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PUSHOVER ANALYSIS OF DIAGRID STRUCTURES BY VARYING OPTIMUM ANGLE

SHREEWATHS DAHAL
UG Student, Department of Civil Engineering,
Bangalore Technological Institute
Bangalore-35,India
vabisdahal69@gmail.com

HEMANTH H.M.
Assistant Prof. , Department of Civil Engineering
Bangalore Technological Institute
Bangalore-35,India
hemanthhmkumar@gmail.com

ABSTRACT

A steel structure can be viewed as a metal structure which is made up of steel components connect with each other by welding , riveting , or bolting to carry loads and provide full rigidity. In modern days due to rapid population growth, high cost of land and need to preserve important agricultural production area, construction of tall buildings have become a trend. Tall buildings are susceptible to failure under lateral loads like seismic loads and wind loads. So to counteract these lateral forces, Diagrids, also known as Diagonal grids can be provided at the periphery of the structure. The Diagrid structure is best known for its structural efficiency and flexibility compared to conventional buildings, also sums up to the aesthetics of buildings storey. The Diagrid can be provided with various angles. For the present study, building of 12 storey each storey having height of 3m is taken and ETABS software is used for modeling and analysis of diagrid structural system. Pushover analysis is carried out using ETABS software to determine the structural parameters like storey displacement, spectral displacement capacity, spectral acceleration capacity and base shear.
Keywords—ETABS, diagrid, spectral displacement, spectral acceleration, base shear

I. INTRODUCTION

At present days the rapid growth of urban population, scarcity and high cost of available land and need to avoid a continuous urban sprawl has influenced the construction of buildings. Due to this, construction of tall buildings is trending. As the building height increases, the lateral load resisting system becomes more important than the structural system that resists gravity loads. The lateral loads resisting system are rigid frame, shear wall wall-frame, braced tube system, outrigger system and tubular system. Nowadays Diagrid (Diagonal grid) system is widely used for high rise buildings due to its structural efficiency and aesthetic potential provided by unique geometric configuration of the system.

II. OBJECTIVES

- To perform the pushover analysis of diagrid structure with varying optimum angle.
- To know the maximum storey displacement experienced by the structure
- To find base shear of all the three structures under lateral loads.
- To obtain the pushover curve and know the response and performance of buildings under lateral loads.
- To find seismic capacity and demand for the three structures

III. METHODOLOGY

For the present study ETABS software is used for modeling and analysis of structural members. The following things are done for the modeling and analysis of structure.

- 12 storey buildings with plan (18×18) m, each storey having height 3m is taken.
- The diagrids of varying optimum angles (61.92°, 73.74°, 90°) is used.
- Dead load, live load, super dead load and lateral loads (seismic and wind) loads are defined as per IS1893-2002.

- All the structural elements are designed as per IS 800:2007 considering all load combinations.
- The size of frame section and slab section are selected as per standards.
- The characteristics strength for concrete and steel and yield strength for steel is also selected.
- Live load to be assigned at slab and floor is considered as 5 KN/m2
- Modeling is done, errors are checked and analysis is carried out

Table 1: Building Data

Area of plan	18m × 18m
Height of building	36m
Number of stories	12 Nos.
Height of each storey	3m
Type of analysis	Non- Linear Analysis
Optimum angles of diagrid	61.92˚, 73.74˚, 90˚

Table 2: Data For Analysis

Density of Steel	76.9729 KN/m3
Density of reinforced concrete	25KN/m3
Live load	5 KN/m2
Importance factor (I)	1.5
Poisson's ratio of concrete	0.2
Poisson's ratio of steel	0.3
Seismic zone	Zone V
Soil type	Type III
Seismic Zone Factor	0.36
Response Reduction Factor (R)	5.0

IV. RESULTS AND DISCUSSIONS

The modeled building is analysed using Nonlinear Static (Pushover) analysis. This chapter presents Nonlinear Static (Pushover) analysis results and its discussions. Pushover analysis was performed first in a load control manner to apply all gravity loads on to the structure (gravity push). Then a lateral pushover analysis in transverse direction was performed in a displacement control manner starting at the end of gravity push. The results obtained from these analysis are checked by comparing spectral displacement demand and spectral displacement capacity from the pushover curve.

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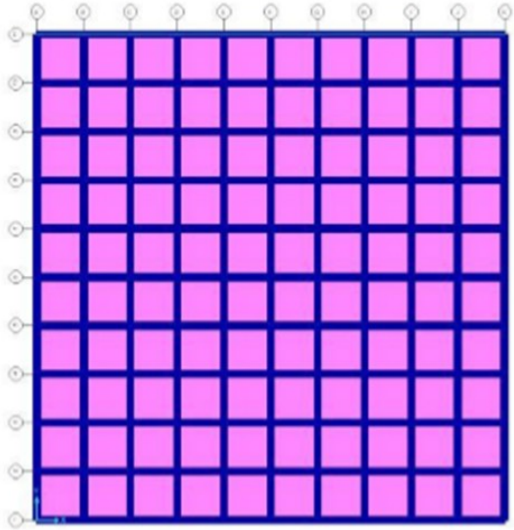

Fig 1: Plan of Diagrid Building of model 1

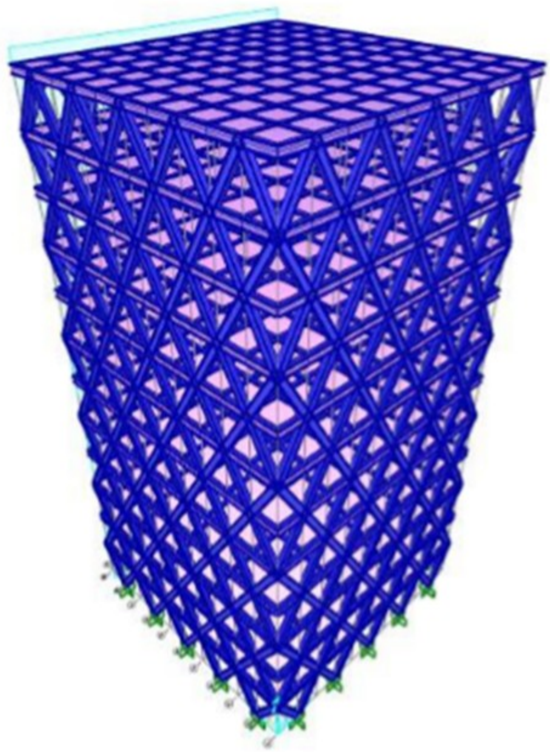

Fig 2 : 3D Diagrid Building of Model 1

NON-LINEAR STATIC ANALYSIS:

Nonlinear Static (Pushover) Analysis permits to identify critical members likely to reach limit states during the earthquake. Nonlinear Static Analysis is carried out after assigning flexural hinges (FEMA 440 Auto hinges) using ATC 40 Capacity Spectrum Method. As a result performance points & levels (IO, LS, and

CP) are found in different pushover steps and Base shear vs. Displacement Graph & Spectral Acceleration vs. Spectral Displacement Graph is drawn and Spectral Displacement Demand & Spectral Displacement Capacity is calculated.

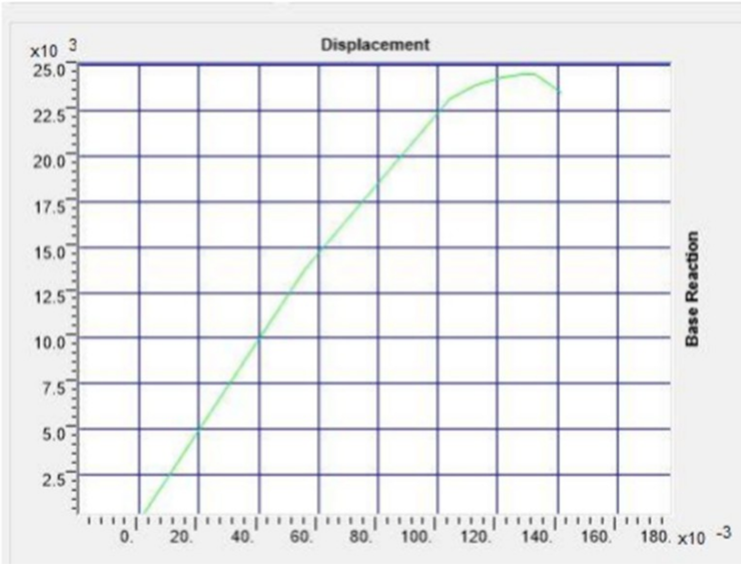

Fig 3: Pushover curve for model 1.

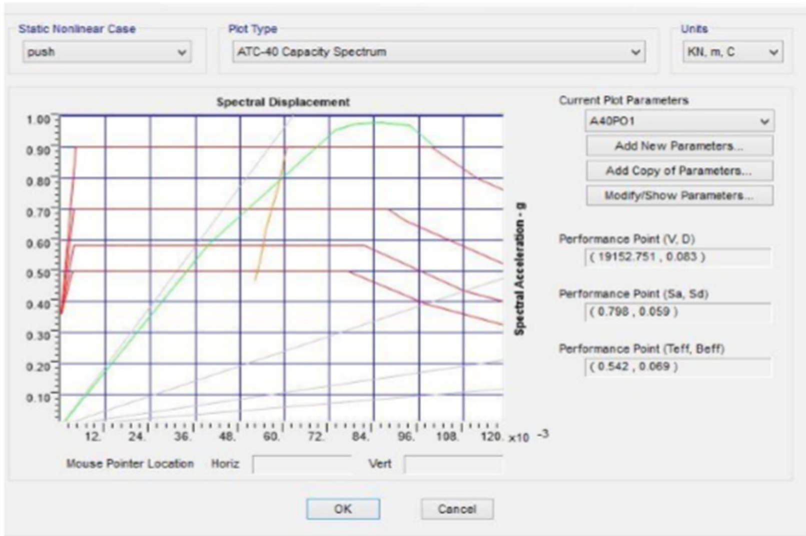

Fig 4: spectral displacement curve for model 1

Similarly model 2 and model 3 analysis are carried out for the diagrid angle 73.74° and 90° respectively.

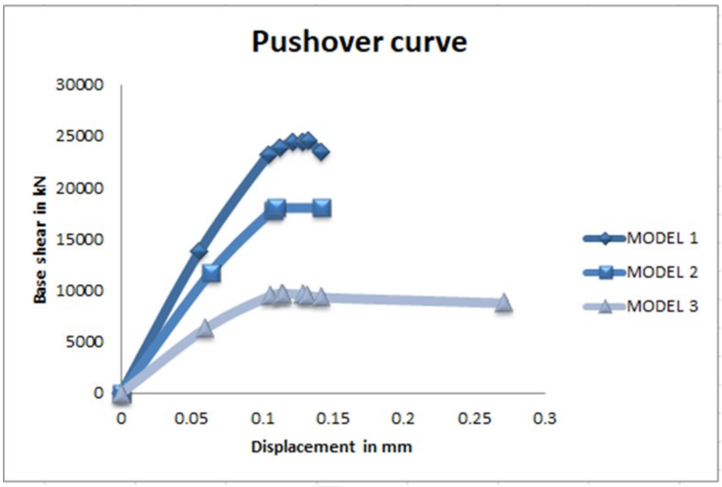

Chart 1: Comparison between Base shear and Displacement for all the three models

From the above three cases spectral displacement capacity and demand of the structure are as follows:

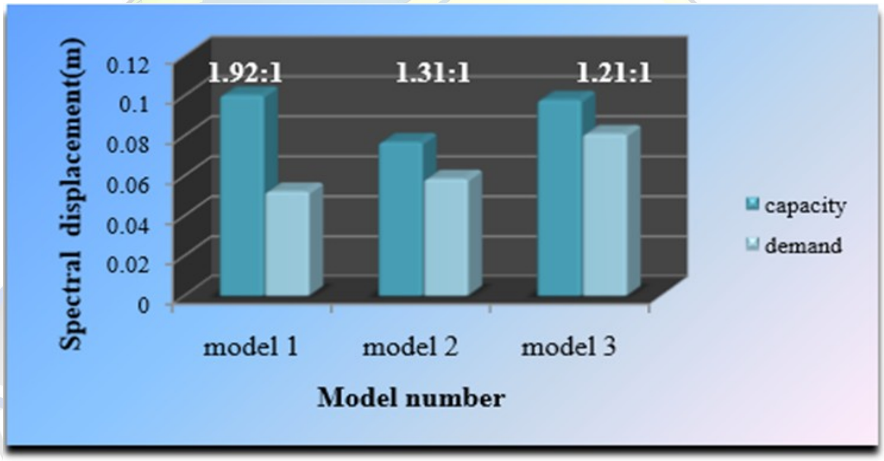

Chart 2: Spectral displacement capacity and demand ratio chart

From the above three cases spectral acceleration capacity and demand of the structure are as follows:

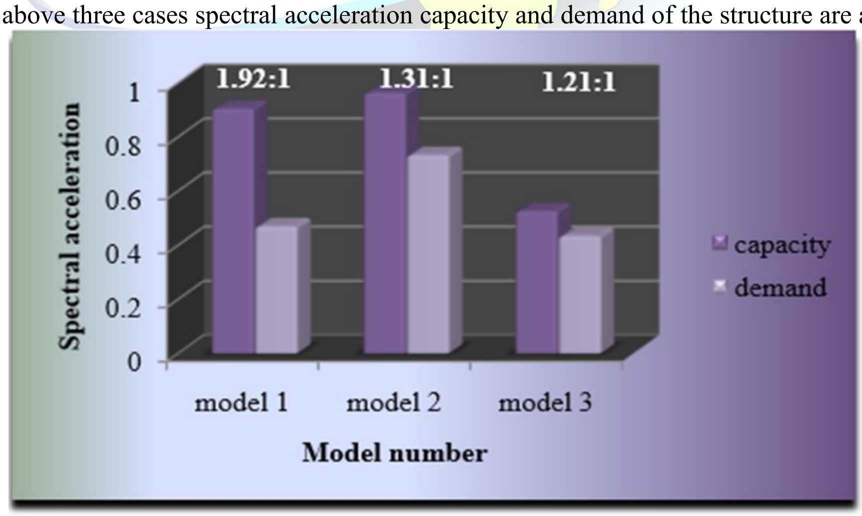

Chart 3: Spectral acceleration capacity and demand ratio chart

From chart 1 we can clearly observe that displacement and base shear of model 1 (61.92°) is less than model 2 (73.74°) and model 3 (90°). From chart 2 we can conclude that spectral displacement capacity of model

1 (61.92°) is more than model 2 (73.74°) and model 3 (90°).From chart 3 we can conclude that spectral acceleration capacity of model 1 (61.92°) is more than model 2 (73.74°) and model 3 (90°)

V. CONCLUSION

In this study, attempt has been made to compare the diagrid structures with varying optimum angle of diagrid taking 3 different models. Linear static and non-linear static analysis is carried out on the 12 storey diagrid steel structural building using ETABS software. From analysis following conclusions are derived,

- The storey displacement is less for 61.92° diagrid angle compared to 73.74° and 90°. So 61.92° diagrid angle is more optimum.
- As the diagrid angle increases the base shear value decreases.
- From capacity spectrum it is evident that spectral displacement capacity and demand ratio decreases with increase in optimal angle of the diagrid.
- From capacity spectrum it is evident that spectral acceleration capacity and demand ratio decreases with increase in optimal angle of the diagrid.

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