

## REVIW PAPER ON COMPARATIVE INVESTIGATION OF CONVENTIONAL FRAME, CHEVRON BRACED FRAME AND DIAGRID FRAME WITH PLAN IRREGULARITY

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DOI: <https://www.doi.org/10.58257/IJPREMS38251>

### ABSTRACT

The origin of the diagrid structural technology lies at the crossroads of engineering and architecture. The diagrid structural system is adopted these days for tall buildings because of its stiffness and flexibility in the architectural planning and civil engineer programming. This Dissertation paper represents the study of G+31 storey in which diagrid structure is compared with chevron braced frame structure and comparing with conventional frame structure under their dynamic loadings. The building is considered to be irregular plan of RC building for irregular plan, C-shape Plan, T-shape Plan and L-shape Plan considered. The analysis is done on by using STAAD-PRO software. Study develops a comparison on some prime parameters namely Lateral displacement, story drift, base shear, time period, etc.

**Keywords:** Diagrid frame system, chevron frame system, conventional Frame system, plan Irregularity.

### 1. INTRODUCTION

In the today's latest generation, the rate of population is increased day by day, Due to this space required for land is insufficient So, civil engineer constructs a building in sufficient space with maximum height with regular and irregular plan of their structure. In old days, these high-rise buildings only use for a commercial purpose it is used for both commercial and residential purpose due to lack of space. For safety strength and aesthetical point of view structural engineer and architect construct a high-rise building. Wind and earthquake loads must be taken into account when designing high-rise structures since the structural system must with stand these lateral loads. In this Project we compared three lateral load resisting frames with their plan irregularity that is diagrid frame and chevron braced frame with conventional frame system. The seismic analysis and wind loading analysis is done on these three frames. The structures are analyzed by Response Spectrum method and building is considered to be irregular in plan.

For irregular plan C-Shape plan, T-Shape plan, and L-Shape plan separately and after that second overall comparison is between C-Plan, T-Plan and L-Plan. The analysis is done by using STAAD-PRO software. In this thesis analysis of a G+31 storey building with their different frame and irregular plans.

### 2. LITERATURE REVIEW

**Manthan I. Shah & Snehal v. Meveda & Vishal B. Patel [1] (2016)** have carried out study, and compare the performance of Diagrid structural system and chevron braced frame by using Staad pro software. To analyses the stability of structure in seismic zone according to comparison between bending moment diagram, shear force variation and the STAAD-PRO software is used to develop 3D rendering modelling and to carry out the analysis the models and comparing the both diagrid, conventional, chevron structure by using STAAD-PRO software.

The lateral loads such as earthquake loads wind loads to be applied on the buildings are based on the Indian standards. On this paper study on performed for seismic zone –IV (Delhi) as per IS 1893:2002 (Earthquake load). The models of Diagrid frame, chevron braced and conventional frame for C-Type and T-type is analyse by Equivalent static analysis (linear static response method). Analysis has been performed as per IS 1893 (part-1) 2002 for each model using STADD Pro V8i (computer and structures) software. Displacements are found out and inter storey drift, comparison between Diagrid model, chevron braced and conventional model for C-Type and T-Type done separately by using different types of parameters. Earthquake Load case calculation according to is code and its distribution along the height of building is done and the seismic weight is calculated using full dead load of structure plus 25% of live load are calculated and there are different parameters such as stiffness, axial force, drift, shear force and bending moment are studied for all the model used.

**Navneet Kumar & M. C. Paliwal [2] (2017)** A presentation is provided on the comparative analysis of Diagrid and Chevron Braced frame Structure under Dynamic Loadings and analysis and the design of diagrid node connections and its effect on overall economy of building can be studied, Different building shape like spherical, hexagonal can also be considered. The model of building represents the study of G+ 29 storeys in which Diagrid structure is compared with chevron braced frame structure under dynamic loadings. A diagrid's module has a diamond shape and described into

four different groups including small modules for (2-4 stories), mid-size modules for (6-8 stories), large modules for (more than 10 stories) and irregular modules. The analysis of a G+29 storey diagrid and chevron braced frame model is analysed by using STAAD.pro V8i software. Both models with 24X24m plan dimension, and 3m height of each storey is taken and the seismic effects on the buildings are taken as zone factor 0.1, soil type II, Importance factor 1.5, Response Reduction 5 and Damping ratio 5% as per IS-1893-2002. For Bhopal location. The wind loads coefficients are taken for Bhopal location, the basic wind speed 39 m/s, Terrain category 3, Structure class C, Risk Coefficient K1 1.06, Topography Factor K3. That all required data taken and comparative analysis results of both structures in different aspects of suitable design lateral load, wind load and earthquake load whichever will be greater than it is further analysed for lateral displacement.

**Prof. Girish Sawai & Priya Uikey [3] (2022)** Analysis of Conventional Chevron Braced Frame and Diagrid Frame with Plan Irregularity the diagrid from various perspectives its performance across multiple building level. In this study six models are considered with C-Type plan and T-type plan layout. For C-Type layout, model is dividing into three part and for T-type, model is also dividing into 3 parts, in their there are total 6 models named as C-1, C-2, C-3, T-1, T-2, T-3. The models are analyzed by using STAAD Software. The height building is considered to be 30m. The building is divided into 10 storeys. Each storey has 3m height. The span between column to column is 3m. The size of column considers to be 450 mm by 450 mm. The First Comparison is between diagrid system, chevron braced system and conventional frame system for C-Type and T-Plan separately and after that second overall comparison is between C-Plan and T- plan. The analysis is done on by using STAAD Software.

In c-plan structure, for base shear, diagrid structure is 7.20% effective than chevron braced structure and 8.38% effective than conventional frame structure. In c-plan structure, Storey drift and displacements structure on each storey in diagrid are observed to be less in diagrid structure as compared to chevron braced system and simple conventional frame system. The value of storey drift is observed to be in limit  $0.004xh$  where h is storey height.

A significant decrease of bending moment, shear force and axial force in interior column of diagrid building is found in comparison to conventional building and chevron braced building.

**Priyanka Panwar and Anubhav Rai [4] (2023)** The objective is to be conduct a consider G+3, G+11 and G+19 storey Reinforced concrete buildings with plan size 15 m x15 m located different types of zones II and III for analysis their it is concluded that displacement is less in zone 2 and zone 3 in the diagrid building. The diagrid structure is stiffer, and they displace less as compared to a conventional building as compare to diagrid building. Storey drift is found less in zone 2 which means relative displacement between two floors is also less than zone 3 more stability. Due to a smaller number of columns, ETABS 17 software is used for the study of structural members. The compares maximum storey displacement, maximum storey drift, storey stiffness, shear force and bending moment with different result both. Lateral loads in diagrid buildings are resisted by inclined members which are placed at the exterior of the building. The concrete diagrid structure is analysed and compared with the conventional concrete building according to earthquake conditions. The detection of element damages in the

semi-rigid connected structures is outlined. The diagrid structure is stiffer, and they displace less as compared to a conventional building.

**Mr. Dheekshith K & Ms. Durga & Mr. Bhavani Shankar [5] (2020)** The individual has conducted an evaluation and contrast of data. The study involved the modelling, analysis, and comparative study of regular and irregular plan geometric diagrid structure on varying soil stratum under lateral loading using E-Tabs (2017) software.

The design and analysis of a G+16 storey diagrid structural system with a plan of 21x21m. An carrying geometric irregularity and symmetry, designed on varying soil stratum namely hard soil, medium soil and soft soil for regular and irregular plan. Additionally, the regulation of lateral force is also established. Soil type structure due to the fact that structures when subjected to numerous earthquake forces, they behave distinctly with change in soil type that's hard and soft soil. based on the quantitative analysis conducted in the current research endeavour, the following primary deductions can be made the diagrid structural system is a superior option for resisting lateral loads due to its ability to minimize lateral displacements, reduce steel weight, and increase stiffness. irregularity's most of all structures relies on structural configuration and its geometry depends structural soil RC building. In a 16-story building, the weight of a diagrid frame is calculated by lateral forces on soil calculated in E-Tabs software.

**Robin Singh and Barkha Verma [6] (2022)** The objective is to conduct a to enhance the structural performance of tall structures in both lateral and gravity loads, various structural systems comparative study of the seismic performance of Tubular Frame, Diagrid, Pentagrid, and Hexagrid structural systems using ETABS software.

The aims to perform a seismic analysis using the response spectrum method on a multistorey steel tube building with various structural systems, which include tubular frame, diagrid, pentagrid, and hexagrid all types of

structural frame. The ETABS V.19 is used to design and analyse steel tube buildings for seismic load performance. Models for seismic zone-V for tubular frame, diagrid, pentagrid, and hexagrid are compared for result parameters which include storey displacement, storey drift, and storey shear. The horizontal pentagrid structure was more irregular than the diagrid structures hence the structural behaviour increases in storey displacement and storey drift after switching from a horizontal to a vertical orientation, while it reduces in storey shear. While the tubular frame structure showed minimum structural behaviour other than diagrid, pentagrid, and hexagrid.

**Shehata E. Abdel Raheem and Momen M. M. Ahmed and Mohamed M. Ahmed and Aly G. A. Abdel-shafy [7] (2018)** The evaluation of plan configuration irregularity effects on seismic response demands of L-shaped MRF buildings. To investigate structural seismic response demands for the class of L-shaped MRF buildings through evaluating the plan configuration irregularity of re-entrant corners and lateral-torsion coupling effects on measured seismic response demands on the L- plan. overturning moment, bending moment, torsion moment at the base and over building height, and torsional irregularity ratio three-dimensional finite element model for nine stories symmetric buildings as reference model is developed G+8. In addition, six L-shaped building models are formulated with gradual reduction in the plan of the reference building model. The study yielded the following conclusion, The seismic response demands due to lateral bending torsional coupled behaviour and stress concentration. In the plan irregular building the torsion phenomenon can induce additional force demand in structural elements of L plan type building that the outer perimeter of the building hence the class of L-shaped buildings through evaluating the plan configuration irregularity of re-entrant corners.

**Yash Chhatani and Dr. Prashant Y Pawade & Dr. Kuldeep R Dabhekar & Dr. Isha P Khedikar [8] (2021)**

The study examined various n Seismic Performance of L-Shaped building through plan Irregularities different type of plan on L shaped building. Analysis shall be done through a comparable static horizontal power technique and reaction range examination that is dynamic investigation. The basic reactions will estimate regarding story displacement, inter-story drift ratio, torsional irregularity ratio, torsional diaphragm rotation, normalized base shear force, and overturning moment, which are also called seismic response demands it also called earthquake demand, The structure will be analysed and compare with different types of other shape plan required to make sure that the designing the L-Shaped building in high seismic prone areas are really safe as per earthquake point of view and its safe from earthquake loads. The output is expressed in terms of displacement. It has been observed from almost all literature review the building structures are L shaped seems to give better results if the code provisions are sufficient. Hence, finally from the study it can be concluded that as far as possible, the designer should take all the specialized viewpoints to make the structure seismic tremor resistant and safe from seismic loads.

**Kumar Saurabh Vikesh Kumar Mewada [9] (2022)** The studies of Comparative analysis of steel diagrid building and conventional building for different factors. A regular G+15 storey steel building consider with a plan size of 18 m x 18 m, located in a seismic zone V is analysed and designed by STAAD Pro Software. The structural response of conventional and diagrid building is investigated to evaluate the structural benefits of diagrid system and conventional building after all comparatives that's conclude which structure is best of RC building. According to the seismic forces are considered as per Indian codal provision for earthquake resistant design of structure IS Code (IS 800:2007) for construction steel. The creation of highly advanced structural systems with aesthetic look expression, structural efficiency, and, most importantly, geometric versatility is required for the design and construction of artificial infrastructure based on biomimetic principles are important factors. an its conclude that the Diagrids, the most recent tubular structural mutation exhibit the best mix of the above features. Then the diagrid with its ideal combination of artistic expression, structural efficiency, and geometric diversity, is the modern builder's language used. There are a number of engineering reasons why a diagrid should be used other than conventional building structure.

**Reshma Shaji & Dona Sunny [10] (2022)** A presentation is provided on that topic Analysis of Diagrid structures and Bare Frame Structures using E-TABS and Comparing Symmetric and Asymmetric Plan of both frame diagrid and bare frame. The utilization of diagrid structural system exhibits reduced lateral displacement and drift as compared to bare building structures. Design the G+10 stories located over a medium soil is focused for comparing of both structures. In the symmetric building five bays are kept along both direction while in the Asymmetric building, 5 bays are along Y direction and 4 bays along X direction. Zone V is analysed for considering and resist from earthquake loads on structure that's consider zone V and the response using E - TABS 2016 software.

Framing Building without any load resisting system shows highest drift on conventional frame structure / bare frame building, when compared to diagrid system. They give sufficient efficiency to lateral loads considering the fact that all vertical columns have been eliminated as compared to the bare frame. The diagrid structural system exhibits superior lateral load resistance as a result of its diagonal columns of building situated on the periphery.

In traditional construction, the inner and outer columns are engineered to withstand both vertical and horizontal forces. Then the conclude that's the diagrid building frame structure give more aesthetic look and gives more interior space due to less columns and façade of the building can also be planned more efficiently. Diagrid buildings exhibit superior aesthetic when compared to traditional buildings making them a crucial for high-rise structures.

**Rohan Singh & Prof Rakesh Kumar Grover [11] (2024)** I have conducted an analysis and design on diagrid structures building and conventional building for a seismic loading. To investigate the high-level (G+10) structure reinforced concrete building of the earth considering seismic load, dead load and live loads, by using E-TABS software. ETABS covers all aspects of the engineering design process which required for structure, the most effective results are advanced elements like beams and columns in multi-storied R.C buildings used. The axial load experienced by an internal column is comparatively lower in a diagrid building when compared to a conventional building. The diagonal grid structural system exhibits a lower shear force in the interior beam when compared to a conventional building. This software is mainly used for tall buildings structures like concrete and steel high – rise building structure. In the conventional building of G+10 found static (99.99%) and dynamic (98.87%) acceleration times in the UX direction its concluded on its and the diagrid structure more effective increase percentage as compared to conventional building frame structures. Static and acceleration performance the diagrid structure best suitable compared to conventional structure frame structure.

**Mohammed Touseef & Prof. Amaresh Patil [12] (2023)** The behaviour of seismic forces on bare frame, braced frame and diagrid frame with varying different angles with symmetric plan of 24x24m. The G+15 storey is investigated in which 6 models are prepared out of which one is bare frame, one is braced frame and rest of 4 models are diagrid angles, by using ETABS software. The equivalent static and time history analysis method is carried out in terms of displacement, storey drift ratio, base shear and time period using ETABS 2020 software. Time period and to check which structural system is efficient. Total 6 models are prepared, out of which one is bare frame and one is brace frame and others are 4 different models with different angle of diagrid building structure. It is concluded on from the diagrid model 5 of angle 64.880 and model 4 of angle 57.990 is best suitable for particular displacement and story drift ratio case. This analytical study concludes that the diagrid structural system has greater capacity resisting seismic forces compare to bare frame and bracing structural system.

### 3. CONCLUSION

The literature review presented above demonstrates a comparative analysis of diagrid structure models with chevron braced frame model and conventional frame models. Different type of structural irregularities plan are taken into account while considering various angles of diagrid and various earthquake zone and soil and different types of angles. The utilization of various software programs of that's structure such as STAAD Pro, ETABS, and SAP2000 is necessary for conducting response spectrum method, time history, and story displacement, etc Based on the findings of the literature review, it can be inferred that the diagrid structure best structure greater stiffness in comparison to the conventional model.

- The diagrid structural system exhibits higher resistance to lateral loads in comparison to the braced frame structural system and conventional frame structural system.
- The optimal angle varies in relation to the height of the diagrid structure depends on storey of building structure.

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