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PUSHOVER ANALYSIS OF CIRCULAR STEEL DIAGRID STRUCTURES

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Abstract- *Diagonalized grid structures have emerged jointly of the most effective,advanced and variable approaches in constructing steel skyscrapers. it's a selected kind of house truss, it consists of lateral components gift at the boundary of the building created from a series of triangulated truss system. It's shaped by interconnecting the diagonal and horizontal parts.*

Multi-storey buildings construction is increasing at a quicker rate throughout the globe. Development in construction technology, materials, structural systems, varied analysis and style software package have helped the event of various varieties of buildings. Diagrid buildings ar rising as structurally economical in addition as architecturally and esthetically important assemblies for tall buildings. In recent times these diagrid structural systems are looselyused for tall buildings as a result of the structural effectiveness and aesthetic potential provided by the distinctivegeometric configuration of the system. This paper presents a twelve construction steel diagrid structure that is 36mtall. Circular structural configurations of diagrid structures were modelled ANd analyzed victimisation SAP 2000 bycreating anallowancefor burden, superload and seismal masses (IS 1893-Part-1, 2002). Then independent agency 356 hinges (auto hinges) ar assigned to identical structure and nonlinear Static (Pushover) analysis is distributed by victimisation seismal load because the pushover load case to search out out the performance points that's Immediate Occupancy, Life Safety, and Collapse hindrance of diagrid components victimisation static pushover curve. At identical time spectral displacement demand & spectral displacement capability in addition as spectral acceleration demand and spectral acceleration capability is compared to grasp the adequacy of the look byvictimisation ATC capability spectrum technique.

Key Words**:** *Diagrid, Pushover analysis, Spectral displacement demand, Spectral displacement capacity, Spectral acceleration demand, Spectral acceleration capacity.*

1. INTRODUCTION

The evolution of tall-building structural systems, supported new structural ideas with freshly adopted high-strength materials and construction ways, has been towards „stiffness‟ and „lightness‟. Structural systems today have become stiffer and lighter. Diagrid, ar referred to as a really light-weight structure and one in all the strongestonce it involves withstanding against lateral forces. The term "diagrid" may be a combination of the words "diagonal" and "grid" and refers to a structural system that's single-thickness in nature and gains its structural integrity throughthe utilization of triangulation. The lighter a structure is, the upper it will rise. On the opposite hand, it's conjointlyeasier to blow away a light-weight object than a significant one. Diagrid will save from 2 hundredth to half-hourthe number of steel in high-rise buildings. Moreover, high-strength material technology has come back an extendedmeans since the invention of contemporary high-rise buildings in 1930‟s, materials themselves ar stronger and lighter. Diagrid structures carry lateral wind masses far more expeditiously thanks to their diagonal member‟s axial action compared to the traditional orthogonal structures for tall buildings like framed tubes. Today‟s architects are losing interest in aesthetic expressions provided by standard braced tubes composed of orthogonal members and hugediagonal members as a result of they perpetually look for one thing new and completely different.

2. NON LINEAR STATIC PUSHOVER ANALYSIS

The static pushover analysis is changing into a preferred tool for seismal performance estimation of existing and new structures. This analysis methodology, conjointly referred to as successive yield analysis or just "Pushover" analysis has gained important quality throughout past few years. it's one amongst the 3 analysis techniques counseled byFederal Emergency Management Agency 356 and a main part of capability spectroscopicanalysis methodology(ATC-40). The expectation from the pushoveranalysisis, it'll offer enough information on seismal demands applied through the look ground motion on the elements and its structural system. By subjecting a structure to a monotonicallyincreasing pattern of lateral forces a pushover analysis is performed, representing the interior forces which might be fully fledged by thestructure once subjectedtogroundshaking. below incrementallyincreasingmasses varied structural parts experiences a loss in stiffness. employing a pushover analysis, a characteristicnonlinear force-displacement relationship may be determined.

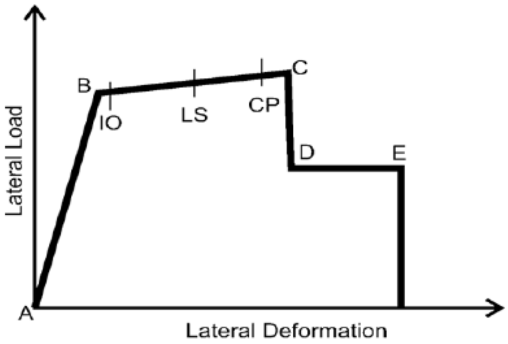

Figure 1: Static pushover curve

We 1st styleed the steel moment resisting frame by the elastic design approach referring to the Indian normal code (IS800:2007) mistreatment the SAP2000 software system. For applying the static Pushover Force the Hinges area unit assigned in beams and column. Then the frame was analyzed by the nonlinear static Pushover analysis in SAP2000. the complete frame is administrated up to the target drift in nonlinear static pushover analysis, bymistreatment style lateral force distribution. The failure mechanism of the frame obtained by SAP2000. Response characteristics which will be achieved from the pushover analysis area unit summarised as follows:
a) Estimates force and displacement capacities of the structure and sequence of the member yielding and also theprogress of the general capability curve.
b) Estimates force (axial, shear and moment) demands on doubtless brittle components and deformation demands onductile components.
c)Estimates international displacementdemand,correspondin g inter-storey drifts and damages on structural and non-structural components expected underneath the earthquake groundmotion thoughtof.
d) Sequences of the failure of components and also the subsequent result on the general structural stability.
e)Identificationofthe essential regions, wherever the inelastic deformations area unit expected to be high and identification of strength irregularities (in arrange or in elevation) of the building.

3. CAPACITY SPECTRUM METHOD (ATC 40)

In this technique the most dead deformation of a nonlinear SDOF system areoften approximated from the mostdeformation of a linear elastic SDOF system with identical amount and damping. This procedure uses the estimates ofplasticity to calculate effective amount and damping. This procedure uses the pushover curve in associateacceleration-displacement response spectrum (ADRS)format. thiswill beobtainedthrough straightforward co nversion victimization the dynamic properties of the system. The pushover curve in associate ADRS format is termed a "capacity spectrum" for the structure. The unstable ground motion is depicted by a response spectrum within thesame ADRS format and it's termed as demand spectrum that is as shown in Fig. 1. The equivalent amount (Teq) is computed from the initial amount of vibration (Ti)ofthe scheme anddisplacement plasticity quantitative relation (μ). Similarly, the equivalent damping quantitative relation (βeq) is computed from initial damping quantitative relationandthereforethe displacement plasticity quantitativer elation (μ).ATC forty provides thesubsequent equations to calculate equivalent period of time (Teq) and equivalent damping (βeq).

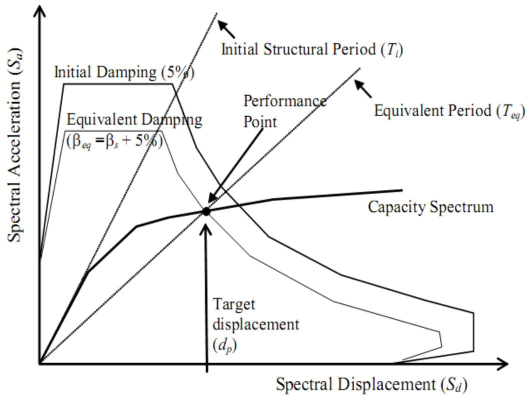

Figure 2: Schematic representation of Capacity Spectrum Method (ATC 40)

4. PROBLEM IDENTIFICATION

This unit presents the main points regarding dimensions of building, material used and kind of study for this study and ar as in TABLE one. A twelve construction steel circular diagrid structure having height 36m and radius 6m is taken into account for the analysis. The load, liveload and unstable masses and also default load comboswere thought of for the analysis and also the structure is modelled in SAP 2000 and Linear Analysis is conducted to urge the most bending moment, shear force and axial force. Later the FEMA 356 Hinges were outlined withinthemodel and nonlinear Static (Pushover) Analysis has beenconducted mistreatment ATC-40 capability spectrummethodology to calculate Base Shear, Displacements, Effective, Spectral Displacement capability & Spectral Displacement Demand and additionally Performance points of Diagrid Structure.

Table-1: Building Details Considered for analysis

Building Details		
Sl. No	**Description**	
1	Dimensions of Building	6m radius
2	Height of Building	36 m
3	No. of Stories	12 No's
4	Storey Height	3 m
5	Type of Structure	Diagrid Steel Structure
6	Type of Analysis	Linear & Nonlinear Analysis

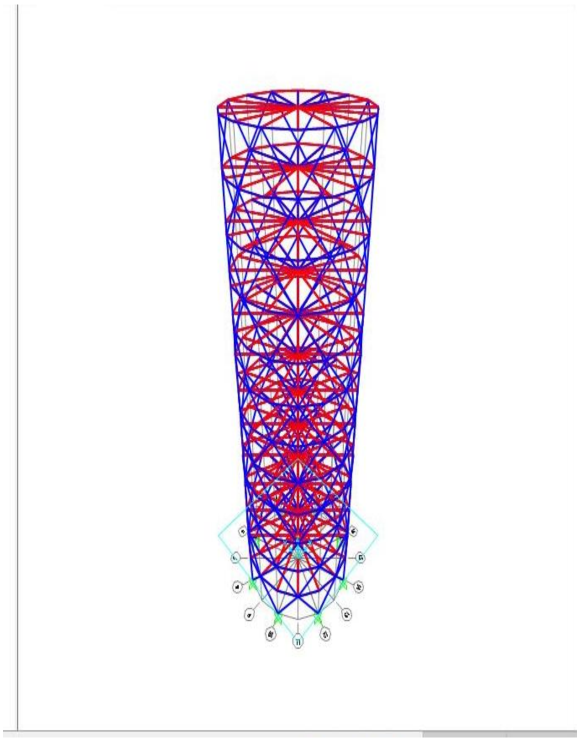

Figure 3: Elevation of the building

Table-2: input data for analysis

Input Data for Analysis		
Sl.No	**Particulars**	
1	Density of reinforced concrete	25 kN/m^3
2	Density of Steel	76.9729 kN/m^3
3	Intensity of live load	5kN/m^2
4	Importance Factor (I)	1.0
5	Response Reduction Factor (R)	5.0
6	Poisson's Ratio of Concrete	0.2
7	Poisson's Ratio of Steel	0.3
8	Modulus of Elasticity of Steel	1.999 X 10^{8}kN/m^2
9	Seismic Zone	Zone V
10	Seismic Zone Factor	0.36
11	Soil Type	Type III

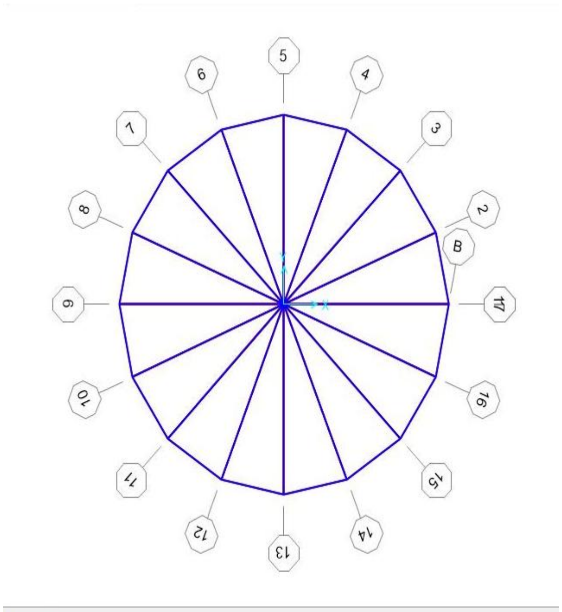

Figure 4: plan of the building

5. RESULTS AND DISCUSSIONS

The modelled building is analysed exploitation nonlinear Static (Pushover) analysis. This chapter presents nonlinearStatic (Pushover) analysis results and its discussions. Pushover analysis was performed 1st during a load managementmanner to use all gravity masses on to the structure (gravity push), then a lateral pushover analysis in transversaldirection was performed during displacement management manner beginni ng at the top of gravity push. The results obtained from this analysis square measure checked by examination spectral displacement demand and spectral displacement capability from the pushover curve.

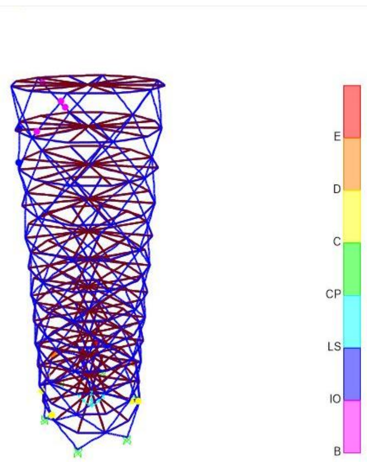

Figure5: Pushover step-3

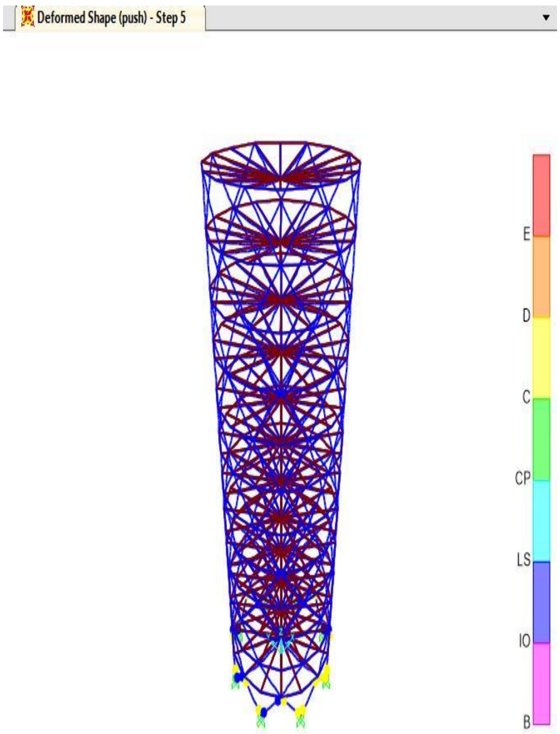

Figure 6: Pushover step-5

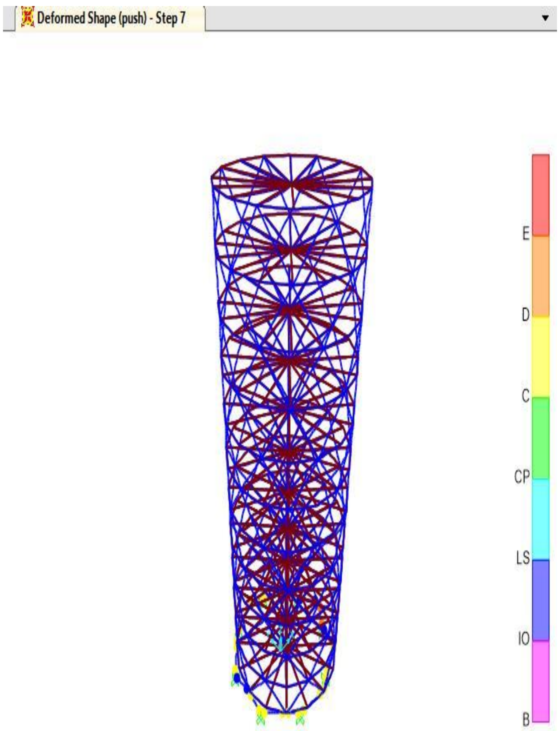

Figure 7: Pushover step-7

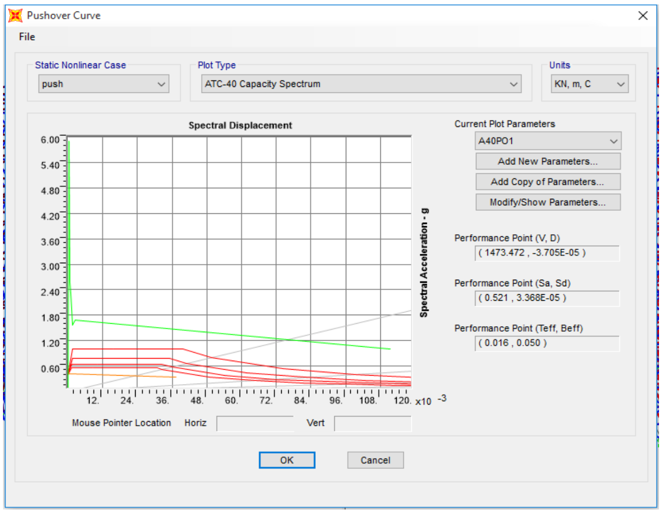

Chart 1: Pushover Demand Capacity Curve (ATC 40)

Table-3: Pushover curve demand capacity ATC-40

Step	SdCapacity	SaCapacity	SdDemand	SaDemand
	m	Unitless	m	Unitless
0	0	0	0.000034	0.520996
1	0.000381	5.900338	0.000034	0.520996
2	0.000738	2.568276	0.000119	0.413362
3	0.000926	2.30433	0.000167	0.415803
5	0.00153	1.562601	0.000416	0.424663
6	0.002473	1.682302	0.000632	0.430221
7	0.111473	0.994592	0.037376	0.333477

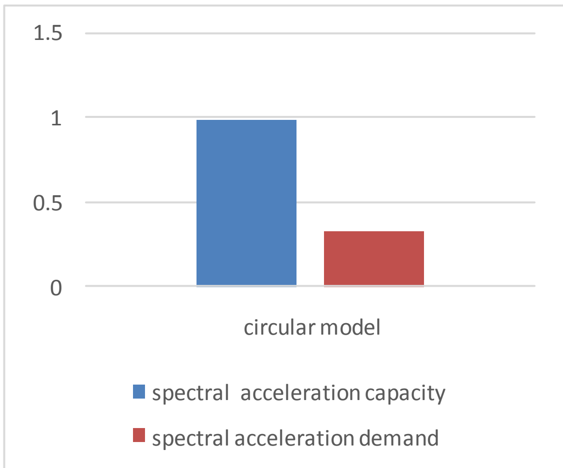

Chart 2: Comparison between Capacity & Demand

5. CONCLUSIONS

It can be concluded that from the pushover analysis one can know the state of the structure by observing changes in the hinge states.
From Chart 2 it can be observed that spectral acceleration capacity of circular steel diagrid building is more than that ofspectral acceleration demand by 200% for the same height and plan area.

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