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# A REVIEW ON ANALYSIS OF DIFFERENT GEOMETRICAL PATTERNS FOR DIAGRID STRUCTURE

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**Abstract**—*The evolution of tall building structural systems based on new structural concepts with newly developed high strength materials and newly construction methods have been towards become a structure system stiffer and lighter. Structure design of high rise buildings is governed by lateral loads like to wind or earthquake. Lateral load resistance of structure is provided in interior structural system or exterior structural system. All lateral loads are act as axial action on inclined column. This paper contain, various Storeys like G+36, G+48 and G+60analysis of various geometry patterns of diagrid structure under different parameters like base shear, model time period, storey drift, story displacement, structural weight and economy of building.*

***Keywords***-*Diagrid Structural System, High-Rise Building, Storey Drift, Top-Storey Displacement, time period, lateral loads.*

## I. INTRODUCTION

Growth of urban population is increase with respect to construction land. So now a days high rise buildings are very popular for urban development. When height of structure is increase then lateral load consideration is very much important. There are many lateral load resisting systems are used in rigid frame, braced tube system, shear wall, outrigger system, tube-in-tube system, etc. earlier tall buildings was constructed with conventional steel frames with wind bracing to resist lateral loads. Fasul khan was proposed concept of "premium of height", means taller building. Due to "premium of height" lateral loads on building is increase with respect to height. As per solution of that problem, if rigid frame used for tal building then column size is decrease as per height is increase. Due to that gravity load is increase and weight of building also increasing. So to decrease gravity load and increase a structural efficiency diagrid structure are aesthetic trend for tall building.

Now a day the diagrid structure (diagonal grid structure) is widely used in high rise buildings. Diagrid structure are very popular in architectures and structure designers because for architectures diagrid structure is gives aesthetic view and for structure engineers, it is useful for resist lateral load and increase efficient of structure. Diagrid structure is very popular for Tall buildings to resist lateral loads like wind and earthquake load. Lateral load resistance by interior system or exterior system. In which shear wall core and braced frame are interior system and frame tube, tube in tube, outer periphery bracings are exterior system. In diagrid building vertical columns are eliminate. Because diagonal member are carry gravity load as well as lateral load.

In normal steel conventional building vertical columns are there for load transfer mechanism and in diagrid structure there are inclined columns at exterior side of building for load transfer.Column has a more capacity to resist axial load with respect to incline load. So Due to incline column lateral loads are act as axial load. So lateral load resist capacity become batter in incline column. A major reason for diagrid craze is structural efficiency and economy. There are many diagrid geometry patterns are available, all that patterns are stiffer and efficient in different parameters like time-history analysis, top drift analysis, stiffness of structure, lateral load resistance capacity, weight, economical and high strength. So analysis and design of all that geometrical patterns of diagrid structure and get that which geometry patterns are perform best in particular parameters.

 

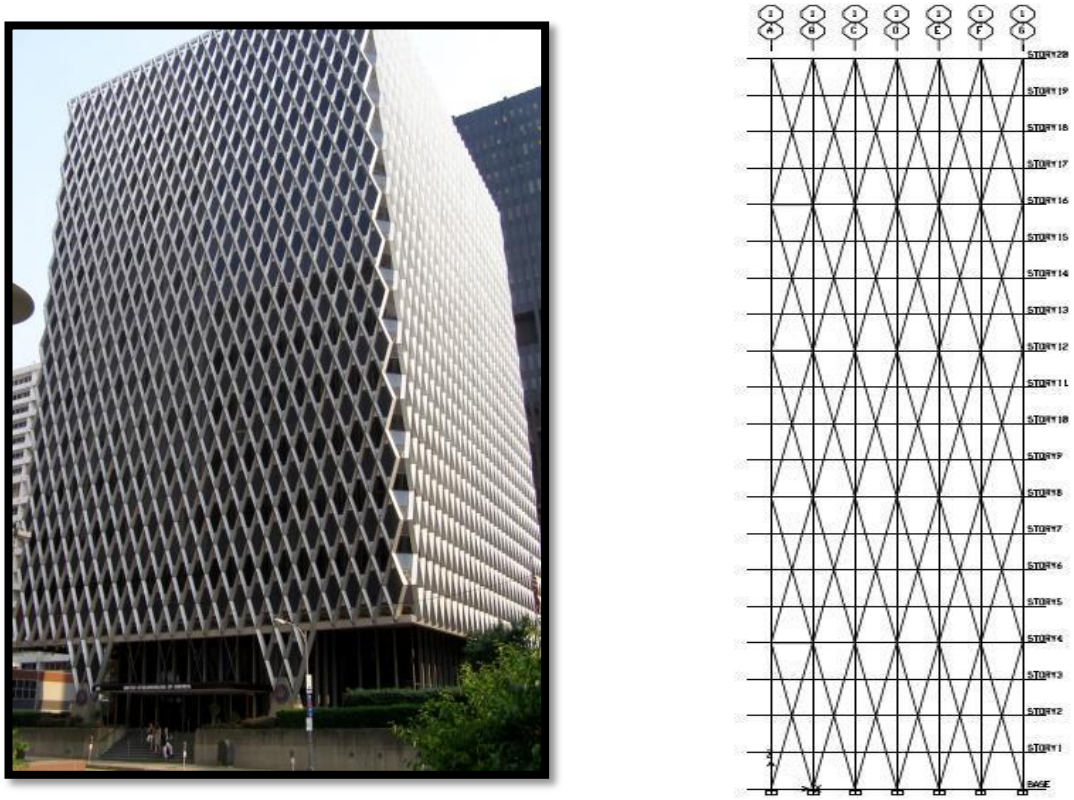

*Figure.1: layout of typical diagrid structure*

## II. LITERATURE REVIEW

### A. Analysis and Design of Diagrid Structural System for High Rise Steel Buildings, Procedia Engineering 51 ( 2013 ) 92 – 100

**KhushbuJani ,Paresh V. Patel,**Diagrid are used for tall structure due to structural flexibility and stiffness. In which they was compared vertical column in frame tube and inclined column for exterior surface of diagrid surface. Diagrid structure generally do not required for core because lateral shear can be carried by diagonals on periphery of building. In which they was analysis and designed of 36 storied building. There was regular floor plan of 36m x 36m size and Etabs software used for modeling and design.Design was done as per is-800:2007 with all load combination. Analysis and design was considered along wind and across wind for 50,60,70,80 story diagrid structure. The angle of inclination was uniform in diagrid structure through all height. Inclined column are provide 6m spacing along perimeter. In which interior frame was designed as only gravity load. the dynamic loading of wind was computes as per IS-875 (part3) and parameters of earthquake design was computed based IS-1893:2002. The analysis and design was done with Etabs software and analysis result shows various parameters like time history analysis, story drift, structural weight, interior story drift.

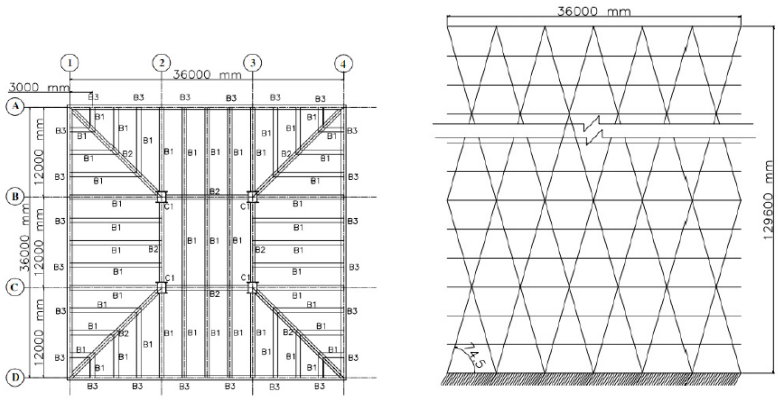


*Figure.2: Typical Floor Plan and Elevation of 36 Storey Buildings.*

 

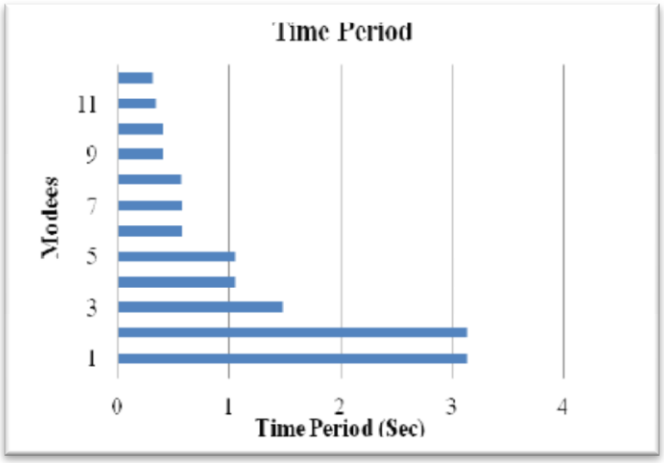


***Figure.3: Time period of 36 storeydiagrid structural system***

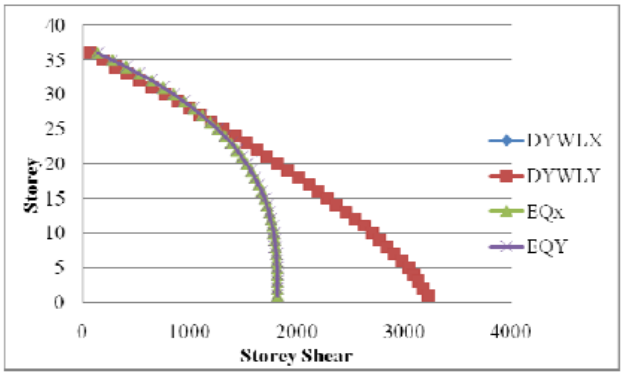


***Figure.4: Storey shear of 36 storeydiagrid structural system***

**B. Secondary bracing systems for diagrid structures in tall buildings Engineering Structures 75 (2014) 477–488. Giovanni Maria Montuori , Elena Mele, Giuseppe Brandonisio, Antonello De Luca**, In this literature they was design diagrid tall building with present methodology. They was provided secondary bracing system(SBS) for diagrid geometry and applied to 90 story tall building.in which they was compared with SBSdiagrid structure and without SBC structure diagrid . As per structure weight is increased 3% due to use of SBS. Also a elastic analysis is shows that with SBS diagrid structure is more stable against without SBC structure diagrid. In some diagrid patterns spacing along incline column is more so vertical truss are provide at panel point or diagrid nodes. There was 90 story building with different diagonal geometry. So here 3 diagonal angular patterns with angle of 60, 70 and 90. Here analysis of structure was done in etabs software. Here elastic analysis of structure was compared and as per result with SBS structure is stiffer then without SBS. Structural weight was increase much more but SBS structure is more efficient in lateral load resistance.

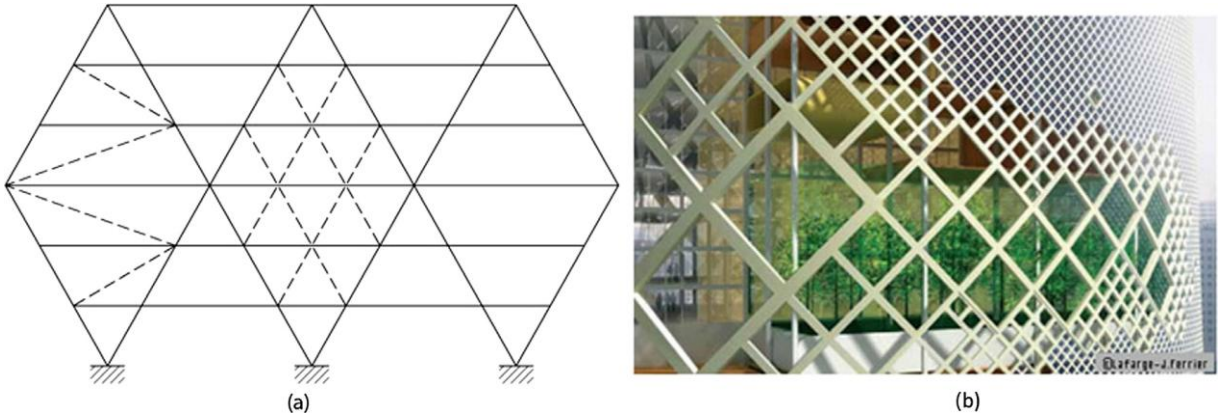


*Figure.5: Secondary Bracing System in diagrid*

 

**C. Geometrical patterns for diagrid buildings: Exploring alternative design strategies from the structural point of view, Engineering Structures 71 (2014) 112–127**

**Giovanni Maria Montuori , Elena Mele, Giuseppe Brandonisio, Antonello De Luca**In this literature they was provided different diagrid geometry configuration for 90 story building. They was evaluate diagrid structure under wind loads, gravity loads and various performing parameters. Comparison in terms of structure weight and efficiency for different patterns. Here tall building model has different diagrid patterns. The building was 90 storey with square plae 53m X 53m with central core 25.4m X 25.4m and height of building was 351m with 3.9m floor height. There was various loads applied like dead load, love load and also a lateral load like wind load and earthquake load as per ASCE-07 provision. Here composite steel deck of 110mm thickness was provided. For diagrid steel box sections was adopted. There was different strategies had adopted for generating model. Strategy 1: regular diagrid have 3 patterns with constant angle and variation of height of 60,70 and 80m. Strategy 2: three patterns with various angle and constant height. Strategy 3: constant angle but variable size along height. Then analysis of that all patterns with various patterns like steel weight, lateral drift, stiffness etc.

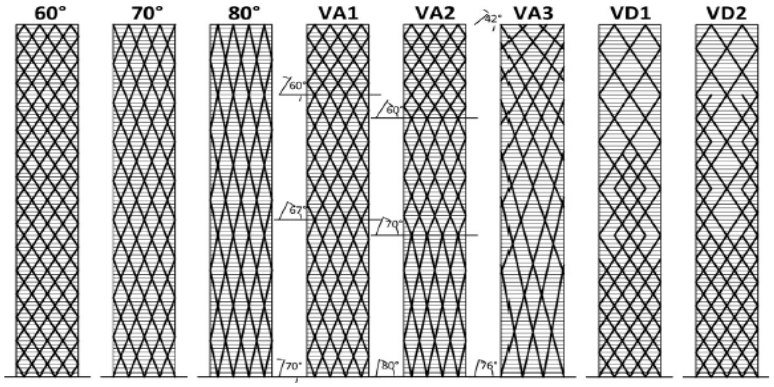


***Figure:6: different geometry patterns of diagrid structure***

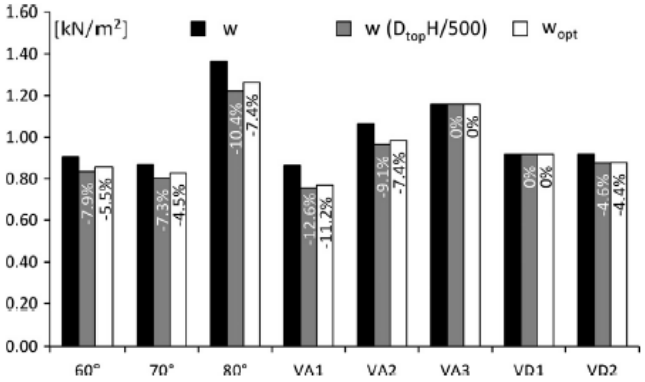


***Figure:7: Comparison between unit steel weight of diagrid patterns***

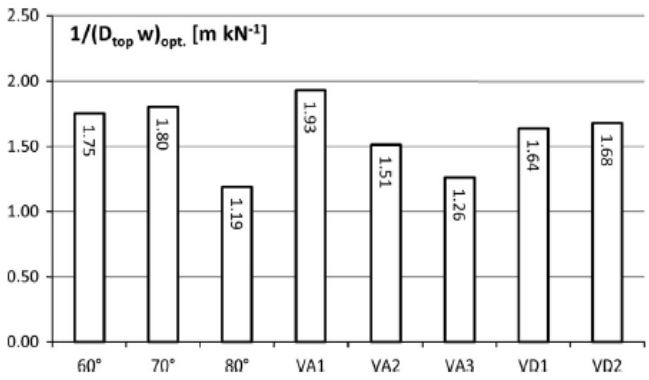


***Figure:8: top storey data of different diagrid patterns***

 

**D. Analysis and comparison of diagrid and conventional structural system, Volume: 02 Issue: 03 |June -2015, e-ISSN: 2395-0056, p-ISSN: 2395-0072**

**Raghunath .D. Deshpande, Sadanand M. Patil, SubramanyaRatan,** In that literature they was done structure design of tall building which was governed by horizontal forces due to earthquake and wind load. They was study exterior and interior frame system. Usually braced frame, shear wall core and their combination was used in internal frame system and for external system diagrid structure was used. Due to diagrid structure system flexibility was increase in flore area. Here inclined column was provided and vertical column was avoided. Diagrid structure was don not provide in core of building because lateral load was impacted at outer side of building. Here analysis and design of 60 story diagrid steel structure was presented. Rectangular floor plan of 24m X 24m size was considered. Etabs software was used for modelling and analysis of structural member. Design was done as per IS-800:2007 consideration for all load combination. Dynamic wind load consideration as per IS-875 (part 3) and earthquake was considered as per IS-1893:2002. Here core wall dimension was 12m x 12m. Total height of building was 60 and floor slab thickness was 150m. weight of steel in tone was 15255 tone and 11247 tone in normal steel building and diagrid structure respectively. Maximum deflection was 84mm in conversional building and 75mm in diagrid building. So as per conclusion diagrid was more stiffer and flexible then convesional steel building.

**E. Diagrid structural system: strategies to reduce lateral forces on high-rise buildings, eISSN: 2319-1163 | pISSN: 2321-7308**

**Nishith B. Panchal1, Vinubhai R. Patel,** In this paper, 20 story simple building and diagrid building comparison was done. In which comparison of analysis of results in terms of top story displacement, story drift, steel and concrete consumption. There was 18m x 18m floor plan and 721m total height of the building .the story height is 3.6m. the building data was same for both the buildings. The slab thickness was 120mm and diagrid size was 300x300 mm with 78.2 angle. For simple (1)steel building column size was 450mm x 450mm. dead load and love load are as per IS -800, wind load calculation as per IS-875 (part 3) with location of vadodra and wind speed 44m/s. earth quake load as per IS -1893 2002 .with response reduction method. As per analysis total gravity load of normal steel building was 87600kn and for diagrid structure 84144kn. Earthquake reaction in steel building and diagrid building was respectively 913kn and 905kn. Wind load reaction in steel building and diagrid building was nearly same 2310kn. Story displacement in steel building and diagrid building was respectively 0.514mm and 0.354mm. The consumption of steel in steel diagrid structure was 57.9% with respect to normal steel building and for concrete it was 13.01%.

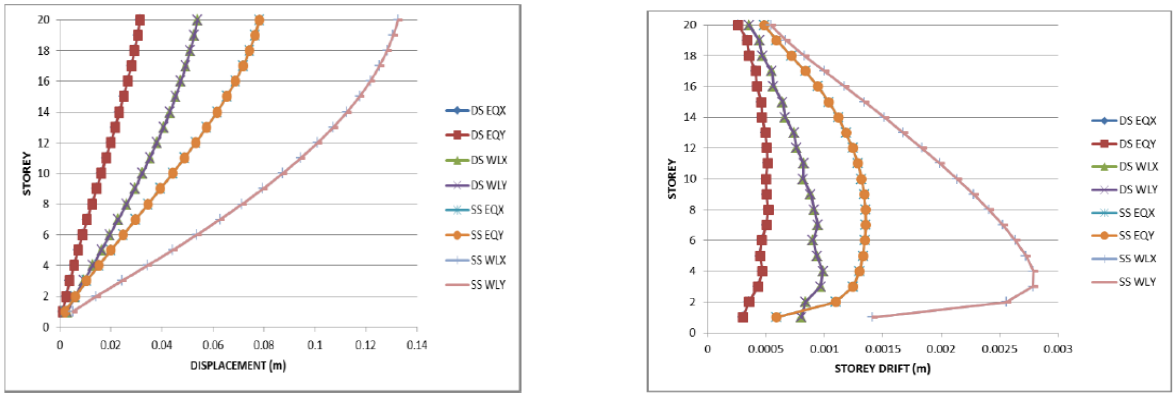


***Figure:9: storeyvs displacement and storey drift***

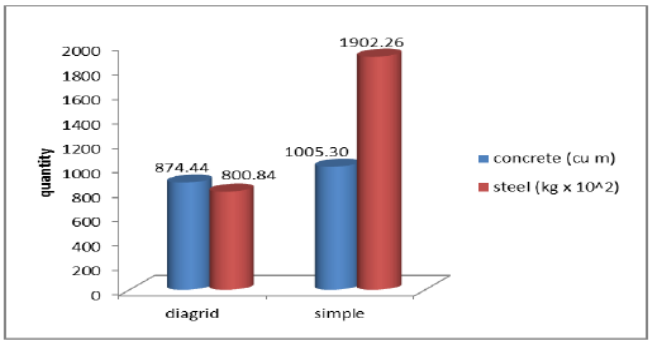


***Figure:10:quantitycomparison of steel and concrete***

## III. CONCLUSION

From the above literature we conclude that,

1. Lateral loads are resisted by diagonal columns so the top storey displacement is very much less in diagrid structure as compared to the simple frame building.
2. The storey drift and storey shear is very much less for diagrid structural system.
3. Diagrid structure system provides more economy in terms of steel and concrete as compared to simple conventional building.
4. In comparison to conventional building, diagrid buildings are more aesthetic in look and it becomes important for high rise buildings.
5. Lateral and gravity load are resisted by axial force in inclinedcolumn on periphery of structure, which make system more effective.

## IV. REFRENCES

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