ANALYSIS OF DIAGRID STRUCTURES WITH PLAN IRREGULARITY

Chetan S.Pattar[1], Prof. Smt. Varsha Gokak[2]

[1] Post-Graduate Student, Dept. of Civil Engineering
KLE Dr. M.S. Sheshgiri College of Engineering and Technology, Belagavi.
[2]Asistanat Professor, Dept. of Civil Engineering
KLE Dr. M.S. Sheshgiri College of Engineering and Technology, Belagavi.

Abstract - *In modern era, construction of high-rise buildings is rapidly increasing throughout the world. Due to decrease of available free land and due to wide spread urban area, the architects and the engineers have started developing cities vertically. Recently, the diagrid structural system has been widely used for tall buildings due to structural efficiency and aesthetic potential provided by triangulation of the system. Compared to the conventional frame buildings having exterior vertical column, diagrid structure resists the lateral loads more efficiently due to presence of inclined columns. In diagrid system the lateral loads are resisted by the axial action of the inclined columns that are placed at the exterior periphery of the buildings. In the present study a 16-story square plan structure is considered along with C-Type and L-Type structure which have plan irregularity in them. The structures are analyzed by dynamic linear method that is response spectrum method. The results obtained are compared using various parameters like base shear, top story shear, top story displacement,* time period, storey drift, quantity of material consumed.*t. The behavior of plan irregular structure is compared with regular structure.*

***Key Words*: Diagrid, Lateral loads, Inclined columns, Axial action, Plan irregularity.**

1.INTRODUCTION

Generally, tall buildings are used as commercial buildings for official purpose, but there is rapid increase in use of tall buildings as residential purpose and mixed use such as residential and commercial. Diagrid system has unique geometric configuration which consist of inclined columns on periphery of the buildings. This system is found to be better at lateral load resisting when compared to other structural systems. Diagrid structures are generally stiffer than equivalent tubular system and provide more efficient use of material. The triangulation configuration of diagrid on periphery provides increased stability and distributes the forces in much uniform manner. The diagrid members provide bending and shear rigidity, effectively due to their unique diamond shape arrangement. Diagrid system are better at providing alternate load path and load redistribution in event of structural failure. The overall materials required for construction in terms of steel weight and volume of concrete is much less for diagrid structure when compared to conventional system. Diagrid structures give a better appearance on building façade and hence are good from architerual point of view and provide more flexibility in architeural planning.

2. Objective of study

- To analyze the diagrid structure with plan irregularity for seismic loading.
- To study the behavior of diagrid structure with plan irregularity under seismic loading.
- To study and compare the parameter such as like base shear, top storey displacement, top storey shear, time period, storey drift, quantity of material consumed.

3. Modelling

In this study three models are considered, regular square plan, C-Type plan and L-Type plan layout. All the plan have same area of 324m^2 . The structure are modelled in ETABS software as shown below.

Regular diagrid structure.

- Plan dimension: 18m×18m.
- Slab: 120mm thick
- Column section: 500×500mm.
- Beam section: ISMB 300.
- Diagrid section: Pipe section outside diameter 350mm and wall thickness 12mm.
- Typical story height: 3.6m.
- Number of story: 16 storey.

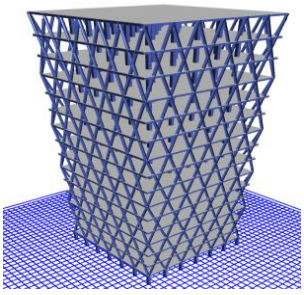


Figure 3.1- 3D view of regular diagrid structure.

C-Type diagrid structure.

- Plan dimension: C-Shape plan.
- Slab: 120mm thick
- Column section: 500×500mm.
- Beam section: ISMB 300.
- Diagrid section: Pipe section outside diameter 350mm and wall thickness 12mm.
- Typical story height: 3.6m.
- Number of story: 16 story.

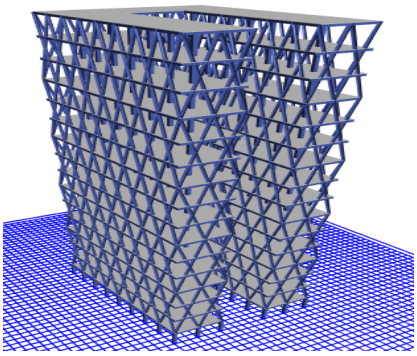


Figure 3.2 - 3D view of C-Type diagrid structure.

L-Type diagrid structure.

- Plan dimension: L-Shape plan.
- Slab: 120mm thick.
- Column section: 500×500mm.
- Beam section: ISMB 300.
- Diagrid section: Pipe section outside diameter 350mm and wall thickness 12mm.
- Typical story height: 3.6m.
- Number of story: 16 story.

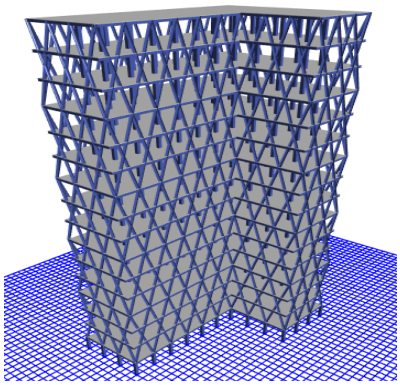


Figure 3.3 – 3D view of L -Type diagrid structure

Material Properties

- Steel properties –
  - Grade of steel – Fe250.
  - Modulus of elasticity – 200GPa
- Concrete properties –
  - Grade of concrete – M30
  - Density of Reinforced concrete – 25kN/m^2
  - Poisson's ratio – 0.2
  - Coefficient of thermal expansion – 5.5×10^6/C

Loading Data

Dead load - Intermediate storey = 1kN/m^2.

Top storey = 1.5kN.m^2.

Live load - Intermediate storey = 4kN/m^2.

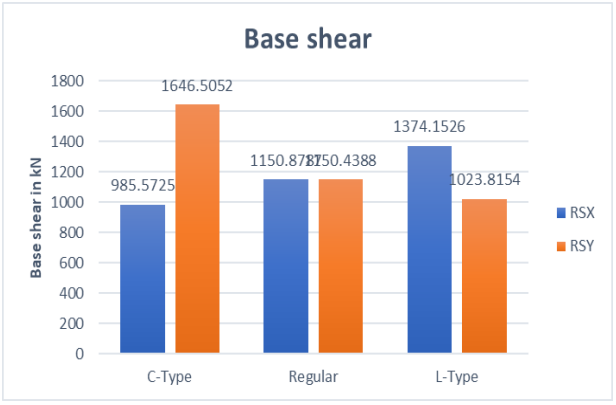
Top storey = 1.5kN.m^2.

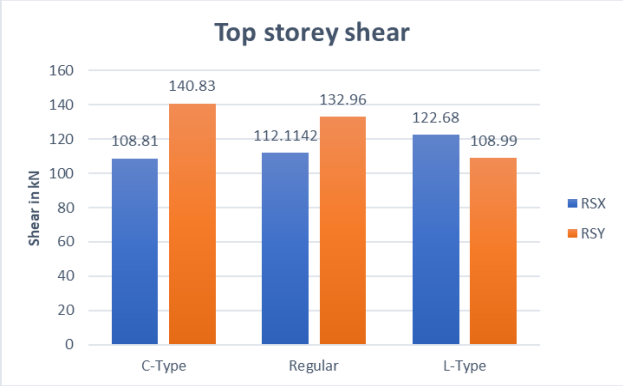
Seismic load –

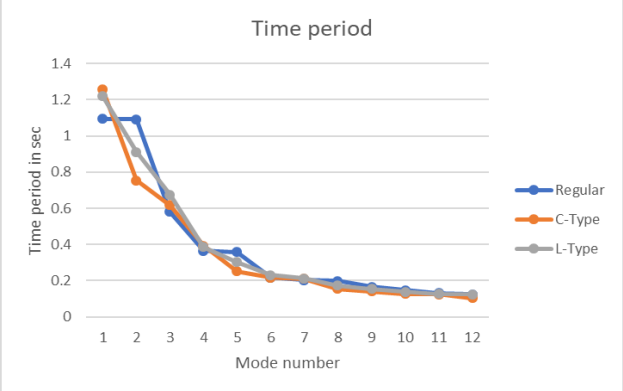
- Seismic zone: Zone V
- Zone factor: 0.36.
- Response reduction factor: 5, Special Moment Resisting Frame (SMRF).
- Soil type: Type 2 (medium soil).
- Importance factor: 1.

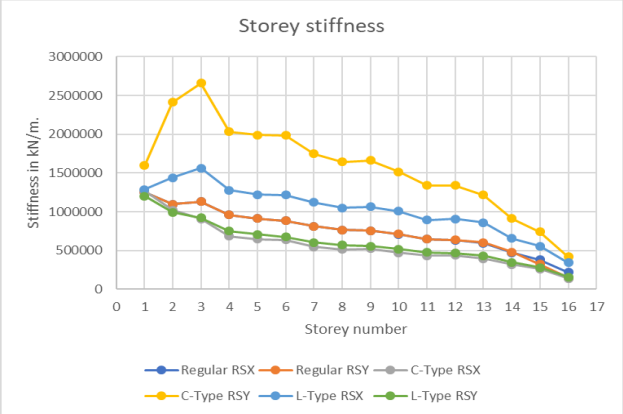
3. RESULTS

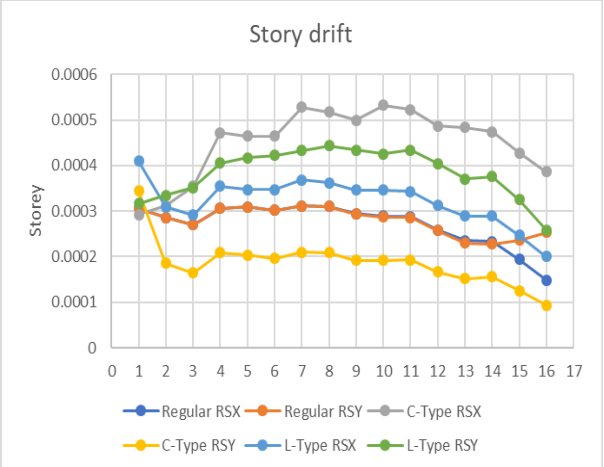
The results obtained are shown below in form of graphical representation.

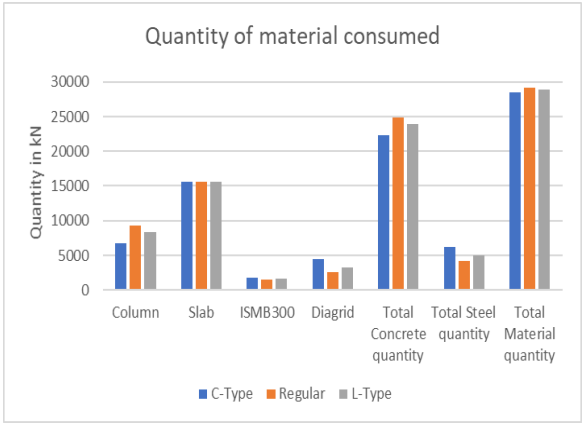












3. CONCLUSIONS

- Considering base shear L-Type diagrid structure is best suited.
- Considering top storey shear C-Type diagrid is better choice.
- Considering top storey displacement, L-Type diagrid structure is more efficient.
- Considering time period, both structure perform in similar way.
- Considering storey stiffness, L-Type diagrid structure is more efficient than C-Type structure.
- Considering storey drift, L-Type diagrid structure.
- Quantity of material consumed is least for C-Type diagrid structure.
- Overall performance of L-Type diagrid structure is more efficient.

REFERENCES

[1] R.Khan, S.Shinde (2013) "Analysis of diagrids using symmetric and asymmetric plan geometry". ISSN(online): 2437-2812, volume-4,Issue-3,2016.

[2] Harshita T, Dr.Sarita Singla " DIAGRID STRUCTURAL SYSTEM FOR R.C.FRAMED MULTISTORIED BUILDINGS". International Journal of Scientific and Engineering Research, volume 7, Issue 6, June-2016.

[3] Nishith.B.P, Vinubhai.R.P, "DIAGRID STRUCURAL SYSTEM: STRATEGIES TO REDUCE LATERAL FORCES ON HIGH-RISE BUILDINGS", IJRET: International Journal of Research in Engineering and Technology, volume-3, Issue:4, April 2014.

[4] Giovanni M, Elena M, Guiseppe B, Antonello L, "Geometrical Patterns for Diagrid Buildings: Exploring Alternative Design Strategies from Structural Point of View", ELSEVIER, volume-4, Issue:3, April 2014.

[5] Femy, Mariya, Thomas, Binu Issae, Jessymol G, "Performance Evaluation of Tall Buildings with Steel Diagrid System", 2nd International Conference on Science, Technology and Management, University of Delhi, Conference center, New Delhi(India) September 2015.

[6] Pallavi B, P Salunke, "Analytical Study and Design of Diagrid Building and comparison woth conventional frame building", International Journal of Advanced Technology in Engineering and Sience, Vol No.4, Issue No.01, January 2016.

[7] Shah, M.Mevada, S.V.Patel,"Comparative study of diagrid structures with conventional frame structures", Int. Journal of Engineering Research and Application, Vol 6, Issue 5(part2) ISSN 2248-9622, May 2016.

[8] Rohit, K.Vovek, S. Garg." Analysis and design of concrete diagrid building and its comparison with conventional frame building:, International Journal of Science, Engineering and Technology, Vol 6, ISSN 2348-4098, August 2014.

[9] Kyoung Sun Moon " Comparative efficiency of structural system for steel tall buildings" ISSN: 2093-761X (Print) 2093-7628 (Online) Journal, Sep 2014.