavior under dynamic lateral loading. This is because the geometry is mainly responsible for the stiffness of the chimney. Some basic geometrical parameters of the steel chimney (e.g. total height, diameter at the exit, etc.) they are associated with the corresponding environmental conditions. In addition to that design code (IS-6533: 1989 Part 2) several criteria are imposed on the geometry of steel chimneys to ensure a desired failure mode. Two important geometric consideration form IS-6533: 1989 Part 2 are.

> The minimum outside diameter of the unlined chimney at the top should be one-twentieth of the height of the cylindrical section of the chimney.
>
> The minimum outside diameter of the flared chimney without lining at the base must be 1.6 the outside diameter of the chimney at the top.

Present study attempt to relate the geometric ratios and the deflection of steel chimney using Staad Pro. Software and manual calculation using MS Excel.

## II OBJECTIVE OF STUDY

1) To study the effect of wind loads loads on the structure and to determine the loads that are more effective on the dynamic behavior of the structure.

2) Study will be more focused on the deflection of the tall chimney due to wind and earthquake and the analysis done will be the dynamic analysis and the static analysis.

3) Deflection is also the governing factor for the tall structure. Depending upon the type of structure there are different permissible value of deflection thus study will keep deflection in permissible limits for all the diameters considered.

4) The objective of current study also the aspects influence of tall chimney design.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 02, February-2021

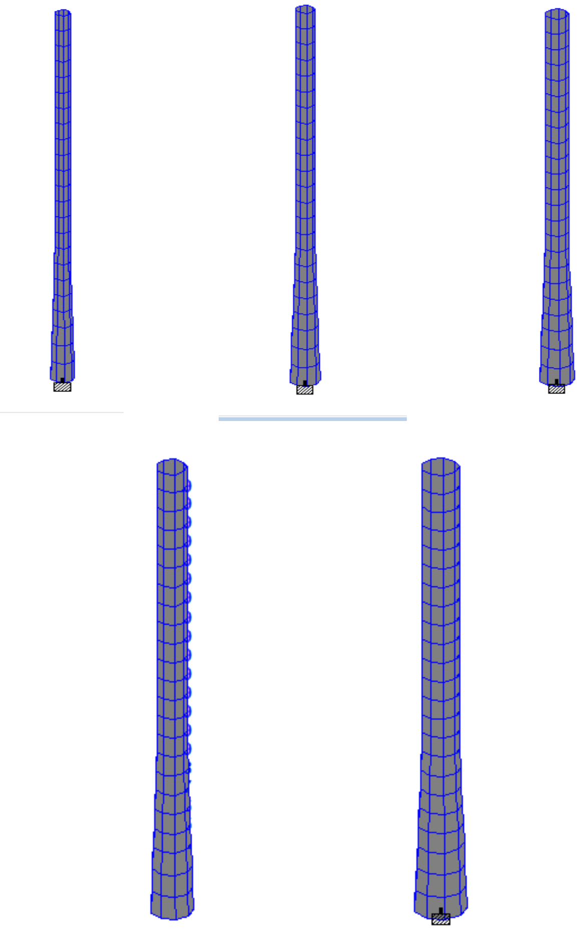


Fig 1.1: Chimney with different top and bottom diameter

## II. LITERATURE SURVEY

**Kirtikanta Saho (2012)**, "Analysis of Self Supported Steel Chimney as per Indian Standard" the target of this paper is to justify the code criteria with relevancy basic dimension of commercial steel chimney. A total of sixty six variety independent steel flaring unlined chimneys with totally different top-to-base diameter magnitude relation and height-to-base diameter ratios were thought of for this study. The thickness of the chimney was unbroken constant for all the cases. most bending moment and stress for all the chimneys were calculated for the dynamic wind load as per the procedure given in IS 6533: 1989 (Part 2) victimization MathCAD software package. Also, the results were verified with finite component analysis victimization business package ANSYS.

**K. Chaithanya Varada Prasad, Dr. K.L. Radhika , Mrs. P. Anuradha , B. Santhosh Reddy (2018) ,** "Dynamic Analysis of a Tall Chimney" the target of this paper confirm that masses ar predominant on the structure and to seek out the slope that generates the smallest amount deflection for a chimney height of 310m. The cross section area, bottom diameter and thickness of the chimney is maintained same. the hundreds ar calculated as per code IS 4998 (part-1):1992. The analysis is done using the STAAD-Pro. The deflections area unit determined and checked whether or not they area unit below the limiting worth as mentioned within the code. a complete of eight models with totally different slopes area unit generated and analyzed. The deflections and stresses at various levels area unit determined and therefore the best slope combination that provides least deflection is terminated.

**G.Murali, B.Mohan, P.Sitara, P.Jayasree (2012) "**Respnse of Mild Steel Chimney Under Wind Loads**"** This paper deals with the analysis of 3 chimney of 55m height and designed as per IS 6533-1989[1] and wind masses were calculated as per IS 875-1987 [2]. The wind speed thought-about were forty seven m/s, 50 m/s, fifty five m/s and also the static force, dynamic forces, static moment, dynamic moment and thickness of those chimney shells ar compared.

**Kalpesh Dhopat, Shrirang Tande, Abhijeet Oundhakar (2018)** "Analysis of Self-Supported Steel Chimney with the Effects of Geometrical Parameters" 49 range of steel chimney seven totally different height and high diameter area unit hand-picked and analyzed for wind loading and seismal loading as per IS 6533 half II and IS 1893 half IV and analyzed by mistreatment the finite part software package STAA professional Vi8 and MS surpass. The investigation has been distributed the variation of parameter in impact of height to base diameter magnitude relation and high to base diameter magnitude relation.

**Prof. Udaysingh Patil, Prof. Devendra Padole, Prof. Devendra Padole (2018)** "Static and Dynamic Analysis of Steel Chimneys Using Different Codes" Different cross section of the chimney has been thought-about and analyzed for the wind load. each static and dynamic analysis had been performed of the chimney. Comparative study has been done by mistreatment typical methodology with the static moment obtained by IS 6533 half a pair of. equally the dynamic moment at the bottom of the steel chimney square measure compared considering IS 6533 part2, AS/NZS: 1170.2: 2002 and DD ENV 1991 -2 - 4: 1995.

**Mr. Praveen Kumar, Dr. Ajay Swarup (2016)** "Analysis of Self Supporting Steel Chimney" The effects of lateral force because of wind and earthquake masses square measure analyzed by the same static load methodology and dynamic analysis by response spectrum methodology. The region has been considered of Nashik and tract class has been thought-about consequently. The wind load and earthquake parameter were thought-about as per IS 1893 [IV] and 875 part [III]

| Model | Top Dia(m) | Buttom Dia(m) | Height(m) |
|---|---|---|---|
| 1 | 2 | 3.2 | 75 |
| 2 | 2.75 | 4.15 | 75 |
| 3 | 3.5 | 5.1 | 75 |
| 4 | 4.25 | 6.05 | 75 |
| 5 | 5 | 7 | 75 |

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 02, February-2021

## III. METHODOLOGY

**For a comparative analysis, a steel chimney has been considered.**

To achieve the objective following step-by-step procedures are followed:

1. Carry out literature study to find out the objectives of the project work.
2. Select chimney geometry for all the three locations.
3. Calculate the loading on chimney and load combinations.
4. A study on the various parts of a chimney, Understand the procedure of design of a steel chimney as per IS 6533:1989. Select various points and following the various limitations as per the Indian Standard Code.
5. Analyses and design using STAAD pro. and Excel sheet calculation for five different geometries and compare deflection chimneys with different geometric ratios .

## IV. MODELLING AND PROBLEM FORMULATION

In the present study a Steel chimney of 80m height subjected to the wind loads imposed due to the mean hourly wind speed of 39m/sec in the seismic zone III is considered for the analysis. Single flue of structural steel is provided to discharge the flue gases. The shell rests on R.C.C. mat foundation of circular shape. The following are the details of the chimney considered

| | | |
|---|---|---|
| Unit Weight of Steel | - | 78.5 KN/ $m^3$ |
| Height of chimney | - | 75 m |
| Maximum outer diameter at bottom | - | 6.5 m |
| Minimum outer diameter at top | - | 2.0 m (min) |
| Thickness of shell at bottom | - | 24 mm |
| Thickness of shell at top | - | 20 mm |
| Grade of Steel | - | Fe 250 |
| Basic wind Speed | - | 39 m/sec |
| Base | - | Rigid |
| Seismic Zone | - | III |
| Damping Ratio | - | 5% |
| Geometric Variation | - | Top Dia to Height Ratio Buttom Dia to Height Ratio |

Calculation of wind load and moment will be done using IS 875 – 2015 (Part 3) and IS 6533 – 1989 (Part 2)

### 4.1 LOADING COMNDITIONS

Loding line diagram in Staad Pro. is as shown below for static loading and dynamic loading for all five model

(a) Live Loads: as per IS: 875 (part-2) 1987
(b) Wind load as per IS 875 - 2015 part III

### LOAD COMBINATIONS

1. DL
2. DL + WL
3. .9DL + WL

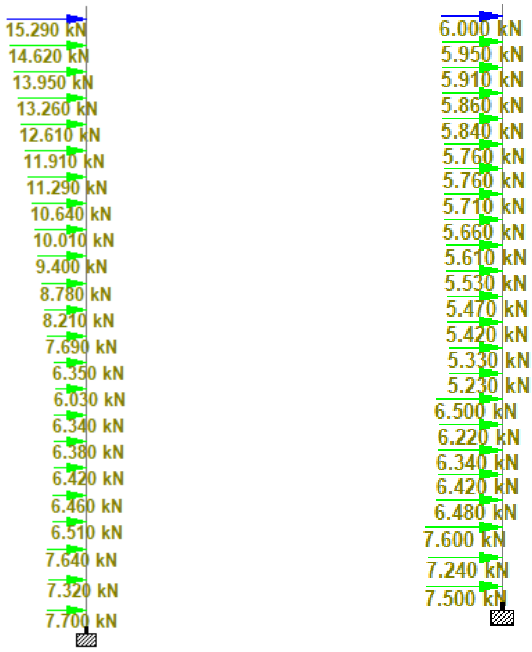



Fig 4.1: Static and Dynamic Load for Model 1

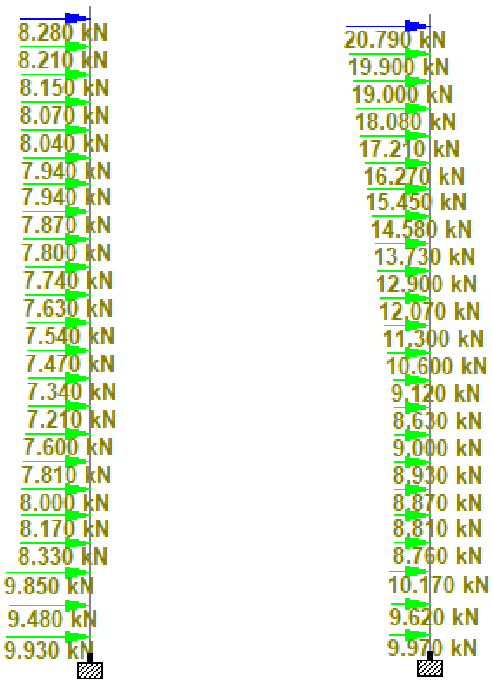



Fig 4.2: Static and Dynamic Load for Model 2

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 02, February-2021

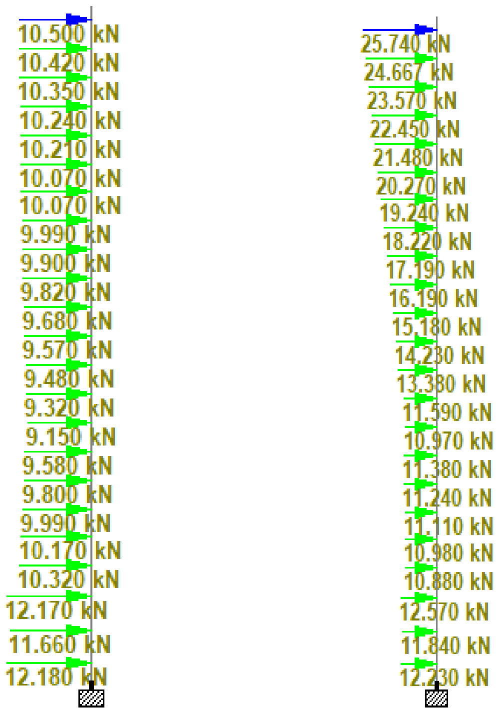



Fig 4.3: Static and Dynamic Load for Model 3

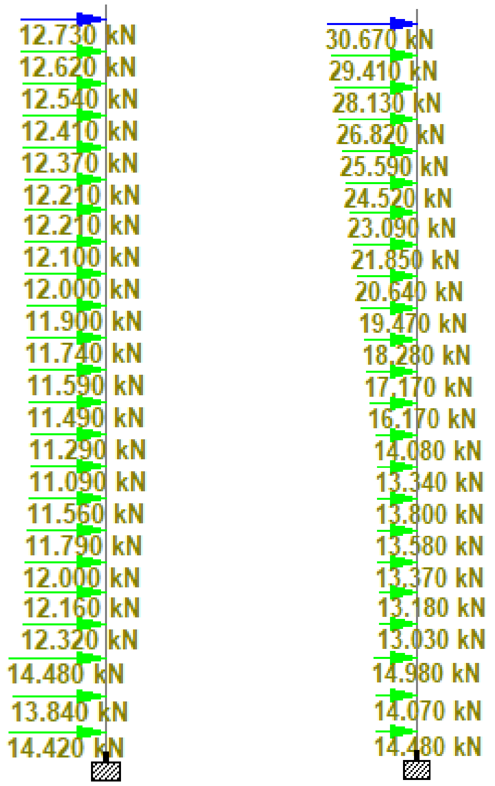



Fig 4.3: Static and Dynamic Load for Model 3

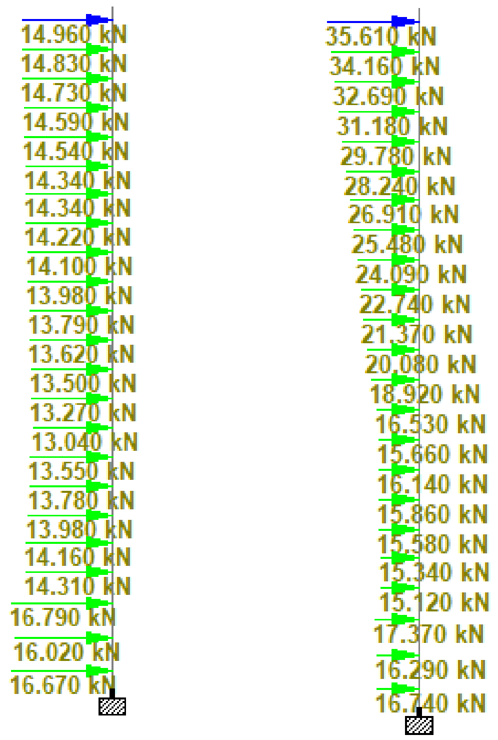



Fig 4.5: Static and Dynamic Load for Model 5

## V. COMPARITIVE RESULTS

### 5.1 Percentage increase in load from static to dynamic

#### 5.1.1 Model 1

| Node | Static Wind Force | Dynamic Load | % Change In Load |
|---|---|---|---|
| 1 | 6.05 | 9.23 | 52.56 |
| 2 | 6.00 | 8.62 | 43.67 |
| 3 | 5.96 | 7.98 | 33.89 |
| 4 | 5.90 | 7.35 | 24.58 |
| 5 | 5.88 | 6.72 | 14.29 |
| 6 | 5.80 | 6.10 | 5.17 |
| 7 | 5.80 | 5.90 | 1.72 |
| 8 | 5.75 | 4.89 | -14.96 |
| 9 | 5.70 | 4.30 | -24.56 |
| 10 | 5.66 | 3.70 | -34.63 |
| 11 | 5.50 | 3.20 | -41.82 |
| 12 | 5.51 | 2.69 | -51.18 |
| 13 | 5.46 | 2.22 | -59.34 |
| 14 | 5.30 | 0.90 | -83.02 |
| 15 | 5.27 | 0.75 | -85.77 |
| 16 | 5.61 | 0.73 | -86.99 |
| 17 | 5.82 | 0.56 | -90.38 |
| 18 | 6.01 | 0.10 | -98.34 |
| 19 | 6.18 | 0.20 | -96.76 |
| 20 | 6.33 | 0.10 | -98.42 |
| 21 | 7.54 | 0.09 | -98.81 |
| 22 | 7.29 | 0.02 | -99.73 |
| 23 | 7.68 | 0.01 | -99.82 |

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 02, February-2021

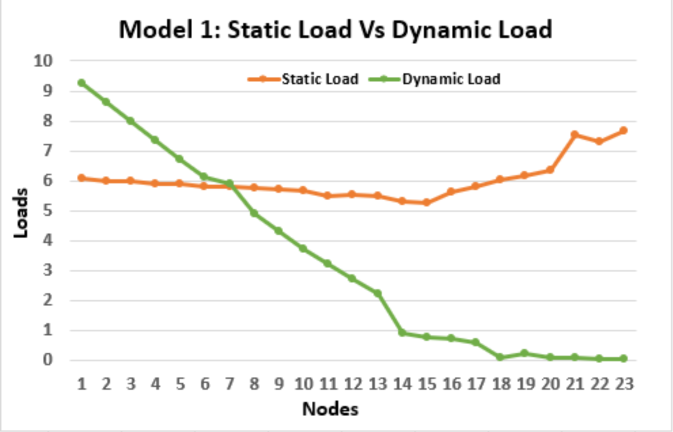



Fig 5.1.1: Model 1

### 5.1.2 Model 2

| Node | Static Wind Force | Dynamic Load | % Change In Load |
|---|---|---|---|
| 1 | 8.28 | 12.51 | 51.09 |
| 2 | 8.21 | 11.69 | 42.39 |
| 3 | 8.15 | 10.80 | 32.52 |
| 4 | 8.07 | 10.00 | 23.92 |
| 5 | 8.04 | 9.16 | 13.93 |
| 6 | 7.94 | 8.32 | 4.79 |
| 7 | 7.94 | 7.51 | -5.42 |
| 8 | 7.87 | 6.70 | -14.87 |
| 9 | 7.80 | 5.92 | -24.10 |
| 10 | 7.74 | 5.16 | -33.33 |
| 11 | 7.63 | 4.44 | -41.81 |
| 12 | 7.54 | 3.76 | -50.13 |
| 13 | 7.47 | 3.12 | -58.23 |
| 14 | 7.34 | 1.77 | -75.89 |
| 15 | 7.21 | 1.41 | -80.44 |
| 16 | 7.60 | 1.10 | -85.53 |
| 17 | 7.81 | 1.12 | -85.66 |
| 18 | 8.00 | 0.86 | -89.25 |
| 19 | 8.17 | 0.63 | -92.29 |
| 20 | 8.33 | 0.43 | -94.84 |
| 21 | 9.85 | 0.31 | -96.85 |
| 22 | 9.80 | 0.14 | -98.57 |
| 23 | 9.93 | 0.04 | -99.64 |

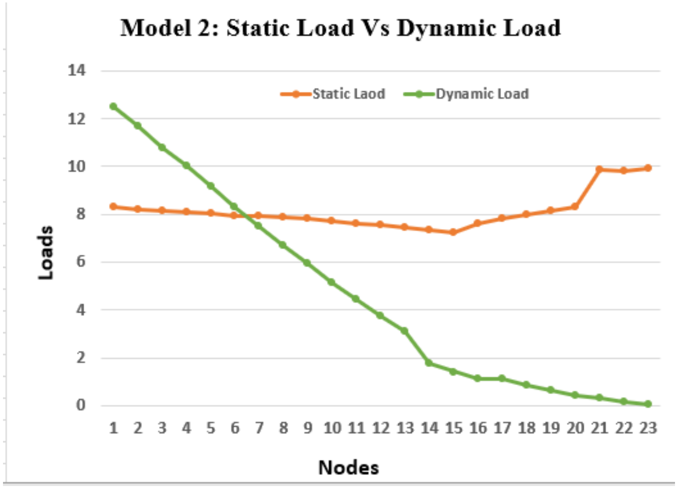



Fig 5.1.2: Model II

### 5.1.3 Model 3

| Node | Static Wind Force | Dynamic Load | % Change In Load |
|---|---|---|---|
| 1 | 10.5 | 15.23 | 45.05 |
| 2 | 10.42 | 14.24 | 36.66 |
| 3 | 10.35 | 13.22 | 27.73 |
| 4 | 10.24 | 12.20 | 19.14 |
| 5 | 10.21 | 11.27 | 10.38 |
| 6 | 10.07 | 10.19 | 1.19 |
| 7 | 10.07 | 9.16 | -9.04 |
| 8 | 9.99 | 8.23 | -17.62 |
| 9 | 9.9 | 7.28 | -26.46 |
| 10 | 9.82 | 6.37 | -35.13 |
| 11 | 9.68 | 5.49 | -43.29 |
| 12 | 9.57 | 4.66 | -51.31 |
| 13 | 9.48 | 3.89 | -58.97 |
| 14 | 9.32 | 2.27 | -75.64 |
| 15 | 9.15 | 1.81 | -80.22 |
| 16 | 9.58 | 1.79 | -81.32 |
| 17 | 9.8 | 1.44 | -85.31 |
| 18 | 9.99 | 1.11 | -88.89 |
| 19 | 10.17 | 0.81 | -92.04 |
| 20 | 10.32 | 0.56 | -94.59 |
| 21 | 12.17 | 0.01 | -99.92 |
| 22 | 11.66 | 0.18 | -98.43 |
| 23 | 12.18 | 0.05 | -99.61 |

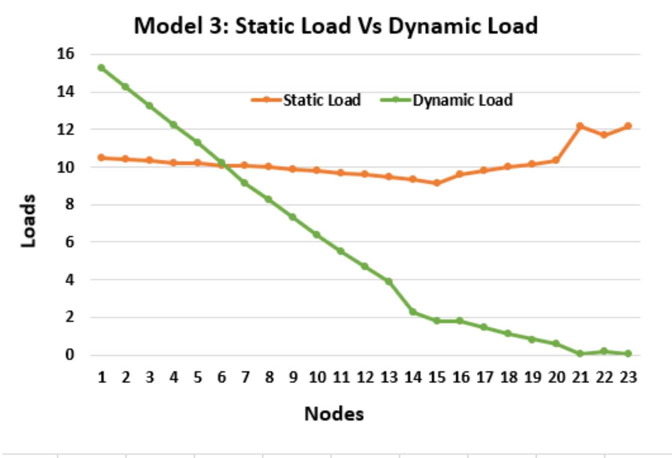



Fig 5.1.3: Model III

### 5.1.4 Model 4

| Node | Static Wind Force | Dynamic Load | % Change In Load |
|---|---|---|---|
| 1 | 12.73 | 17.94 | 40.93 |
| 2 | 12.62 | 16.78 | 32.96 |
| 3 | 12.54 | 15.59 | 24.32 |
| 4 | 12.41 | 14.40 | 16.04 |
| 5 | 12.37 | 13.22 | 6.87 |
| 6 | 12.21 | 12.04 | -1.39 |
| 7 | 12.21 | 10.88 | -10.89 |
| 8 | 12.1 | 9.75 | -19.42 |
| 9 | 12 | 8.64 | -28.00 |
| 10 | 11.9 | 7.57 | -36.39 |
| 11 | 11.74 | 6.54 | -44.29 |
| 12 | 11.59 | 5.57 | -51.94 |
| 13 | 11.49 | 4.67 | -59.36 |
| 14 | 11.29 | 2.78 | -75.38 |
| 15 | 11.09 | 2.24 | -79.80 |

| | | | |
|---|---|---|---|
| 16 | 11.56 | 2.23 | -80.71 |
| 17 | 11.79 | 1.79 | -84.82 |
| 18 | 11.99 | 1.38 | -88.49 |
| 19 | 12.16 | 1.01 | -91.69 |
| 20 | 12.32 | 0.71 | -94.24 |
| 21 | 14.48 | 0.49 | -96.62 |
| 22 | 13.84 | 0.22 | -98.41 |
| 23 | 14.42 | 0.06 | -99.60 |

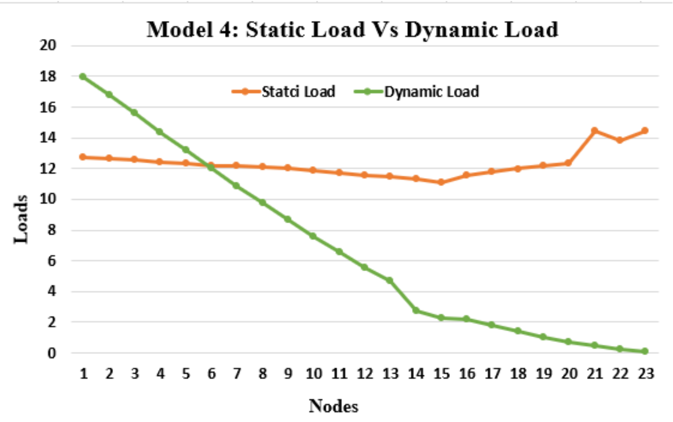



Fig 5.1.4: Model IV

**5.1.5 Model 5**

| Node | Static Wind Force | Dynamic Load | % Increase In Load |
|---|---|---|---|
| 1 | 14.96 | 20.65 | 38.03 |
| 2 | 14.83 | 19.32 | 30.28 |
| 3 | 14.73 | 17.96 | 21.93 |
| 4 | 14.59 | 16.59 | 13.71 |
| 5 | 14.54 | 15.24 | 4.81 |
| 6 | 14.34 | 13.89 | -3.14 |
| 7 | 14.34 | 12.56 | -12.41 |
| 8 | 14.22 | 11.26 | -20.82 |
| 9 | 14.1 | 9.99 | -29.15 |
| 10 | 13.98 | 8.76 | -37.34 |
| 11 | 13.79 | 7.58 | -45.03 |
| 12 | 13.62 | 6.46 | -52.57 |
| 13 | 13.5 | 5.41 | -59.93 |
| 14 | 13.27 | 3.25 | -75.51 |
| 15 | 13.04 | 2.62 | -79.91 |
| 16 | 13.55 | 2.59 | -80.89 |
| 17 | 13.78 | 2.07 | -84.98 |
| 18 | 13.98 | 1.60 | -88.56 |
| 19 | 14.16 | 1.17 | -91.74 |
| 20 | 14.31 | 0.80 | -94.38 |
| 21 | 16.79 | 0.58 | -96.56 |
| 22 | 16.02 | 0.26 | -98.36 |
| 23 | 16.67 | 0.07 | -99.59 |

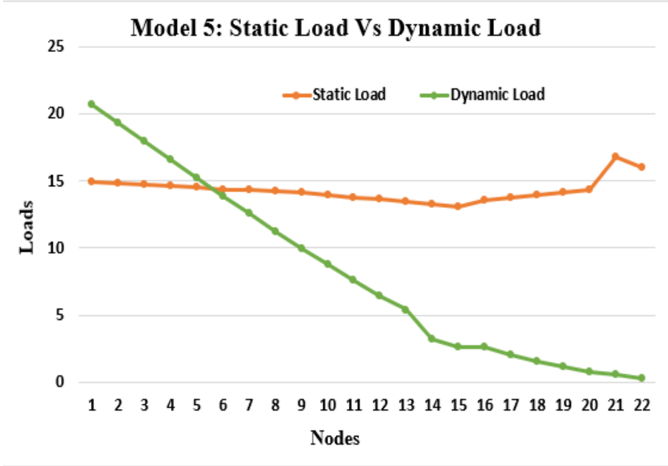
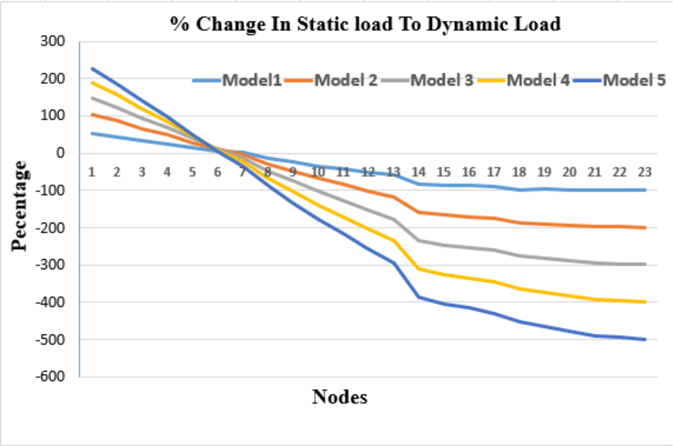



**Fig 5.1.5: Model V**

## 5.2 Percentage Change From Static Load To Dynamic Load

| Node | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| 1 | 52.56 | 51.09 | 45.05 | 40.93 | 38.03 |
| 2 | 43.67 | 42.39 | 36.66 | 32.96 | 30.28 |
| 3 | 33.89 | 32.52 | 27.73 | 24.32 | 21.93 |
| 4 | 24.58 | 23.92 | 19.14 | 16.04 | 13.71 |
| 5 | 14.29 | 13.93 | 10.38 | 6.87 | 4.81 |
| 6 | 5.17 | 4.79 | 1.19 | -1.39 | -3.14 |
| 7 | 1.72 | -5.42 | -9.04 | -10.89 | -12.41 |
| 8 | -14.96 | -14.87 | -17.62 | -19.42 | -20.82 |
| 9 | -24.56 | -24.10 | -26.46 | -28.00 | -29.15 |
| 10 | -34.63 | -33.33 | -35.13 | -36.39 | -37.34 |
| 11 | -41.82 | -41.81 | -43.29 | -44.29 | -45.03 |
| 12 | -51.18 | -50.13 | -51.31 | -51.94 | -52.57 |
| 13 | -59.34 | -58.23 | -58.97 | -59.36 | -59.93 |
| 14 | -83.02 | -75.89 | -75.64 | -75.38 | -75.51 |
| 15 | -85.77 | -80.44 | -80.22 | -79.80 | -79.91 |
| 16 | -86.99 | -85.53 | -81.32 | -80.71 | -80.89 |
| 17 | -90.38 | -85.66 | -85.31 | -84.82 | -84.98 |
| 18 | -98.34 | -89.25 | -88.89 | -88.49 | -88.56 |
| 19 | -96.76 | -92.29 | -92.04 | -91.69 | -91.74 |
| 20 | -98.42 | -94.84 | -94.59 | -94.24 | -94.39 |
| 21 | -98.81 | -96.85 | -99.92 | -96.62 | -96.57 |
| 22 | -99.73 | -98.57 | -98.43 | -98.41 | -98.36 |
| 23 | -99.82 | -99.64 | -99.61 | -99.60 | -99.60 |

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 02, February-2021




Scale on Y Axis 1:5
Fig 5.2.1: Percentage Change In Load

### 5.3 Geometric ratios and deflection by static analysis

| Model | Top Dia/Ht(m) | Buttom Dia/Ht(m) | Deflection(cm) |
|---|---|---|---|
| 1 | 0.03 | 0.04 | 18.98 |
| 2 | 0.04 | 0.06 | 14.4 |
| 3 | 0.05 | 0.07 | 9.3 |
| 4 | 0.06 | 0.08 | 6.3 |
| 5 | 0.07 | 0.09 | 4.4 |

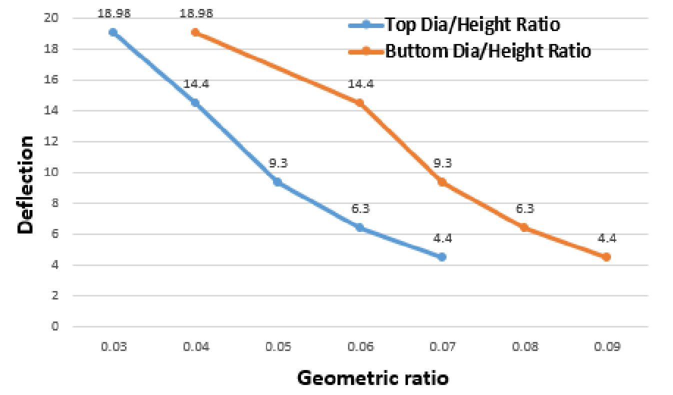



Fig 5.3.1: Geometric ratios and deflection by static analysis

### 5.4 Geometric ratios and deflection by dynamic analysis

| Model | Top Dia/Ht(m) | Buttom Dia/Ht(m) | Deflection(cm) |
|---|---|---|---|
| 1 | 0.03 | 0.04 | 53.04 |
| 2 | 0.04 | 0.06 | 29.66 |
| 3 | 0.05 | 0.07 | 18.71 |
| 4 | 0.06 | 0.08 | 12.63 |
| 5 | 0.07 | 0.09 | 9.38 |

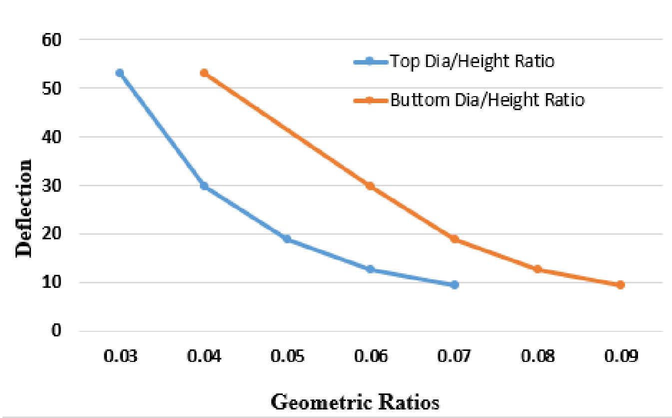



Fig 5.4.1: Geometric ratios and deflection by dynamic analysis

### 5.5 Percentaage change in deflection from static to dynamic analysis

| Model | Static Deflection | Dynamic Deflection(cm) | % Change |
|---|---|---|---|
| Model 1 | 18.98 | 53.04 | 179.45 |
| Model 2 | 14.4 | 29.66 | 105.97 |
| Model 3 | 9.3 | 18.71 | 101.18 |
| Model 4 | 6.3 | 12.63 | 100.48 |
| Model 5 | 4.4 | 9.38 | 113.18 |

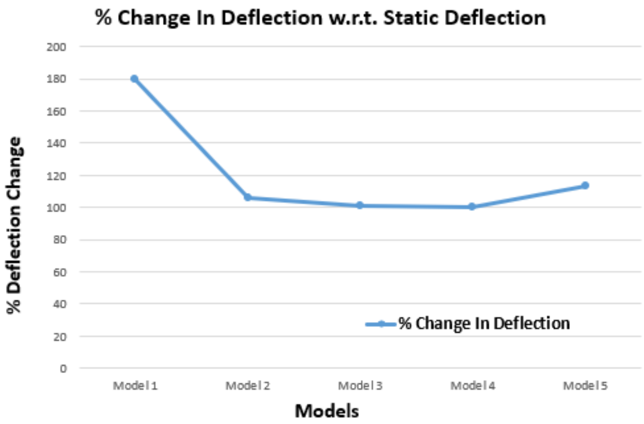



Fig 5.5.1: Percentage change in deflection

## VI. RESULTS

1) It is observed that for model 1 & 2 dynamic load more for higher elevation but after height but after height of 52m it becomes less and become very less for lower elevations.

2) It is observed that for model 3, 4 and 5 dynamic load more for higher elevation but after height but after height of 56m it becomes less and become very less for lower elevations.

## VII. CONCLUSION

1) Percentage increase in dynamic force in more in chimney lower diameter as compare to chimney of higher diameter.

2) Decrease in dynamic force in more significant from top to bottom as compare to static force.

3) Dynamic force become lower then the static force for elevation below certain level from the top.

4) Chimney with lesser diameter undergoes more deflation as compare to chimney of higher diameter.

5) For same geometric ratio deflection after applying dynamic load is more as compare to deflection after static analysis.

6) Percentage increase in deflection after dynamic analysis is more for chimney of lower diameter as compare to chimney of higher diameter.

7) For chimney of higher diameter percentage change in deflection is less significant as compare to chimney of lower diameter

## VIII. FUTURE SCOPE OF WORK

1. To further study and incorporate the recommendation of Indian standard code, with regards to provision of instrumentation to the chimney at different levels, to continuously measure and monitor wind data.

2. Location of stress concentration due to high temperature of flue gases, consequent crack originating / spread and the remedial additional design reinforcements.

3. Discussion on Flue opening (Breach opening).

4. Comparison between different types of foundation which are suitable for Steel chimney with take care of wind effect and Earthquake effect.

## REFERENCES

[1] G. Murali, B. Mohan, P. Sitara and P. Jayasree, "Response of mild steel chimney under wind loads "International Journal of Engineering Research and Applications (IJERA), Vol.2, issue 2, Mar-Apr 2012, pp.490-498.

[2] Sagar S, Basawaraj Gudadappanavar, "Performance Based Seismic Evaluation of Industrial Chimneys by Static and Dynamic Analysis" International Research Journal of Engineering and Technology (IRJET), Vol-2, Issue- 04, July 2015, pp 1670-1674.

[3] M R Tabeshpour, "Nonlinear Dynamic Analysis of Chimney-like towers",Asian Journal of Civil Engineering (Building and Housing), vol.13, NO.1 (2012), pp.97-112.

[4] Jisha S V, Dr B R Jayalekshmi, Dr R Shivashankar, "Across Wind Response of Tall Reinforced Concrete Chimneys Considering the Flexibility of Soil" International Journal of Engineering Research and Technology (IJERT) Volume-1, issue-8, october-2012, pp.1-8.

[5] Aneet Khombe, Anand Bagali, Md Imran G, Irayya R, Prof Sachin, R Kulkarni "Dynamic Analysis of RCC Chimney- A Review" IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 02, 2016

[6] K.R.C. Reddy, O. R. Jaiswal, P.N. Godbole, "Wind and Earthquake Analysis of Tall RC chimneys", International Journal of Earth Sciences and Engineering, Vol.4, Oct 2011, pp.508-511.

[7] Sagar S, Basawaraj Gudadappanavar, "Performance Based Seismic Evaluation of Industrial Chimneys by Static and Dynamic Analysis" International Research Journal of Engineering and Technology (IRJET), Vol2, Issue- 04, July 2015, pp 1670-1674.

[8] Kalpesh Dhopat , Shrirang Tande, Abhijeet Oundhakar "Analysis of Self-Supported Steel Chimney with the Effects of Geometrical Parameters" Kalpesh Dhopat Int. Journal of Engineering Research and Application ISSN : 2248-9622, Vol. 8, Issue5 (Part -II) May 2018, pp04-09

.