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Review Paper on Comparative Analysis between Diagrid and Normal Frame Structure with Contrasting Parameters.

Sahil.M.Kaspate*(M.Tech Students, JSPM's RSCOE, Tathwade, Pune)*
Prof. J.S.Kanase*(Faculty, JSPM'S RSCOE, Tathawadw,Pune)*
Prof. Dr. Ajit Patil*(Faculty, JSPM'S RSCOE, Tathawade, Pune)*
Prof. Dr. Deepali Yerudkar*, (Faculty, JSPM'S RSCOE, Tathawade, Pune)*

ABSTRACT:*The diagrid system nowadays widely used for high rise buildings due to its structural efficiency. In present research work, steel diagrid structure at an outer portion of the building at 60 degrees having an inner core of R.C.C columns with R.C.C beam and the slab is analyzed and compared with a conventional concrete building. The diagonal member of diagrid structure transferred the lateral loads by axial action compared to bending of vertical columns in the conventional building system. A regular eleven storey RCC building with plan size 16 m × 16 m located in seismic zone V & III is considered for analysis. STAAD.Pro software is used for modeling and analysis of structural. Seismic zone is considered as per IS 1893(Part 1): 2002. The Comparison between the diagrid and conventional building analysis results presented in terms of a node to node displacement, bending moment,storey drift, shear forces, an area of reinforcement, and additionally the economical aspect.*

Key words: *soft story analysis, etabs, stadd.pro, SAP2000, time history analysis, response spectrum analysis, pushover analysis.*

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I. REVIEW OF LITERATURE:

1. ROHIT KUMAR SINGH, DR. VIVEK GARG, DR. ABHAY SHARMA (2014)

A regular five storey RCC building with plan size 15 m × 15 m located in seismic zone V is considered for analysis. STAAD.Pro software is used for modelling and analysis of structural members. All structural members are designed as per IS 456:2000 and load combinations of seismic forces are considered as per IS 1893(Part 1): 2002. Comparison of analysis results in terms of storey drift, node to node displacement, bending moment, shear forces, area of reinforcement, and also the economical aspect is presented. In diagrid structure, the major portion of lateral load is taken by external diagonal members which in turn release the lateral load in inner columns. This causes economical design of diagrid structure compared to conventional structure. Drift in diagrid building is approx. half to that obtained in conventional building. In this study, steel reinforcement used in diagrid structure is found to be 33% less compared to conventional building.

2. Avnish Kumar Rai , Rashmi Sakalle (2017)

In present research work, steel diagrid structure at an outer portion of the building at 60 degrees having an inner core of R.C.C columns with R.C.C beam and the slab is analyzed and compared with a conventional concrete building. The diagonal member of diagrid structure transferred the lateral loads by axial action compared to bending of vertical columns in the conventional building system. A regular eleven storey RCC building with plan size 16 m × 16 m located in seismic zone V & III is considered for analysis. STAAD.Pro software is used for modeling and analysis of structural. Seismic zone is considered as per IS 1893(Part 1): 2002. The Comparison between the diagrid and conventional building analysis results presented in terms of a node to node displacement, bending moment,storey drift, shear forces, an area of reinforcement, and additionally the economical aspect.

3. Dr. Rajeev Arya (2017)

Authors have analyses a G+11 storey building in different seismic zones with different types of soil using software Staad.pro V8i. Total eight cases were modelled and designed for comparison. At the end concluded that introduction of Steel diagrid members decreases the cost of same building. It was found that diagrid structure is also capable of reducing the effect of dynamic loading on building.

4. Prakyathud M.R. Suresh, N.Shashikanth (2019)

In this paper, G+ 42 storeys and G+30 storey building have been analyzed for steel and CFST material in different seismic zones with medium soil. Here, the usage of software program ETABS. 12 cases were modeled and analyzed for comparison on steel and CFST. On the quit concluded that steel diagrid found to perform better compare to CFST diagrid and it was also observed that diagrid shape is likewise able to reducing the impact of dynamic loading on constructing..

5. Aditya S. Kulkarni, Sachin P. Patil. (2021)

This research study investigates the change structural system of reinforced concrete moment resisting frame diagrid frame buildings and its comparison with different storey modules diagrid. The Diagrid system has strong structural efficiency than other systems. Diagrid structure has a unique geometric configuration used for various heights of structure. Diagrid structure has a better architectural view. A set of different building models have been developed to perform the analysis as a diagrid frame building with 4 storey, 8 storey and 12 storey level buildings has been analyzed. Nonlinear dynamic time history analysis direct integration method, using nine ground motion records.

6. Dr. Eleyan Issa Jamal Issa (2020)

In This study of the structural efficiency of form of building and geometry pattern the diagrid structure. Form-finding model will be used in the process of optimizing performances of variablesto achieve the high performance for modeling the diagrid structure.

7. Chittaranjan Nayak, SnehalWalke(2019)

This paper includes required data, model, Earthquake and Wind analysis of Braced Tube Structure and diagrid structure with Circular, Square and Rectangular plan. Then by keeping same plan area and structural data for circular, square and rectangular plan, Earthquake and Wind analysis result of both Braced Tube and Diagrid Structures is carried out and by comparing the braced tube structures results and diagrid structures results conclusions drawn from the present investigation.

8. Saurabh Babhulkar, Kuldeep R Dabhekar, S.S. Sanghai (2021)

In this investigation, seismic execution of 15-story diagrid structures with fluctuating points are assessed utilizing reaction range examination further more in request to assess the impact of diagrid center on conduct of designs. Actually diagrid essential system is gotten in tall constructions on account of its basic usefulness and versatility in plan organizing. Stood out from solidly scattered vertical areas in illustrated chamber, diagrid structure includes skewed sections outwardly surface of building. Because of slanted sections horizontal burdens are opposed by hub activity of the askew contrasted with twisting of vertical segments in customary construction. The peculiarities of the diagrid its essential lead under stacking and the arrangement and advancement of diagrid centers are portray A context oriented examination of some new diagrid tall constructions, to be explicit the Swiss Re in London , the hearst tower in New York , and the west Guangzhou Tower in china is moreover presented.

9. Ar. MeghaShroti(2017)

This paper explores the skill of diagrid structural system from the basic of materials, component of such structural system, structural behaviour of diagrid design methodology, diagrid constructability.

10. Berk Ekici, BaşakKundakçıKoyunbaba(2015)

In this study, we consider façade design as a multiobjective optimization problem, integrating diverse design criteria, namely indoor daylight distribution, structural performance and cost. We evaluate design performance by making use of simulation. Consequently, we use Differential Evolution (DE) to search for best-tradeoff solutions. We compare the performance of two DE variants, using the Hypervolume metric, and also through qualitative inspection. We report façade designs that demonstrate interesting and often unexpected features, concluding that the proposed approach may lead to a novel, more integrated design process.

11. HAN Xiaolei , HUANG Chao (2008)

In this diagrid structures have emerged as both structurally efficient and architecturally significant in tall buildings, especially super high-rise buildings with height above 150 m, such as the Swiss Re Building in London, the Hearst Headquarters in New York, the Ministry of Foreign Affairs Building in Qatar, Guangzhou West Tower (432 m), etc. The use of diagrid structures for effective lateral and torsional stiffness has generated interest from structural scholars and designers of tall buildings. Two 1/5.5-scale specimens of a CFST connection in a diagrid structure were tested under monotonic axial loading. The purpose of the study was to investigate the failure modes of the connections, to verify the ultimate capacity of the connection under axial loading, to measure the steel tube's strain distribution, the axial deformation and the lateral deflection of the specimens through the entire test procedure, and to assess the effectiveness of the connection in practical use.

12. Simos Gerasimidis , PanosPantidis , Brendan Knickle(2016)

This paper presents a simple approach on optimizing member sizes for the diagonals of steel diagrid tall buildings. The optimizing method is based on minimizing the volume of the diagonal elements of a diagrid structure. The constraints are coming from the stiffness-based design, limiting the tip deflection of the building to widely accepted regulative limits. In addition, the current paper attempts to open the discussion on the

important topic of optimization and robustness for tall buildings and also studies the future of the diagrid structural system.

13. Harshada A. Naik, Prof. S. R. Suryawanshi(2017)

In this paper presents the literature review of different authors on behavior of diagrid structures under wind loading and seismic loading to understand the performance of diagrid structures. This study gives good indications on parameters in terms of time-period, top-storey displacement, inter-storey drift and storey shear.

14. Manthan I. Shah, Snehal V. Mevada, Vishal B. Patel (2016)

In this study seven steel buildings of identical base area and loadings with different heights are designed for optimum sections for both structural systems diagrid and conventional frame in ETABS. Various parameters like fundamental time period, maximum top storey lateral displacement, maximum base shear, steel weight, percentage differences in change of steel weight, maximum storey displacement and maximum storey drift are considered in this study. A Diagrid structure performs well than conventional frame structures and increase in steel weight with increase in height of building is considerably less in diagrid structures.

15. Nishith B. Panchal, Vinubhai R. Patel (2014)

The selected structural system should be such that it should be effectively utilized for structural requirements. Recently diagrid structural system is adopted in tall buildings due to its structural efficiency and flexibility in architectural planning. Diagrid structure consists of inclined columns on the exterior surface of buildings compared to closely space vertical columns in framed tubes. The lateral loads are resisted by axial action of the diagonal. In this paper, the comparison study of 20-storey simple frame building and diagrid structural system building is presented here. The comparison of analysis of results in terms of top storey displacement, storey drift, steel and concrete consumption is presented here..

16. Khushbu Jani, Paresh V. Patel (2013)

diagrid structural system is adopted in tall buildings due to its structural efficiency and flexibility in architectural planning. Compared to closely spaced vertical columns in framed tube, diagrid structure consists of inclined columns on the exterior surface of building. Due to inclined columns lateral loads are resisted by axial action of the diagonal compared to bending of vertical columns in framed tube structure. Diagrid structures generally do not require core because lateral shear can be carried by the diagonals on the periphery of building. Analysis and design of 36 storey diagrid steel building is presented. A regular floor plan of 36 m × 36 m size is considered. ETABS software is used for modeling and analysis of structural members. All structural members are designed as per IS 800:2007 considering all load combinations. Dynamic along wind and across wind are considered for analysis and design of the structure. Load distribution in diagrid system is also studied for 36 storey building. Similarly, analysis and design of 50, 60, 70 and 80 storey diagrid structures is carried out. Comparison of analysis results in terms of time period, top storey displacement and inter-storey drift is presented in this paper.

17. Neha Tirkey, G.B. Ramesh Kumar (2019)

study on diagonal perimeter often known as the diagrid structure using software ETABS (Extended Three Dimensional Analysis of Building System). The diagrid structure has emerged into an innovative method in the recent construction field and has led to the advancement of tall buildings and high rise structures not only in the engineering field but also in the architectural field. It has also made the structure stiffer and lighter when compared to the normal conventional buildings. The diagrid structure is designed, analyzed and is compared with the conventional building using ETABS software mainly focusing on seismic and wind analysis parameters. As per IS 456:2000 and the Linear Static Method all the structural members of the diagrid model are designed and IS 1893 (PART 1): 2002 is considered for load combination of seismic analysis.

18. Raghunath .D. Deshpande1 , Sadanand M. Patil2 , Subramanya Ratan (2015)

Advances in materials, construction technology, analytical methods and structural systems for analysis and design initiated development of tall Structures. Structural design for tall structures is governed by horizontal forces due to earthquake and wind load. Lateral load is resisted by exterior structural system or interior structural system. Usually braced frame, shear wall core and their combination with frames are interior system, where lateral force is resisted by centrally located elements.Diagrid structural systemis adopted in tall Structures due to its flexibility in floor area and structural. Diagrid consists of inclined columns on the façade. Due to inclined columns lateral loads are resisted by axial action of the diagonal compared to bending of vertical columns in framed tube structure. Diagrid structures generally do not require core because lateral shear can be carried by the diagonals on the periphery of building. Analysis and design of 60 storey diagrid steel building is presented. A regular floor plan of 24 m × 24 m size is considered. ETABS software is used for modeling and analysis of structural members. All structural members are designed as per IS 800:2007 considering all load combinations. Dynamic along wind and across wind are considered for analysis and design of the structure. Later both Conventional and Diagrid Structural Systems are compared.

19. Dejing Chen, XiaoxiongZha, Peichang Xu(2020)

This paper proposes a novel method for strengthening the weak part of the CFST x-column. Axial compression tests are designed and conducted on three through-type and three reinforcedtype CFST x-column specimens. The load-bearing process, failure mode, and load-deformation curve of CFST x-columns are recorded during these tests and analysed in detail. The experimental results show that the stiffness of the reinforced-type x-column is greater than that of the through-type x-column, and its peak bearing capacity is approximately 1.85 times that of the through-type x-column. Moreover, better ductility performance is observed in reinforced-type x-columns. Further, a corresponding finite element model (FEM) is established to simulate the entire loading process during axial compression of CFST x-columns. A parametric study on possible parameters affecting specimen loading behaviours is also conducted. Ultimately, theoretical investigations on CFST x-columns are presented, and formulae for calculating the load-bearing capacity of through-type and reinforced-type CFST x-columns under axial compression are proposed.

20. Harshita Tripathi, Dr. Sarita Singla (2016)

This paper presents a stiffnessbased design methodology for determining preliminary member sizes of r.c.c diagrid structures for tall buildings. The methodology is applied to diagrids of various heights and grid geometries to determine the optimal grid configuration of the diagrid structure within a certain height range. A regular floor plan of 36 m × 36 m size is considered for the structures. ETABS 2015 software is used for modelling, analysis and design of structural members. All structural members are designed as per IS 456:2000 and load combinations of seismic forces are considered as per IS 1893(Part1):2002 considering all load combinations. Dynamic along wind and across wind are considered for analysis of the structure as per IS 875-1987 (part 3). The design methodology is applied to a set of diagrid structures which consist of 24, 36, 48 stories. Dynamic Analysis of 24, 36 and 48 story building with perimeter diagrid with different story module is carried out by Response spectrum method. The comparison of analysis of results in terms of top story displacement, story drift, story shear, time period, angle of diagrid, spectral acceleration coefficients, base reactions for seismic and wind forces is done with in the same story height for different story modules and for different story heights.

II. Conclusion:

1. it is perceived that due to diagonal columns at the outer periphery of the structures, the diagrid structure is more effectivelyresist the lateral load. Due to this property of diagrid structure, the interior column is used of smaller size for gravity load resistance and only small quantity of lateral load is considered for it. While in conventional frame building, both gravity and the lateral load is restricted by both exterior and interior columns. The following points are concluded from above study about diagrid structure • Study shows that diagrid structure decreases bending moment which in results decreases reinforcement requirement. • It shows that lateral displacement in tall structures can be minimized by using diagrids

2. it is shown that by providing diagonal columns at the outer periphery of the structures, the composite diagrid structure is more effectively resist the lateral load in comparison with the bare frame structure. By providing the concept of a diagonal column at the outer periphery of the structure the column at the interior part of the structure is used for resisting very small gravity load and a little amount of lateral load whereas in bare frame structure gravity load and lateral load are transferred by both interior as well as exterior column. Due to this phenomenon of replacing vertical column at an outer periphery of the bare frame structure, there is a huge reduction of concrete in the diagrid structure while the steel may vary on bases of conditions but due to the reduction of concrete in huge percentage stills make the diagrid structure more economical than the bare frame structure. The different points concluded from the above study:-

- The composite diagrid frame providing in zone V with soft soil condition is 32.82% more economical than the bare frame structure as in this case both steel and concrete are reduced in composite diagrid frame as the provided adequate section for beam and column is much smaller.
- Due to the change of soil condition from soft soil to a hard soil in zone V the steel in composite diagrid frame slightly increases with 6.82% while on the same place the concrete is reduced with 63.13% so overall it makes the diagrid frame 22.06% more economical in this case.
- In zone III with soft soil condition the steel increases in composite diagrid frame with 17.45% while concrete reduces with 54.42% so this makes diagrid frame 11.58% more economical.
- In zone III with hard soil condition the steel increases in diagrid frame 32.41% while still the concrete is reduced by 57.35% in comparison with the bare frame which makes diagrid 3.02% more economical

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