Study & Analysis of Diagrid Structures with Conventional Frame Structures

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Abstract -The structure is the backbone of building. Construction of the multi-storey building is quickly increasing throughout the globe. Advances in construction technology, materials, structural systems, and analysis and design software package expedited the expansion of those buildings. Diagrid buildings square measure rising as structurally economical furthermore as architecturally important assemblies for tall buildings. The diagrid structural system may be outlined as a diagonal member shaped as a framework created by the intersection of various materials like metals, concrete or wood beams that are used in the construction of buildings and roofs. Diagrid structures of the steel members are efficient in providing a solution both in term of strength and stiffness. In my thesis work study the safety and minimum harm level of a structure may well be the prime demand of high-rise buildings. In this thesis Analysis and design of 16 storey diagrid building with plan of 18 m × 18 m size is considered.

***Key Words*:** Diagrid building, STAAD-Pro, Storey Drift, Storey Shear

1. INTRODUCTION

Construction of the multi-storey building is quickly increasing throughout the globe. Advances in construction technology, materials, structural systems, and analysis and design software package expedited the expansion of those buildings. Diagrid buildings square measure rising as structurally economical furthermore as architecturally important assemblies for tall buildings. Recently the diagrid structural system has been wide used for tall buildings due to the structural efficiency and aesthetic potential provided by the distinctive geometric configuration of the system. Generally, for tall building diagrid structure steel is employed. In present work, concrete diagrid structure with completely different shapes is analyzed and compared with a conventional concrete building.

Types of Diagrid Structural System and Materials of Construction

i. Availability of material
ii. Erection time
iii. Flexibility
iv. Durability
v. Unit weight of the material
vi. Labor cost
vii. Lead time
viii. Fire resistivity

2. METHODOLOGY

A. Code-based procedure for seismic analysis

Main features of seismic method of analysis based on Indian standard 1893(Part 1): 2002 are described as follows.

I. Equivalent static lateral force method
II. Response spectrum method
III. Square roots of sum of squares (SRSS method)
IV. Complete Quadratic combination method (CQC)
V. Elastic time history methods

B. Equivalent Static Analysis

All design in opposition to seismic loads must remember the dynamic nature of the load. However, for simple everyday structures, analysis with the aid of equivalent linear static methods is regularly enough. This is permitted in maximum codes of practice for every day, low- to medium-rise home. It starts off evolved with an estimation of base shear load and its distribution on each story calculated by way of the use of formulation given inside the code.

C. Response Spectrum Method

The representation of the maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. The maximum response plotted against of un-damped natural period and for various damping values and can be expressed in terms of maximum absolute acceleration, maximum relative velocity or maximum relative displacement.

D. Elastic Time History Method

Nonlinear Dynamic Analysis It is known as Time history analysis. It is an important technique for structural seismic analysis especially.

The evaluated structural response is nonlinear. To perform such an analysis.

A representative earthquake time history is required for a structure being evaluated. Time history analysis is a step-by-step analysis of the dynamic response of a structure to a specified loading that may vary with time. Time history analysis is used to determine the seismic response of a structure under dynamic loading of representative earthquake.

3. EXPRESSION FOR THE VON Mis STRESS

Condition of failure

$$\left\{ \frac{[(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_1 - \sigma_3)]}{2} \right\}^{1/2} \geq \sigma_y$$

Left hand side stresses known as Von mis stresses $\sigma 1$,$\sigma 2$ &$\sigma 3$ are principal stresses denoted by SmaxSmin and third is zero. Von Mis stresses given by

$$VM = 0.707\sqrt{(SMAX-SMIN)^2 + SMAX^2 + SMIN^2}$$

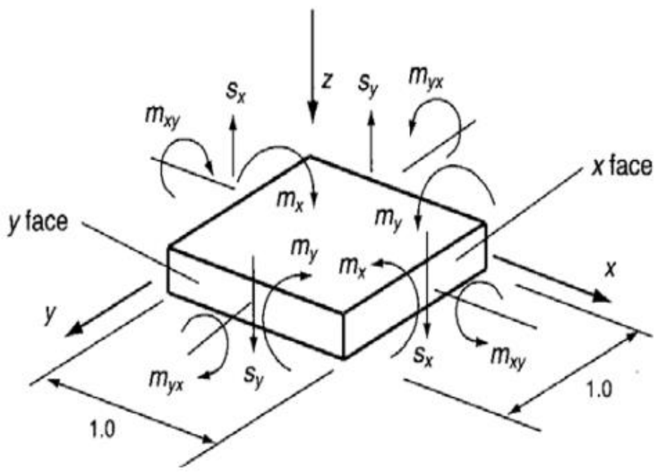

Figure 1 Bending moment on Slab

Finite element program normally provides output of stresses, internal moments and shear for plate bending element. The traditional notation (Timoshenko and woinowsky-krieger) for internal moments and shear in plats shown in above fig 1.

The non-smooth behaviour evinced by the Tresca criterion usually associates with the competition of failure modes such as with a ductile flow mode and a brittle fracture mode. But those competitive effects are not present in ductile materials. It is found that the maximum shear stress criterion (Tresca).

The maximum distortional energy criterion (Mis) are identical, both giving smooth behaviours with continuous first derivatives.

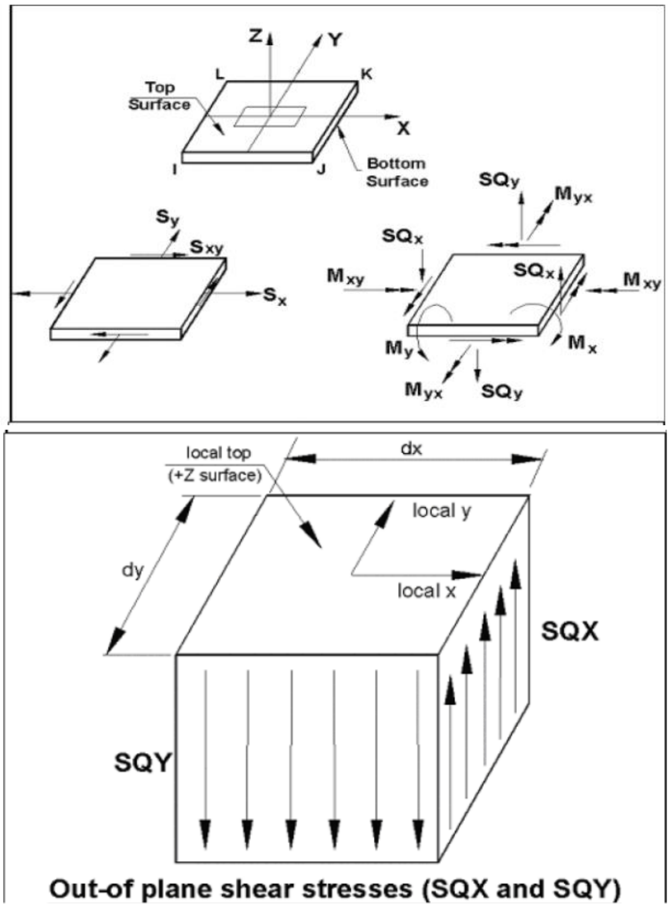

Figure 2 Stresses on Slab

A. Storey Drift:

It is the displacement of one level relative to other level above or below. During an earthquake, large lateral forces can be imposed on structures; Lateral deflection and drift have three primary effects on a structure.

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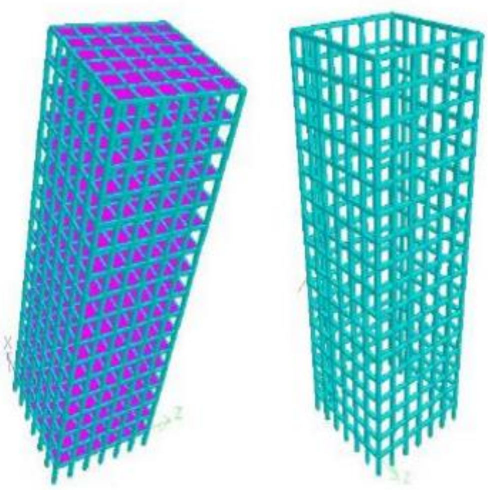

Figure 3 3D model of Conventional Building

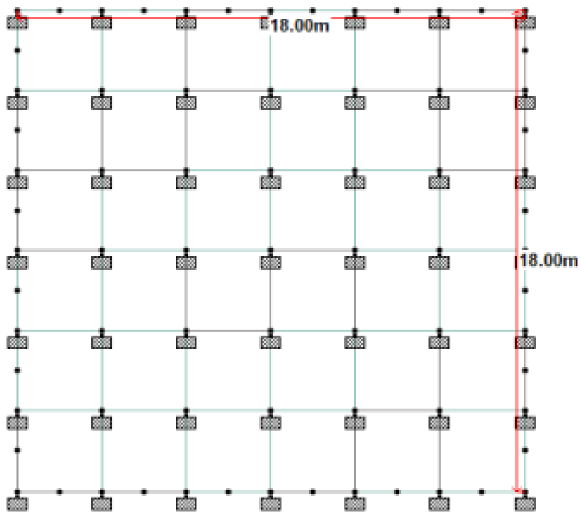

Figure 3 Base of Conventional Building

Plan area of Conventional and Square diagrid Building= 18*18 = 324 sq. meter

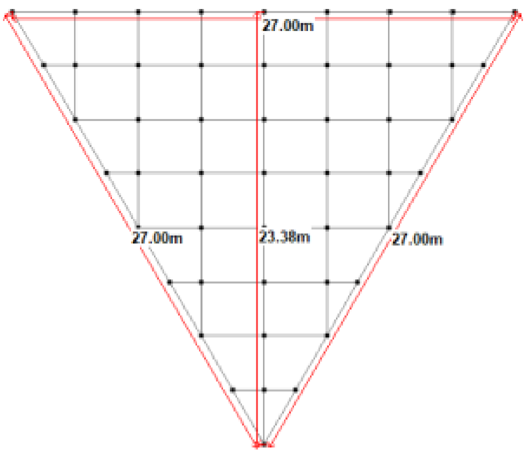

Figure 4 Base of Triangular Building

Plan area of Triangular building= 316 sq. Meter

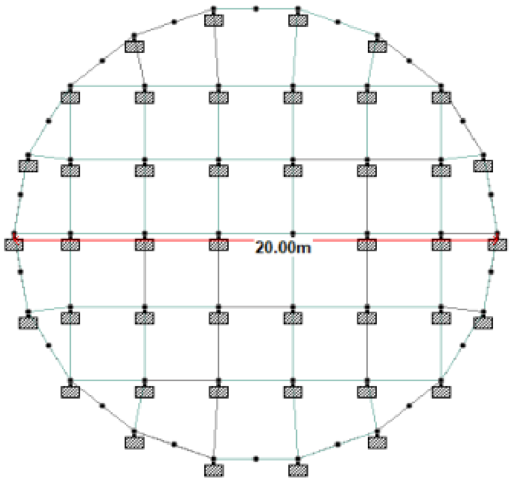

Figure 5 Plan area of Different Shapes of Diagrid buildings

Plan area of Circular Building = 315 sq. Meter approx.

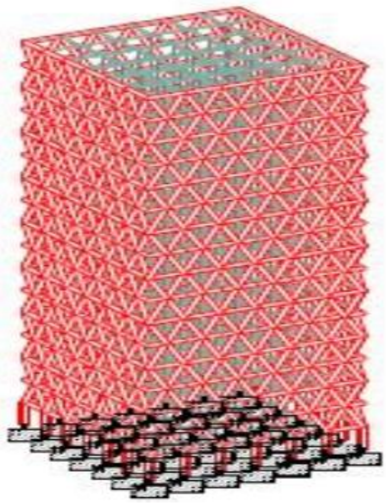

Figure 6 Square Diagrid Model

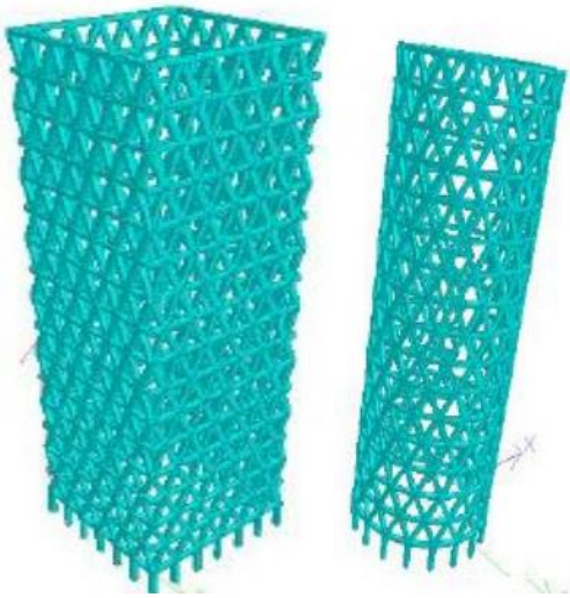

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Figure 7 3D View of Diagrid Model

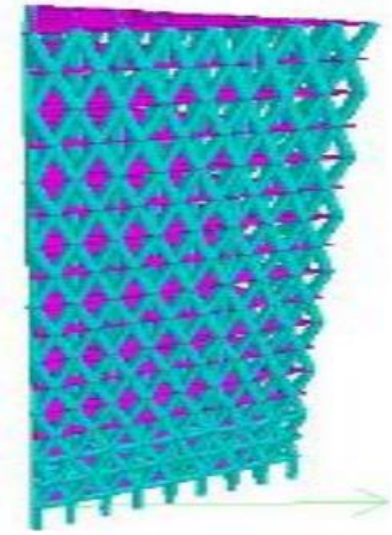


Figure 8 3D View of Triangular Model

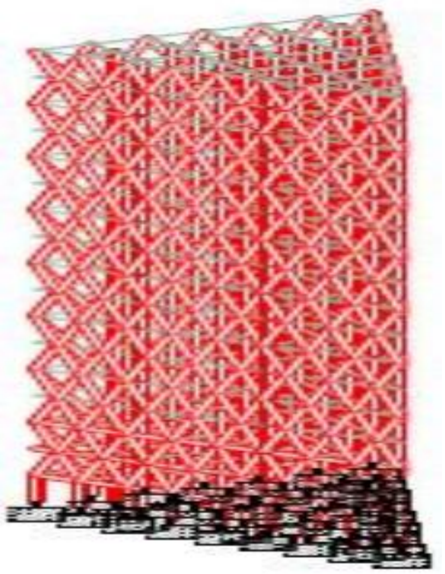
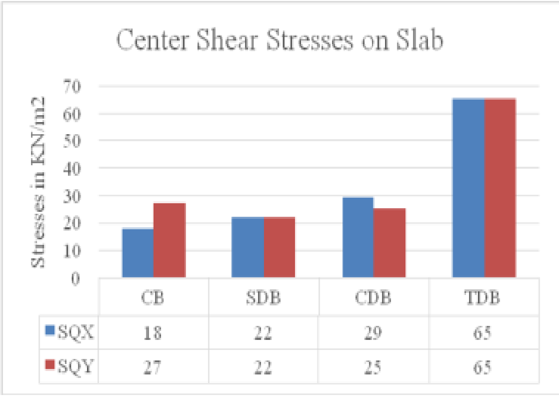


Figure 9 Triangular Diagrid model

4. RESULT & DISCUSSION

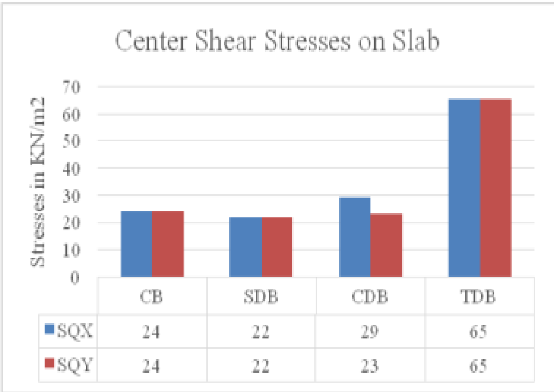
A. Centre Shear Stresses for Seismic force

Table 1 Centre Shear Stresses obtained from Seismic Analysis



B. Center Shear Stresses for Wind force

Table 2 Center Shear Stresses obtained from Wind Analysis



5. Discussion

Centre Shear Stresses for Seismic forces- The maximum plate centre shear stress along X axis i.e. (SQX) increase by 18 % and along Y axis i.e (SQY) decrease by 22% in square diagrid building when it compared with conventional building with considering same plan area.

The maximum plate Center shear stress along X axis i.e. (SQX) increase by 39 % and along Y axis i.e(SQY) decrease by 8% when in circular diagrid building when it compared with conventional building with same plan area.

Centre Shear Stresses for Wind forces- The maximum plate centre shear stress along X axis i.e. (SQX) decrease by 8.3 % and along Y axis i.e (SQY) decrease by 8% in square diagrid building when it compared with conventional building with considering same plan area.

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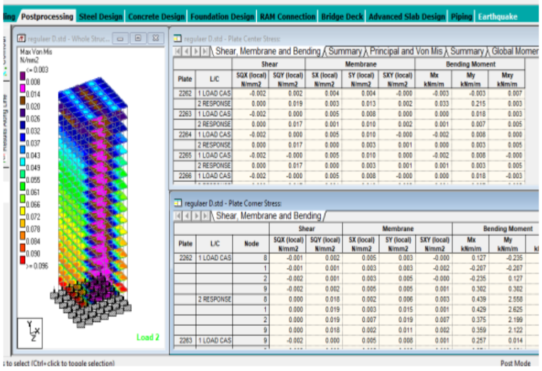

Figure 10 Square Diagrid Building Stresses Contour

6. Conclusion

Response spectrum analysis results provides a more realistic behavior of structure response and diagrid structure is more effective in lateral load resistance Seismic and wind analysis of conventional building with different shapes of diagrid building with equivalent plan area at seismic zone III is carried out and the following conclusions are drawn from the study:

1. Centre shear stresses in Slab SQX and SQY are increase in diagrid buildings as compare to conventional building but in terms of shape of building these stresses shows highs value in triangular shape diagrid building as compare to Square and Circular.

   Reason:- Because in triangular form the slab on the corner of the constructing also assigned as triangular because of this cause at the edge of slab sense greater stresses.
   The High value of shear stresses is the motive of failure of the slab and require more steel which will increase the cost of the building.

2. Maximum bending moment at the center of the slab i.e. MX,MY &MXY more increase in square and triangular shapes of diagrid building as compare to conventional building but slightly increases in circular shape diagrid building in plan.

   Reason: Due circular shape of slab, the moment of inertia of the beam and slab is to be noted here. The moment of inertia is a direct indicator of the moment carrying capacity of the section considering all other factors are the same, moment of inertia is purely dependent on the shape of the beam and slab rather than the material property.

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