Dynamic Analysis Of Multi Storied Residential Building (G+20) In Earthquake Prone Area (Zone-V) By Using ETABS

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Abstract

With the introduction of Limit state design of structures, the safety and serviceability of the structure has accrued prime importance. The present day scenario witnesses a series of natural calamities like earthquakes, tsunamis, floods etc., of these the most damaging and recurrent phenomena is the earthquake. The Effective design and the construction of Earthquake resistant structure have gained greater importance all over the world.

Earthquake load is changing into an excellent concern in our country as a result of not one zone may be selected as earthquake resistant zone. One of the most important aspects is to construct a building structure, which can resist the seismic force efficiently. Study is made on the different structural arrangement to find out the most optimized solution to produce an efficient safe earthquake resistant building. The basic designs for vertical and lateral loads i.e., wind and seismic are the same for low, medium or high rise buildings. The vertical loads increase in direct proportion to the floor area and number of floors. In distinction to the current, the result of lateral loads on a building isn't linear and increase quickly with increase in height. Due to these lateral loads, moments on steel components will be very high.

In this paper the earthquake resistance of a G+20 multi-storey building is analyzed using Equivalent static method with the help of E-TABS 9.7.4 software. The method includes seismic coefficient method as recommended by IS 1893 (part 1):2002.

The building is analyzed in Zone II & Zone V with medium soils in both static & Dynamic Analysis. Moments, Shear, Displacement was compared for all the cases. A commercial package ETABS9.7.4 has been utilized for analyzing high-rise building of 60.3m height and for zone-II & zone-V. The result has been compared using tables & graph to find out the most optimized solution. The parameters studied were displacement, storey drift and storey shears, time history, response spectrum method.

Keywords: Earthquake, E-TABS 9.7.4, displacement, story drift, storey shear, time history.

Introduction

Natural disasters are inevitable and it is not possible to get full control over them. The history of human civilization reveals that man has been combating with natural disasters from its origin but natural disasters like floods, cyclones, earthquakes, volcanic eruptions have various times not only disturbed the normal life pattern but also caused huge losses to life and property and interrupted the process of development. With the technological advancement, man tried to combat with these natural disasters through various ways like developing early warning systems for disasters, adopting new prevention measures, proper relief and rescue measures. But unfortunately it is not true for all natural disasters. Earthquakes are one in all such disasters that's connected with in progress tectonic process it suddenly comes for seconds and causes nice loss of life and property. So earthquake disaster prevention and reduction strategy is a global concern today. Hazard maps indicating seismic zones in seismic code are revised from time to time which leads to additional base shear demand on existing buildings.

Building construction is that the engineering offers with the development of constructing to residential buildings in a really effortless constructing will probably be outline as an enclose area via partitions with roof, Fabric and accordingly the basic desires of contributors. Inside the early earlier interval people lived in caves, over bushes or beneath bushes, to safeguard themselves from wild animals, rain, sun, etc. Because the occasions handed as people being started dwelling in huts created from trees branches. The shelters of these previous are developed at the moment into wonderful residences. Rich individuals reside in sophisticated houses.

Structures are the primary indicator of social growth of the country. Every human has wished to possess houses on an average most commonly one spends his two-third life occasions within the houses. The protection civic feel of the responsibility, These are the few motives which are accountable that the man or woman do utmost effort and pay tough-earned saving in owning houses.

These days the condominium building is essential work of the social progress of the county. Day-to-day new techniques are being developed for the development of residences economically, speedily and pleasing the requirements of the group engineers and designers do the seam work, planning and layout etc, of the constructions.

Trained employees are dependable for doing the drawing works of building as for the path of engineers and designers. The trained worker will have to apprehended his job and could also be competent to comply with the instruction of the engineer and could also be able to attract the desired drawing of the building, website plans and layout plans and many others, as for the necessities.

A constructing body consists of variety of bays and storey. A Multi-storey, multi-paneled body would be a tricky statically intermediate structure. A design of R.C building of G+20 flooring body work is preoccupied. The constructing in arrange (38.5×31) consists of columns designed monolithically forming a community. The scale of constructing is 38.5x31m. The amounts of columns are eighty five. It is residential advanced.

The design is created by using ETABS software. The constructing subjected to every the vertical hundreds additionally as horizontal masses. The vertical load consists of lifeless load of structural elements equivalent to beams, columns, slabs etc and are living loads. The horizontal load includes the wind forces so building is intended for lifeless load, reside load and wind load as per IS 875(part3):1987. The constructing is meant as two dimensional vertical body and analyzed as per IS 456-2000. The help is taken via program furnished in institute and for this reason the computations of hundreds, moments and shear forces and received from this program.

ETABS Introduction

The software used for the present study is ETABS it is a product of Computers and Structures. It is a fully integrated program that allows Model creation, modification, execution of analysis, design optimization, and results review from within a single interface. ETABS is a standalone finite element based structural software for analysis and design of civil structures. It offers a powerful user interface with many tools to aid in quick and accurate construction of Models, along with sophisticated technique to do most complex projects.

Building Description

The Modeling of the G+20 storey with bare frame, bare frame with slab element, full wall element structure, first soft storey, two storey soft storey, three storey's soft storey. Plan area of building is 38.5m x 31m, the building Models having at 3.75m distance in x-direction and 5m distance in y- direction.

Analyzing the data

Linear dynamic analysis has been performed as per IS 1893 (Part 1): 2002 for each model using ETABS analysis package. Lateral load calculation and its distribution along the height are done. The seismic weight is calculated using full dead load plus 25% of live load.

Statement of the Project:

Salient Features:

The design data shall be as follows:-

Utility of Buildings : Residential Building

No of Storey : G+20

Shape of the Building : Square

No. Of Staircases : Four

No. Of Lifts : Two

Types of Walls : Brick Wall

Geometric Details

Ground Floor : 3.3m

Floor-To-Floor Height : 3m

Material Details

Concrete Grade : M30(COLUMNS),M25(BEAMS)

All Steel Grades : HYSD reinforcement of Grade Fe415

Bearing Capacity of Soil : 200 KN/m^2

Type Of Construction : R.C.C FRAMED structure

Objectives of the study:

i. To study irregularities in structures analyze and design of G+20 storied structure as per code (IS1893:2002(part-1)) provision.
ii. Analyze the buildings in Etabs software to carry out the storey deflection, storey drift, storey shear force and base shear of regular and irregular structures using response spectrum analysis and compare the results of different structure
iii. Time history analysis subjected to intermediate frequency ground motion for the response of regular buildings and compare with response spectrum analysis. To analyze the RC frame for static analysis in relation to the storey drift and displacements, base shear using software ETABS.
iv. To investigate the soft storey behavior at different levels of RC frame building for all cases so as to arrive at suitable practical conclusion for achieving earthquake resistant RC frame building.
v. To study the comparison of axial forces, storey drift, storey shear of RCC framed building.
vi. Ductility-based earthquake-resistant design as per IS 13920.

MODELING AND METHODS OF ANALYSIS OF STRUCTURE

In the present study analysis of G+20 multi-storey building in most severs zone for wind and earth quake forces is carried out.3D model is prepared for G+20 multi-storey building is in ETABS. Building has a typical size of

Basic parameters considered for the analysis are

Buildings and this method will give good results for this type of buildings. Dynamic analysis Utility of building : Residential building

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Shape of building : Square
Number of stair cases : Four
Number of lifts : Two
Type of walls : Brick wall

Geometric details

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Methods of analysis of the structure:

The seismic analysis should be carried out for the buildings that have lack of resistance to earthquake forces. Seismic analysis will consider dynamic effects hence the exact analysis sometimes become complex. However for simple regular structures equivalent linear static analysis is sufficient one. This type of analysis will be carried out for regular and low rise will be carried out for the building as specified by code IS 1893 (part 1):2002. Dynamic analysis will be carried out either by Response spectrum method or site specific Time history method. Following methods are adopted to carry out the analysis procedure.

Equivalent Static Analysis:

This approach defines a series of forces acting on building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. For this to be true, the building must be low-rise and must not twist significantly when the ground moves. The response is read from a design response spectrum, given the natural frequency of the building (either calculated or defined by the building code). The applicability of this method is extended in many building codes by applying factors to account for higher buildings with some higher modes, and for low levels of twisting. To account for effects due to yielding of the structure, many codes apply modification factors that reduce the design forces (e.g., force reduction factors).

The seismic design of buildings fallows the dynamic nature of the load. But equivalent static analysis would become sufficient for simpler, regular in plan configuration and it will give more efficient results.

This analysis will flow in a manner with the calculation of design base shear and its distribution to all storey by using the formula given in the code.

Linear Dynamic Analysis:

Static procedures are appropriate when higher mode effects are not significant. This is generally true for short, regular buildings. Therefore, for tall buildings, buildings with torsional irregularities, or non-orthogonal systems, a dynamic procedure is required. In the linear dynamic procedure, the building is modeled as a multi-degree-of-freedom (MDOF) system with a linear elastic stiffness matrix and an equivalent viscous damping matrix.

The seismic input is modeled using either modal spectral analysis or time history analysis but in both cases, the corresponding internal forces and displacements are determined using linear elastic analysis. The advantage of these linear dynamic procedures with respect to linear static procedures is that higher modes can be considered. However, they are based on linear elastic response and hence the applicability decreases with increasing

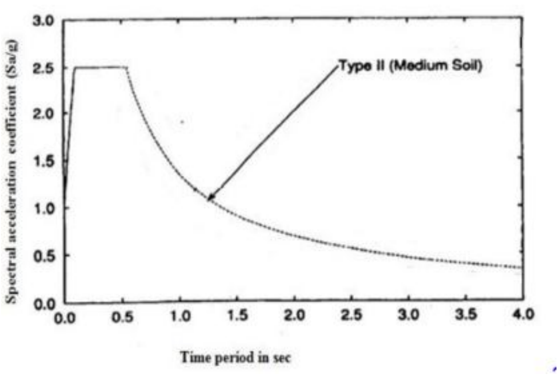
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 07 Issue 02
February 2020

nonlinear behavior, which is approximated by global force reduction factors.

In linear dynamic analysis, the response of the structure to ground motion is calculated in the time domain, and all phase information is therefore maintained. Only linear properties are assumed. The analytical method can use modal decomposition as a means of reducing the degrees of freedom in the analysis.

Response spectrum method:

The representation of maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. This analysis is carried out according to the code IS 1893-2002 (part1). Here type of soil, seismic zone factor should be entered from IS 1893-2002(part1). The standard response spectra for type of soil considered is applied to building for the analysis in ETABS 2013 software. Following diagram shows the standard response spectrum for medium soil type and that can be given in the form of time period versus spectral acceleration coefficient (Sa/g).



Response spectrum for medium soil type for 5% damping

This approach permits the multiple modes of response of a building to be taken in to account (in the frequency domain). This is required in many building codes for all except very simple or very complex structures. The response of a structure can be defined as a combination of many special shapes (modes) that in a vibrating string correspond to the "harmonic" computer analysis can be used to determine these modes for a structure. For each mode, a response is read from the design spectrum, based on the modal frequency and the modal mass, and they are then combined to provide an estimate of the total response of the structure. In this we have to calculate the magnitude of forces in all directions i.e. X, Y & Z and then see the effects on the building. Combination methods include the following:

- Absolute - peak values are added together
- Square root of the sum of the squares (SRSS)
- Complete quadratic combination (CQC) - a method that is an improvement on SRSS for closely spaced modes.

The result of a response spectrum analysis using the response spectrum from a ground motion is typically different from that which would be calculated directly from a linear dynamic analysis using that ground motion directly, since phase information is lost in the process of generating the response spectrum.

In cases where structures are either too irregular, too tall or of significance to a community in disaster response, the response spectrum approach is no longer appropriate, and more complex analysis is often required, such as non-linear static analysis or dynamic analysis.

3.4 Time history analysis:

In this analysis dynamic response of the building will be calculated at each time intervals. This analysis can be carried out by taking recorded ground motion data from past earthquake database. This analysis overcomes all disadvantages of response spectrum analysis if there is no involvement of nonlinear behavior. Hence this method requires greater efforts in calculating response of buildings in discrete time intervals. In this project work BHUJ earthquake of magnitude 7.7 with ground acceleration 0.106g is taken for the time history analysis.

Pushover analysis:

This is a performance based analysis and has aim in controlling the structural damage. In this analysis several built in hinge properties are included from FEM 356 for concrete members. This analysis will be carried out by using nonlinear software ETABS 2013. This software is able to predict the displacement level and corresponding base shear where first yield of structure occurs. The main objective to perform this analysis is to find displacement vs. base shear graph.

Amongst the natural hazards, earthquakes have the potential for causing the greatest damages. Since earthquake forces are random in nature & unpredictable, the engineering tools need to be sharpened for analyzing structures under the action of these forces. Earthquake loads are to be carefully modeled so as to assess the real behavior of structure with a clear understanding that damage is expected but it should be regulated. In this context pushover analysis which is an iterative procedure is looked upon as an alternative for the conventional analysis procedures. Pushover analysis of multi-storey RCC framed buildings subjected to increasing lateral forces is carried out until the preset performance level (target displacement) is reached. The promise of performance-based seismic engineering (PBSE) is to produce structures with predictable seismic performance.

Non linear static analysis:

In general, linear procedures are applicable when the structure is expected to remain nearly elastic for the level of ground motion or when the design results in nearly uniform distribution of nonlinear response throughout the structure. As the performance objective of the structure implies greater inelastic demands, the uncertainty with linear procedures increases to a point that requires a high level of conservatism in demand assumptions and acceptability criteria to avoid unintended performance. Therefore, procedures incorporating inelastic analysis can reduce the uncertainty and conservatism. This approach is also known as pushover analysis.

Non linear dynamic analysis:

Nonlinear dynamic analysis utilizes the combination of ground motion records with a detailed structural model, therefore is capable of producing results with relatively low uncertainty. In nonlinear dynamic analyses, the detailed structural model subjected to a ground-motion record produces estimates of component deformations for each degree of freedom in the model and the modal responses are combined using schemes such as the square-root-sum-of-squares.

In non-linear dynamic analysis, the non-linear properties of the structure are considered as part of a time domain analysis. This approach is the most rigorous, and is required by some building codes for buildings of unusual configuration or of special importance.

GEO-TECHNICAL CONSIDERATIONS

Site Selection

The seismic motion that reaches a structure on the surface of the earth is influenced by local soil conditions. The subsurface soil layers underlying the building foundation may amplify the response of the building to earthquake motions originating in the bedrock. For soft soils the earthquake vibrations can be significantly enlarged and hence the shaking of structures sited on soft soils can be much greater than for structures sited on firm soils. Hence appropriate soil investigation should be carried out to establish the allowable bearing capacity and nature of soil.

Prevention of view is mainly concerned with the stability of the ground. The very loose sands or sensitive clays are responsible to be destroyed by the earthquake so much as to lose their original structure and thereby undergo compaction. This would result in large unequal settlements and damage the building. If the loose cohesion less soils are saturated with water they are likely to lose their shear resistance altogether during ground shaking. This leads to liquefaction. Although such soil can be compacted, for small building the operation may be too costly and the sites having these soils are better avoided. For large building complexes, such as housing developments, new colonies etc., this factor should be thoroughly investigated and the site have to be selected appropriately. Therefore a site with sufficient bearing capacity and free from the above defects should be chosen and its drainage condition improved so that no water accumulates and saturates the ground especially close to the footing level.

LOADS ACTING ON MULTI-STOREY G+20 BUILDING

Loading on tall buildings is different from low-rise buildings in many ways such as large accumulation of gravity loads on the floors from top to bottom, increased significance of wind loading and greater importance of dynamic effects. Thus, multi-storied structures need correct assessment of loads for safe and economical design. Except dead loads, the assessment of loads cannot be done accurately. Live loads can be anticipated approximately from a combination of experience and the previous field observations. Wind and earthquake loads are random in nature and it is difficult to predict them. They are estimated based on a probabilistic approach. The following discussion describes some of the most common kinds of loads on multi-storied structures.

4.1 Dead loads

Dead loads consist of the permanent construction material loads comprising the roof, floor, wall, and foundation systems, including claddings, finishes, and fixed equipment. The values for dead loads are for commonly used materials and constructions in light-frame residential buildings. Table 4.3 provides values for common material densities and may be useful in calculating dead loads more accurately. The design examples in Section 4.10 demonstrate the straight-forward process of calculating dead loads.

Live loads

Live loads are produced by the use and occupancy of a building. Loads include those from human occupants, furnishings, and non fixed equipment, storage, and construction and maintenance activities. Table 4.4 provides recommended design live loads for residential buildings. As required to adequately define the loading condition, loads are presented in terms of uniform area loads, concentrated loads, and uniform line loads. The uniform and concentrated live loads should not be applied simultaneously in a structural evaluation. Concentrated loads should be applied to a small area or surface consistent with the application and should be located or directed to give the maximum load effect possible in end-use conditions.

Gravity loads

Dead loads due the weight of every element within the structure as well as live loads that are acting on the structure when in service constitute gravity loads. The dead loads are calculated from the member sizes and estimated material densities. Live loads prescribed by codes are empirical and conservative based on experience and accepted practice. The equivalent minimum loads for office and residential buildings as per IS 875 are as specified in Table -4.1.

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Table 1: live load magnitudes (IS: 875-1987-part III)

Occupancy Classification	Uniformly Distributed Load KN/mm^2	Concentrated Load in KN
Office Buildings		
Offices and Staff Rooms	2.5	2.7
Class Rooms	3	2.7
Corridors Staff Rooms and Reading Rooms	4	4.5
Residential Buildings		
· Apartments	2	1.8
· Residence	4	2.7
· Corridors	3	4.5

A floor should be designed for the most adverse effect of uniformly distributed load and concentrated load over 0.3 m by 0.3 m as specified in Table- 4.1, but they should not be considered to act simultaneously. All other structural elements such as beams and columns are designed for the corresponding uniformly distributed loads on floors.

Reduction in imposed (live) load may be made in designing columns, load bearing walls etc., if there is no specific load like plant or machinery on the floor. This is allowed to account for reduced probability of full loading being applied over larger areas. The supporting members of the roof of the multi-storied building is designed for 100% of uniformly distributed load; further reductions of 10% for each successive floor down to a minimum of 50% of uniformly distributed load is done.

The live load at a floor level can be reduced in the design of beams, girders or trusses by 5% for each $50m^2$ area supported, subject to a maximum reduction of 25%. In cases where the reduced load of a lower floor is less than the reduced load of an upper floor, then the reduced load of the upper floor should be adopted in the lower floor also.

Wind loads

Wind load is primarily horizontal load caused by the movement of air relative to earth. Wind load is required to be considered in structural design especially when the heath of the building exceeds two times the dimensions transverse to the exposed wind surface.

For low rise building say up to four to five stories, the wind load is not critical because the moment of resistance provided by the continuity of floor system to column connection and walls provided between columns are sufficient to accommodate the effect of these forces. Further in limit state method the factor for design load is reduced to 1.2 (DL+LL+WL) when wind is considered as against the factor of 1.5(DL+LL) when wind is not considered.

The horizontal force exerted by the components of winds is to be kept in mind while designing is the building. The calculation of wind loads depends on the two factors, namely velocity of wind and size of the building. Complete details of calculating wind load on structures are given below (by the IS-875 (Part 3) - 1987).Using color code, basic wind pressure V_b is shown in a map of India. Designer can pick up the value of V_b depending upon the locality of the building.

To get the design wind velocity V_z the following expression shall be used:

$$V_z = k_1.k_2.k_3.V_b$$

Where,

k_1 = Risk coefficient

k_2 = Coefficient based on terrain, height and structure size.

k_3 = Topography factor

The design wind pressure is given by

$$p_z = 0.6\,V_z^2$$

Where,

p_z is in N/m^2 at height Z and

V_z is in m/sec.

Up to a height of 30 m, the wind pressure is considered to act uniformly. Above 30 m height, the wind pressure increases. For detailed information on evaluating wind load, the reader is referred to IS: 875-1987 (Part-III)

NOTE:

Design wind speed up to 10m height from mean G.L shall be considered constant.

K_2 = Category 3

For k_1 = basic wind speed =44 m/sec

Earthquake load

Seismic motion consists of horizontal and vertical ground motions, with the vertical motion usually having a much smaller magnitude. Further, factor of safety provided against gravity loads usually can accommodate additional forces due to vertical acceleration due to earthquakes. So, the horizontal motion of the ground causes the most significant effect on the structure by shaking the foundation back and forth. The mass of building resists this motion by setting up inertia forces throughout the structure. The magnitude of the horizontal shear force F depends on the mass of the building M, the acceleration of the ground a, and the nature of the structure. If a building and the foundation were rigid, it would have the same acceleration as the ground as given by Newton's second law of motion, i.e. F = Ma. However, in practice all buildings are flexible to some degree.

For a structure that deforms slightly, thereby absorbing some energy, the force will be less than the product of mass and acceleration. But, a very flexible structure will be subject to a much larger force under repetitive ground motion. This shows the magnitude of the lateral force on a building is not only dependent on acceleration of the ground but it will also depend on the type of the structure. As an inertia problem, the dynamic response of the building plays a large part in influencing and in estimating the effective loading on the structure. The earthquake load is estimated by Seismic co-efficient method or Response spectrum method. The later takes account of dynamic characteristics of structure along with ground motion.

STEPS FOR ANALYSIS

Design seismic base shear: The design seismic base shear or total design lateral force (V_B) along any principal direction shall be determined by the following expression: $V_B = A_h X W$ Where, A_h = Design horizontal acceleration spectrum value using the fundamental natural period 'T' in the considered direction of vibration
W = seismic weight of the building.
The A_h shall be determined by the following expression:

$$A_h = ZIS_a/2Rg$$

The value of Ah shall not be taken less than Z/2 whatever be the value of I/R.
Where,
Z = Zone factor is determined from the following table

Seismic Zone	II	III	IV	V
Seismic Intensity	Low	Moderate	Severe	Very Severe
Z	0.10	0.16	0.24	0.36

Table 2: Zone factor for different Seismic zones

I = represents the importance factor and it depends upon the functional use of the structures. It is characterized by hazardous consequences of its failure, post earthquake functional needs, historical value or economic importance. 1.5 is considered for the important structures like hospitals, schools, monumental buildings etc. and the rest of the buildings it is taken as 1.
R = It is Response reduction factor which depends on the perceived seismic damage performance of the structure, characterized by ductile or brittle deformations of the structure. This ration should not be greater than one. The values for R are given in Table 7 of IS: 1893. The value for R varies between 3 and 5 with respect to ductile reinforcement detailing.
Sa/g = Average response acceleration coefficient as per clause 6.4.5 of IS 1893:2002 as given by below figure and it is based on the damping and the natural periods of the structures.

NOTE: The value of Ah will not be taken less than ½ where ever the value of I/R

Analyzing the data

Linear dynamic analysis has been performed as per IS 1893 (Part 1): 2002 for each model using ETABS analysis package. Lateral load calculation and its distribution along the height are done. The seismic weight is calculated using full dead load plus 25% of live load.

Table 3**:** Following data is used in the analysis of the RC frame building

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 07 Issue 02
February 2020

Models

Type of frame	**Ordinary moment resisting RC frame OMRF) fixed at the base**
Seismic zones	II,V
Number of storey	G+20 storey
Floor height	3 m
Depth of Slab	150 mm
Size of beam	(300× 500) mm
Size of column	(230 × 500) mm
Spacing between frames in x-direction	3.75m
Spacing between frames in y-direction	5m
Density of concrete	25 kN/m3
Type of soil	Medium soil
Seismic zone	As per IS (1893-2002)
Seismic zone factor, Z	For zone II: 0.10 / For zone V: 0.36

PLAN AND ELEVATION OF G+20 BUILDING

PLAN OF G+20 BUILDING IN ETABS

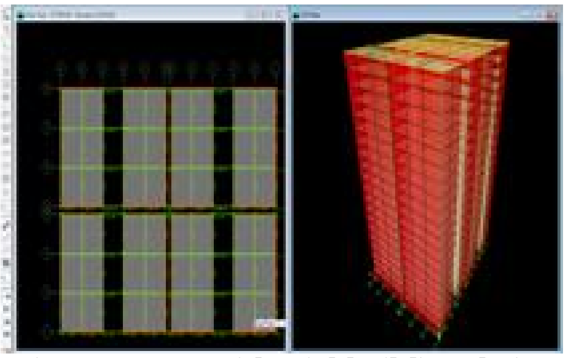
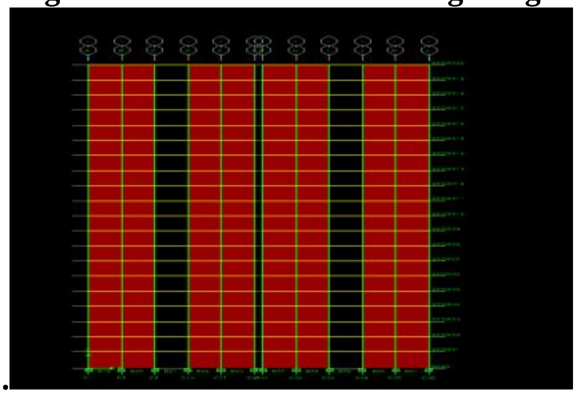


Fig 1: G+20 Residential building design



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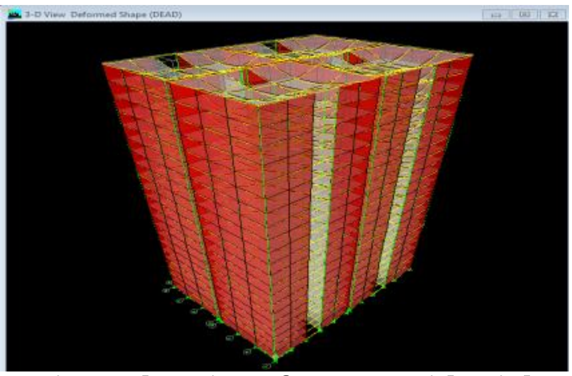


Fig 2: Elevation of G+20 Residential Building

Fig3: 3D view Deformed Dead

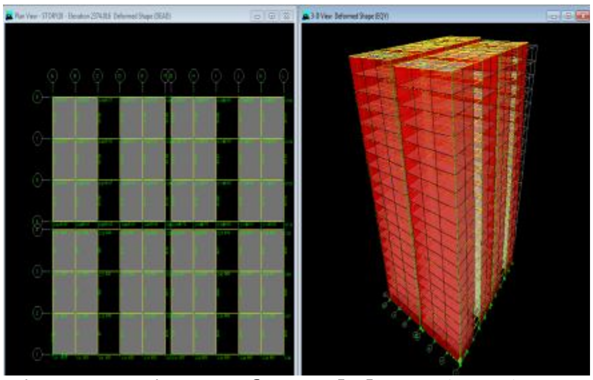


Fig 4: 3D view Deformed shape (EQy)

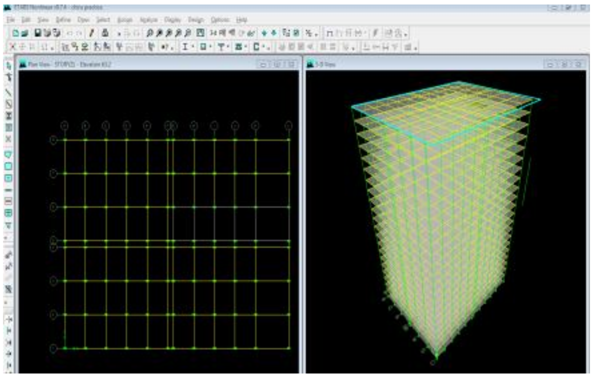


Fig 5: Plan View of Elevation

PLAN OF G+20 BUILDING:

The above figure represents the plan and elevation and 3d view of G+20 building in ETABS software in both zone II and zone V The plan certainly shows that it's a combination of 4 residences We can realize there's a blend between each and each residences

In every slab the whole flooring includes a 3 mattress area apartment that occupies entire floor of a slab. It represents a wealthy locality with massive areas for each residence. It's a g+20 projected building, as a consequence for 4 slabs we have now received 4*20=80 residences. The organize indicates the small print of dimensions of each and every space and hence the type of area and orientation of the quite a lot of areas like bed room, toilet, kitchen, corridor and so forth. All of the 4 flats have an identical area association.The

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 07 Issue 02
February 2020

complete prepare area is regarding 1193 sq.mts.

ELEVATION OF G+20 BUILDING:

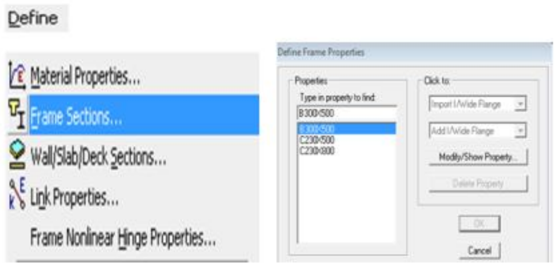
The fig 2 represents the projected elevation of constructing. It suggests the elevation of a g+20 constructing representing the front read which presents the summary of a building slab. The determine represents the location photograph of our structure that's taken on the place .The constructing is surely beneath constructions and every person the analysis and design work is accomplished earlier than the opening of the undertaking. Each and every floor contains top 3m that is taken as per GHMC rules for residential structures.

The building isn't designed for increasing the quantity of floors in future. So the variety of flooring is mounted for future conjointly for this constructing due to the fact of inaccessibility of the permissions of quite a lot of authorities.

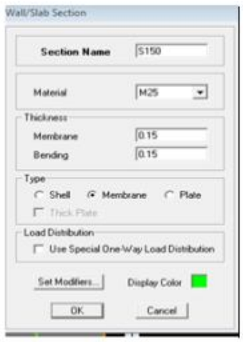
Additionally distinctive substances like ash and self compacted concrete have been conjointly utilized in an effort to decrease the dead load and increase lifetime of the structure and conjointly fortify economy. Nonetheless these materials weren't idea of whereas planning in staad to cut down the complexness and crucial corrections are created for considering the fact that the financial system and defense of the constitution due to the fact it would be a really enormous constructing with thirty residences. This is on the subject of thearrange and small print of the area and subsequent part deals with the seem a part of the building under varied masses that the building is intended.

DESIGN STEPS IN ETABS

Define section columns and beams using Define > Frame section

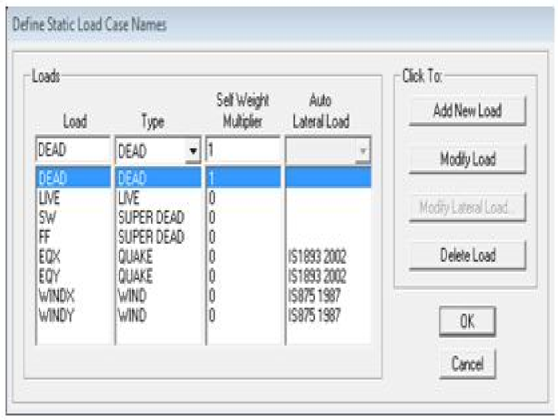


Define wall/slab/deck

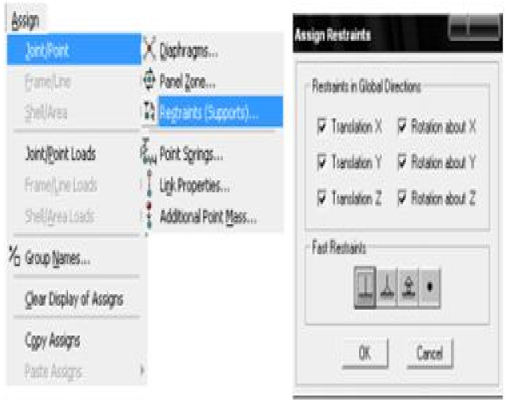


Define various loads (Dead load, live load, wind load, Earthquake load)

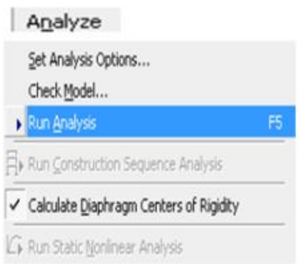
Define > Static Load Cases



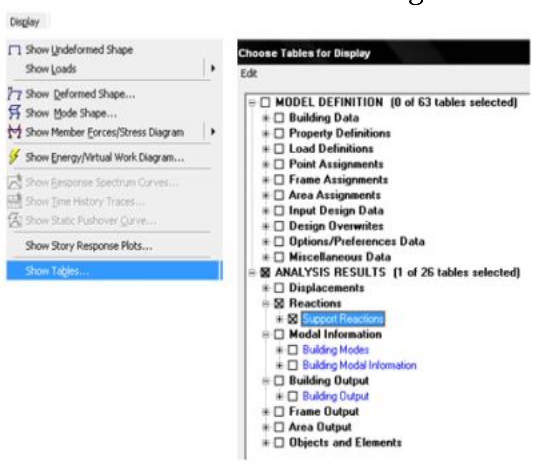
Assign support condition Drop-down box in the lower right-hand corner of the ETABS window, Select only bottom single storey level to assign fixed support using assign > Joint/Point>Restrain (Support) command

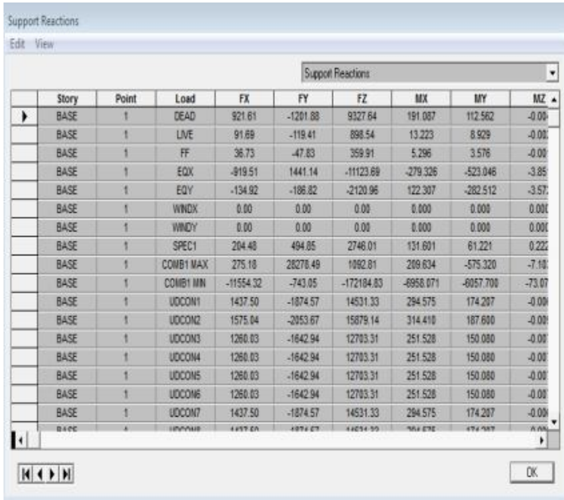


Run analysis from **Analysis > Run Analysis command**



In ETABS, dead load and other loads are shown from table as shown in figure.



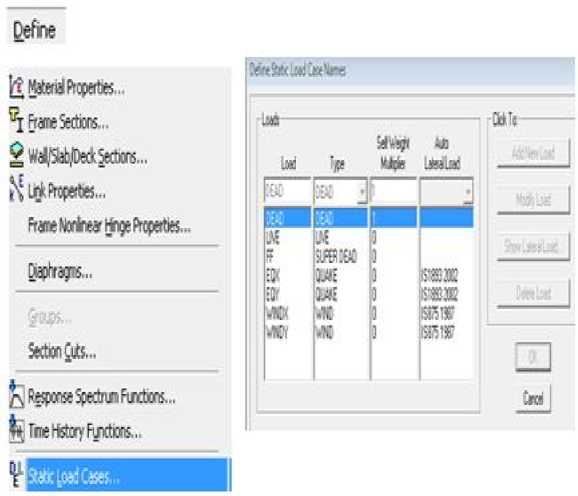

Support Reactions

	Story	Point	Load	FX	FY	FZ	MX	MY	MZ
▶	BASE	1	DEAD	921.61	-1201.88	9327.64	191.087	112.562	-0.00
	BASE	1	LIVE	91.69	-119.41	898.54	13.223	8.929	-0.00
	BASE	1	FF	36.73	-47.83	359.91	5.296	3.576	-0.00
	BASE	1	EQX	-919.51	1441.14	-11123.69	-279.326	-523.046	-3.85
	BASE	1	EQY	-134.92	-186.82	-2120.96	122.307	-282.512	-3.57
	BASE	1	WINDX	0.00	0.00	0.00	0.000	0.000	0.00
	BASE	1	WINDY	0.00	0.00	0.00	0.000	0.000	0.00
	BASE	1	SPEC1	204.48	494.85	2746.01	131.601	61.221	0.22
	BASE	1	COMB1 MAX	275.18	28278.49	1092.81	209.634	-575.320	-7.10
	BASE	1	COMB1 MIN	-11554.32	-743.05	-172184.83	-6958.071	-6057.700	-73.07
	BASE	1	UDCON1	1437.50	-1874.57	14531.33	294.575	174.207	-0.00
	BASE	1	UDCON2	1575.04	-2053.67	15879.14	314.410	187.600	-0.00
	BASE	1	UDCON3	1260.03	-1642.94	12703.31	251.528	150.080	-0.00
	BASE	1	UDCON4	1260.03	-1642.94	12703.31	251.528	150.080	-0.00
	BASE	1	UDCON5	1260.03	-1642.94	12703.31	251.528	150.080	-0.00
	BASE	1	UDCON6	1260.03	-1642.94	12703.31	251.528	150.080	-0.00
	BASE	1	UDCON7	1437.50	-1874.57	14531.33	294.575	174.207	-0.00

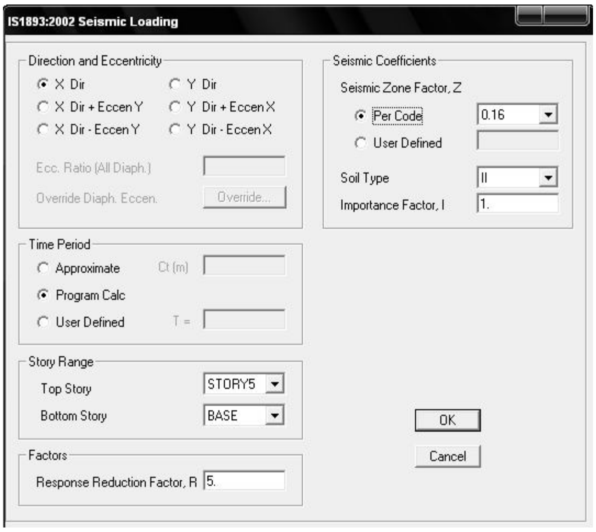
Seismic force calculation as per IS: 1893(Part 1) - 2002.

Static Method

Define static load from **Define > Static load command**

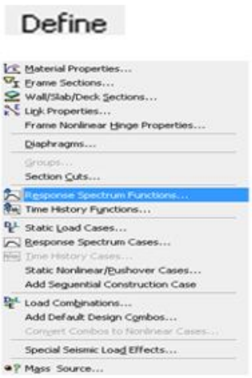
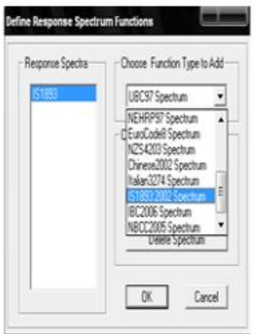


Press modify lateral load to shown below figure and assign various value as per IS1893-2002(part-1).



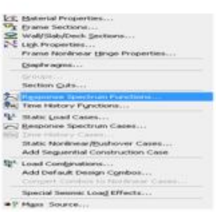
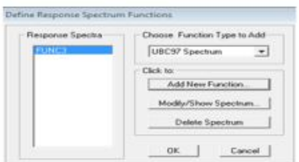
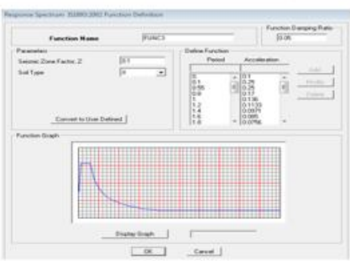
Dynamic Analysis Method

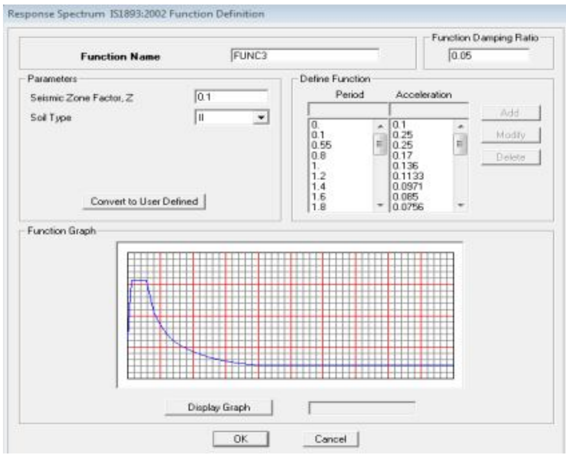
The design response spectra of IS 1893-2002 given as input in the **Define menu** > **Response Spectrum Functions.** Response spectra load cases are define in **Response Spectrum cases**

Site Specific Response Spectrum

Site specific response spectrum is define from **Define > Response Spectrum Function >Spectrum from File.**

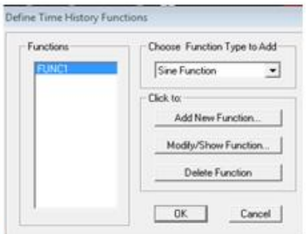


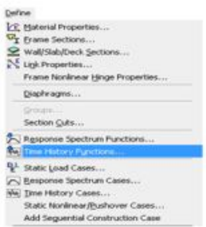
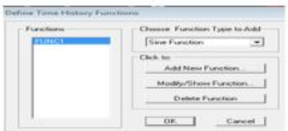
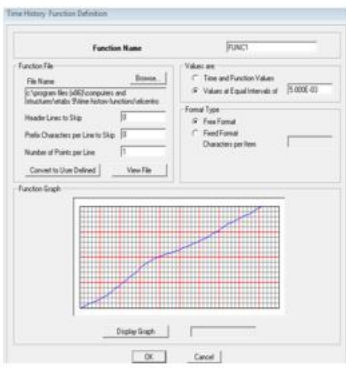
The damping value is specified which is used to generate the response spectrum curve. 5% damping factor and 9.81 (g) scale factor is assigned as shown in above Figure.

Site Specific Time History

Site specific time history is define from **Define > Time History Function**

Site specific time history is define from **Define > Time History Function**

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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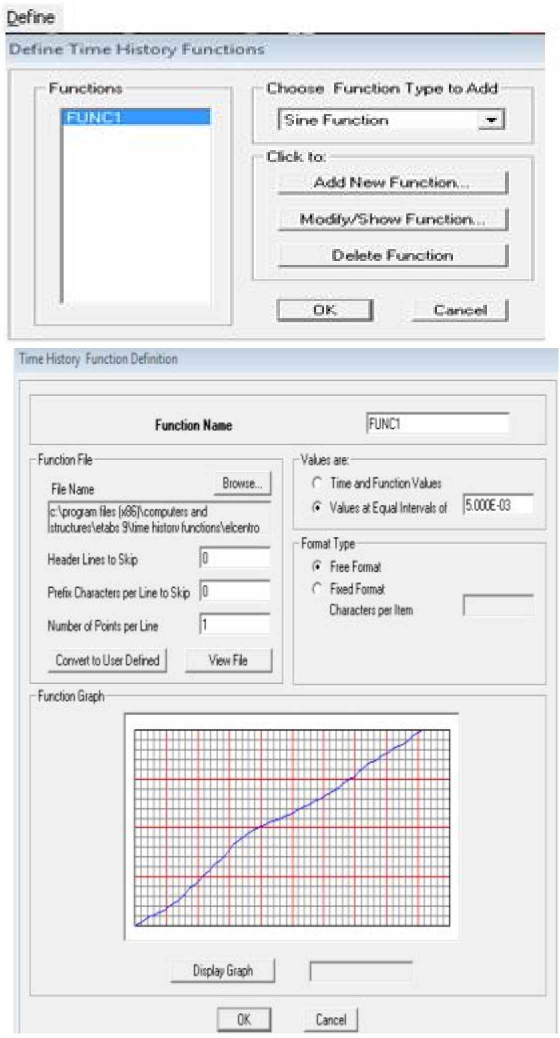
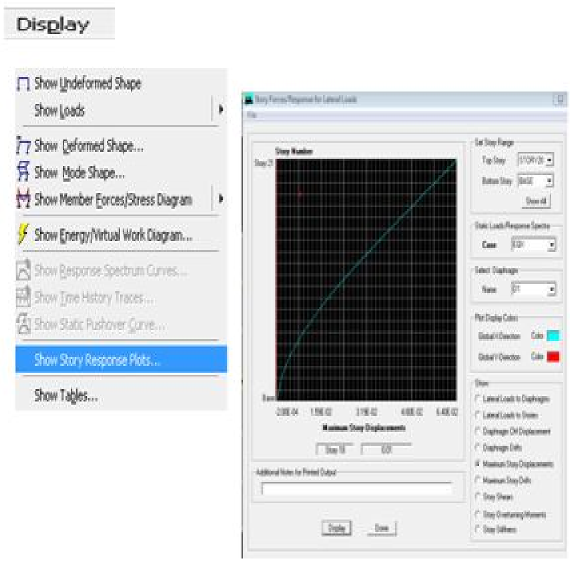
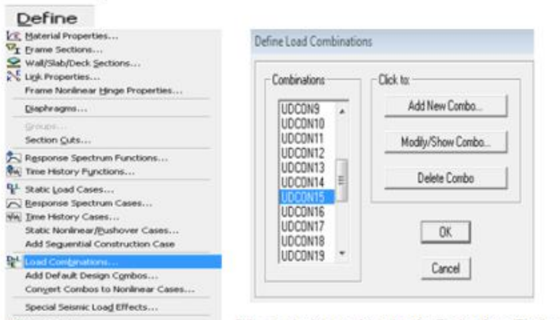


Run the analysis and various curves is shown from **Display > Show Storey Response Plot**



Design under Gravity and Seismic Load

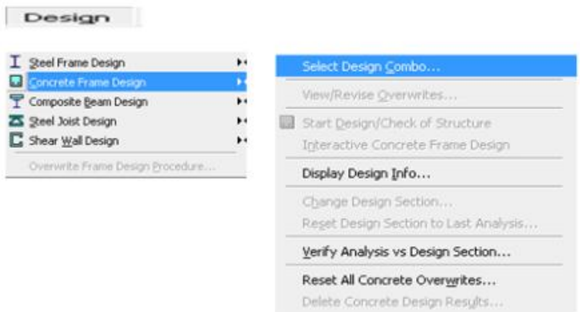
Design is carried out using different combination. ETABS have facility to generate combination as per IS 456-2000.

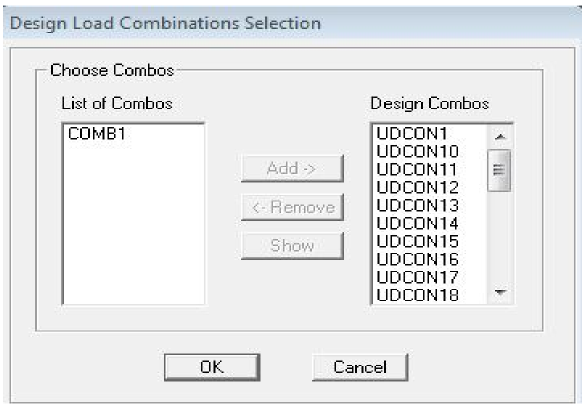


Select assigning combination for Design from **Design**

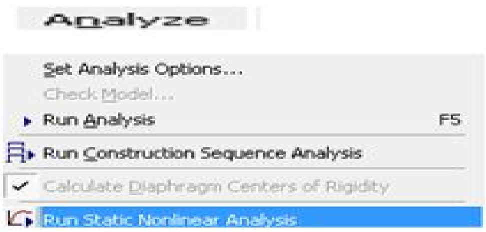
Select assigning combination for Design from **Design**

> Concrete Frame Design > Select Design Combination

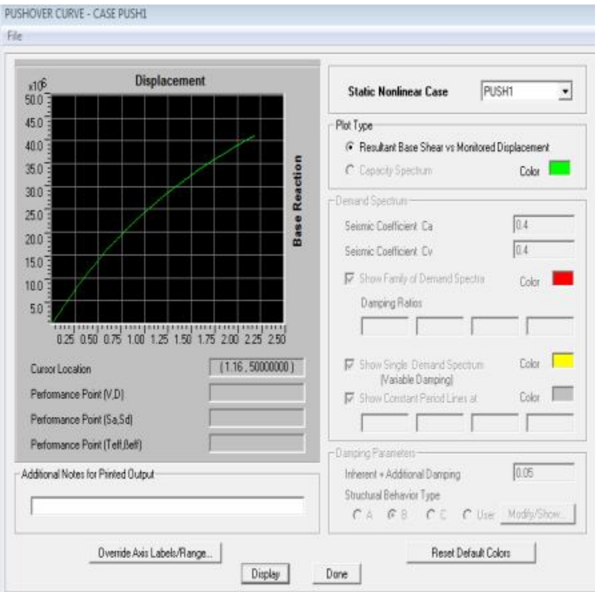




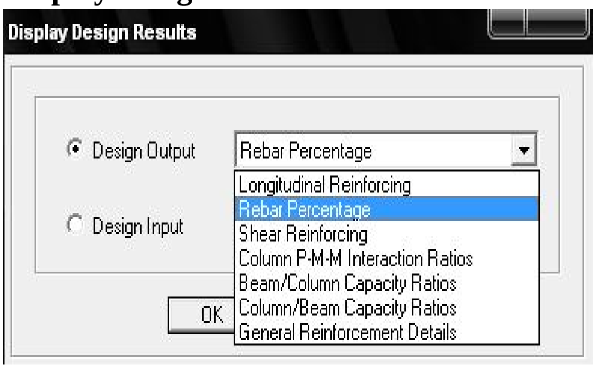
Run the Pushover analysis from **Analysis > Run Static Nonlinear Analysis command.**



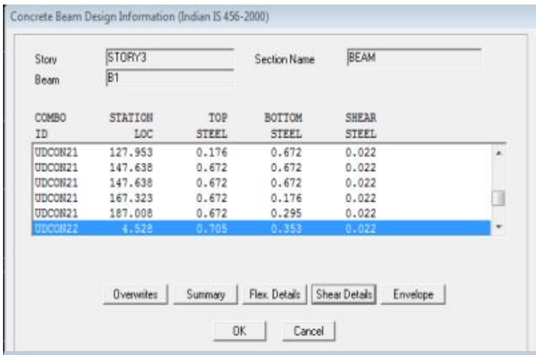
Review the pushover analysis results from **Display > Show Static Pushover Curve Command**

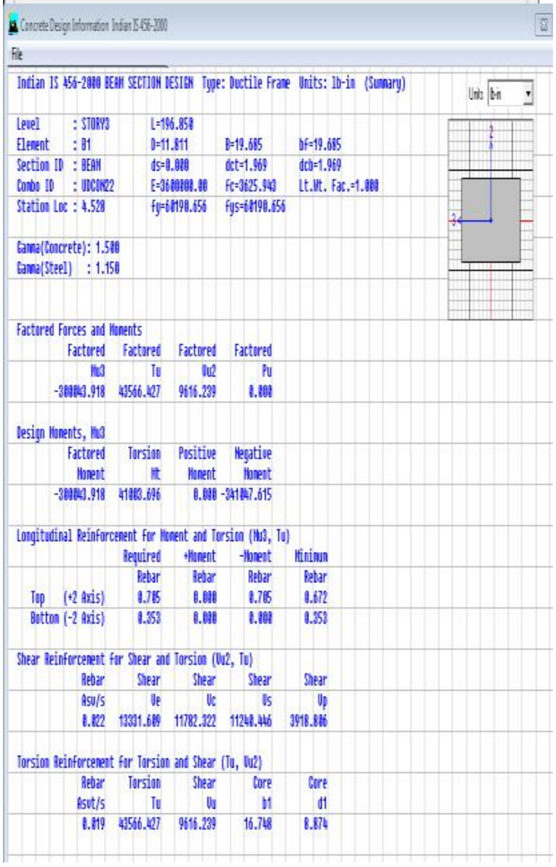


Design > Concrete Frame Design > Display Design Information



Select any beam member and left click to shown below figure





REINFORCEMENT DETAILS

ZONE II

Beam Reinforcement Details:

Storey 3:

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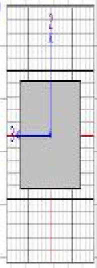
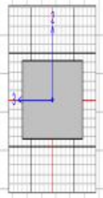
```
Concrete Design Information Indian IS 456-2000
File
                                                                      Units KN-m

Indian IS 456-2000 BEAM SECTION DESIGN  Type: Ductile Frame  Units: KN-m  (Flexural Details)

Level        : STORY3         L=5.000
Element      : B1             D=0.300         B=0.500         bf=0.500
Section ID   : BEAM           ds=0.000        dct=0.050       dcb=0.050
Combo ID     : UDCON22        E=24821128.40   Fc=25000.000    Lt.Wt. Fac.=1.000
Station Loc  : 0.115          Fy=415000.000   Fys=415000.000

Gamma(Concrete): 1.500
Gamma(Steel)   : 1.150


LONGITUDINAL REINFORCEMENT FOR MOMENT AND TORSION, (Mu3, Tu)
                        Required  +veMoment  -veMoment RegularMin SeismicMin
                           Rebar      Rebar      Rebar      Rebar      Rebar
  Top     (+2 Axis)    4.550E-04      0.000  4.550E-04  3.072E-04  4.337E-04
  Bottom  (-2 Axis)    2.275E-04      0.000      0.000      0.000  2.275E-04

Factored Forces and Moments
             Factored   Factored    Torsion
                  Mu3         Tu         Mt
              -33.900      4.922      4.633

Design Moments, Mu3
               Design     Design
            +veMoment  -veMoment
                0.000    -38.533
```




```
Concrete Design Information Indian IS 456-2000
File
                                                                      Units Kip-in

Indian IS 456-2000 BEAM SECTION DESIGN  Type: Ductile Frame  Units: Kip-in  (Shear Details)

Level        : STORY3         L=196.850
Element      : B1             D=11.811        B=19.685        bf=19.685
Section ID   : BEAM           ds=0.000        dct=1.969       dcb=1.969
Combo ID     : UDCON22        E=3600.000      Fc=3.626        Lt.Wt. Fac.=1.000
Station Loc  : 4.528          Fy=60.191       Fys=60.191

Gamma(Concrete): 1.500
Gamma(Steel)   : 1.150


SHEAR/TORSION DESIGN FOR Vu2 and Tu
            Rebar      Rebar     Design     Design     Design
            Asv/s     Asvt/s         Vu         Tu         Pu
            0.022      0.019     13.332     43.566      0.000

Design Forces
         Factored   Factored Equivalent   Capacity    Gravity
               Vu         Tu         Ve         Vp         Vg
            9.616     43.566     16.873      3.919     -9.413

Capacity Moment (Left)
        Long.Rebar Long.Rebar Cap.Moment Cap.Moment
           As(Bot)    As(Top)       Mpos       Mneg
             0.353      0.705    177.948    248.472

Capacity Moment (Right)
        Long.Rebar Long.Rebar Cap.Moment Cap.Moment
           As(Bot)    As(Top)       Mpos       Mneg
             0.295      0.672    149.253    332.842

Design Basis
        Lt.Wt.Reduc   Strength   Strength       Area
             Factor         Fy        Fck         Ag
              1.000     60.191      3.626    232.500

Concrete Capacity
        Conc.Area Tensn.Rein        Ast  Allowable  Allowable CompFactor DepthFactr    Strengh
               Ac   Area Ast          % Tau_c(MPa)      Tau_c      Delta          k     Factor
          193.750      0.705      0.364      0.419      0.061      1.000      1.000      1.000
```



For Storey 8:

```
Indian IS 456-2000 BEAM SECTION DESIGN  Type: Ductile Frame  Units: Kip-in  (Summary)

Level        : STORY8         L=196.850
Element      : B4             D=11.811        B=19.685        bf=19.685
Section ID   : BEAM           ds=0.000        dct=1.969       dcb=1.969
Combo ID     : UDCON2         E=3600.000      Fc=3.626        Lt.Wt. Fac.=1.000
Station Loc  : 4.528          Fy=60.191       Fys=60.191

Gamma(Concrete): 1.500
Gamma(Steel)   : 1.150


Factored Forces and Moments
             Factored   Factored   Factored   Factored
                  Mu3         Tu        Vu2         Pu
             -818.136     60.541     15.087      0.000

Design Moments, Mu3
             Factored    Torsion   Positive   Negative
               Moment         Mt     Moment     Moment
             -818.136     56.980      0.000   -875.117

Longitudinal Reinforcement For Moment and Torsion (Mu3, Tu)
                        Required    +Moment    -Moment    Minimum
                           Rebar      Rebar      Rebar      Rebar
  Top     (+2 Axis)        2.072      0.000      2.072      0.672
  Bottom  (-2 Axis)        1.036      0.000      0.000      1.036

Shear Reinforcement For Shear and Torsion (Vu2, Tu)
                Rebar      Shear      Shear      Shear      Shear
                Asv/s         Ve         Vc         Vs         Vp
                0.022     15.087     18.452     11.240      9.483

Torsion Reinforcement For Torsion and Shear (Tu, Vu2)
                Rebar    Torsion      Shear       Core       Core
               Asvt/s         Tu         Vu         b1         d1
                0.021     60.541     15.087     16.748      8.874
```

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
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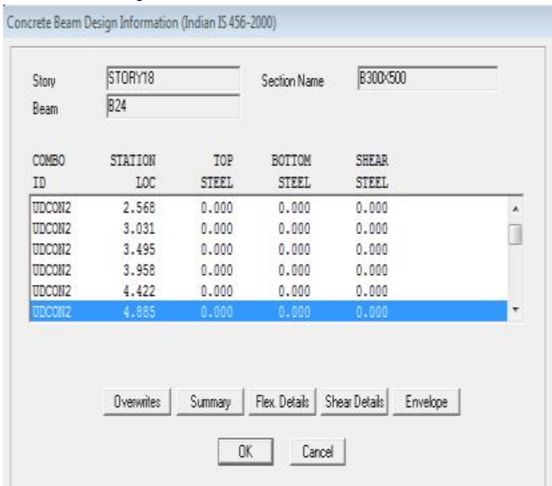
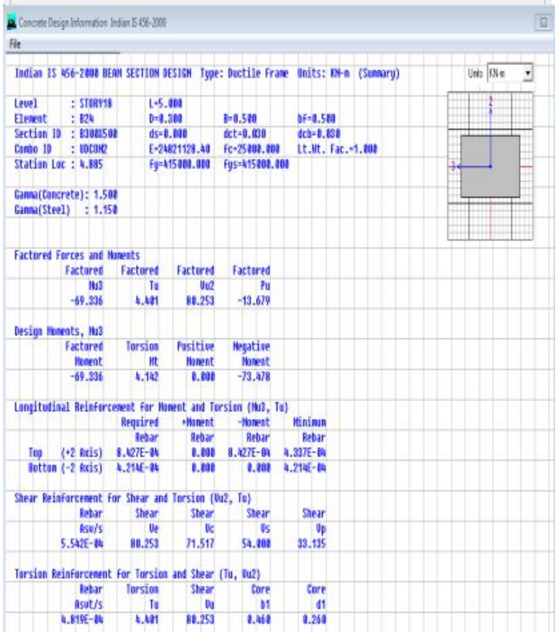
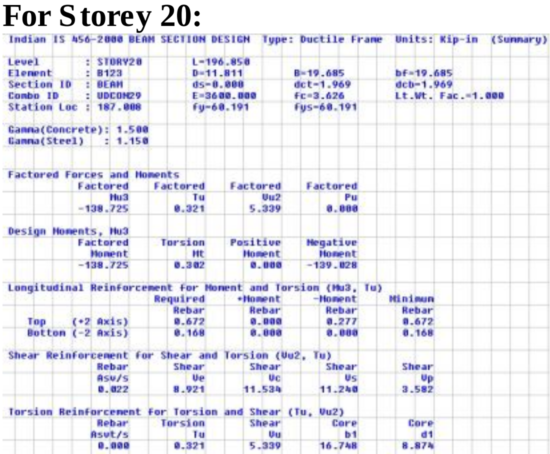
For Storey 18:





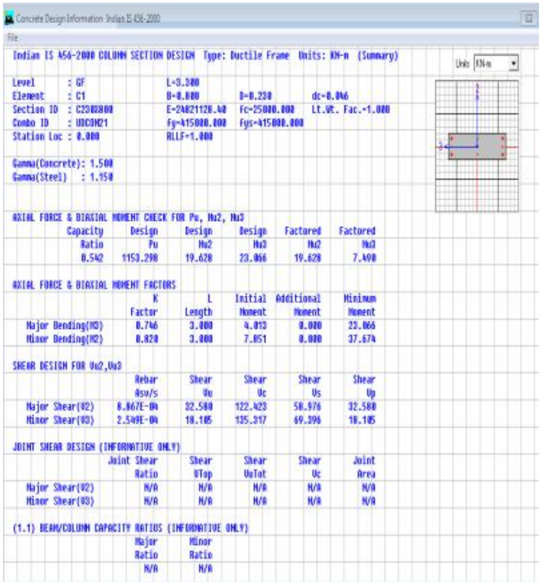
For Storey 20:



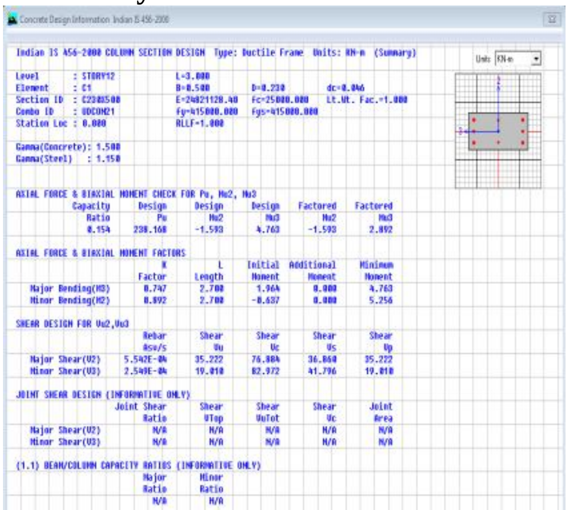
ZONE II

Column Reinforcement Details:

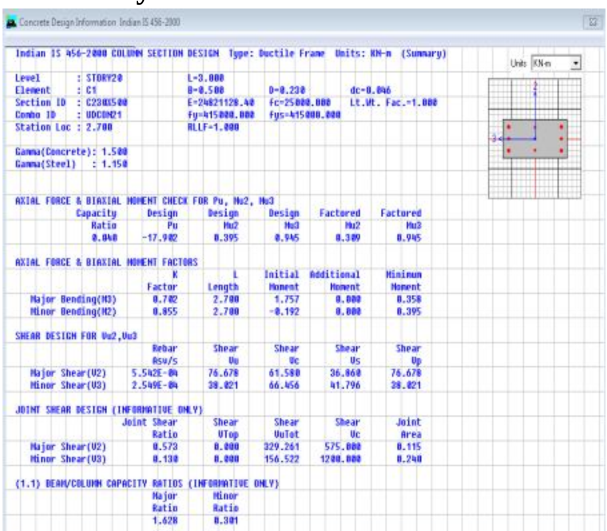
For Storey GF:



For Storey 12:



For Storey 20:



International Journal of Research
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p-ISSN: 2348-6848
e-ISSN: 2348-795X
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ZONE V

Beam Reinforcement Details:

For Storey 1:

```
Indian IS 456-2000 BEAM SECTION DESIGN  Type: Ductile Frame  Units: Kip-in  (Summary)

Level        : STORY1          L=196.850
Element      : B1              D=11.811        B=19.685        bf=19.685
Section ID   : BEAM            ds=0.000        dct=1.969       dcb=1.969
Combo ID     : UDCON29         E=3600.000      fc=3.626        Lt.Wt. Fac.=1.000
Station Loc  : 181.102         fy=60.191       fys=60.191

Gamma(Concrete): 1.500
Gamma(Steel)    : 1.150

Factored Forces and Moments
              Factored   Factored   Factored   Factored
                   Mu3         Tu        Vu2         Pu
              -108.735      8.693      5.000      0.000

Design Moments, Mu3
              Factored    Torsion   Positive   Negative
                Moment         Mt     Moment     Moment
              -108.735      8.181      0.000   -116.916

Longitudinal Reinforcement For Moment and Torsion (Mu3, Tu)
                         Required    +Moment    -Moment    Minimum
                            Rebar      Rebar      Rebar      Rebar
  Top    (+2 Axis)          0.672      0.000      0.232      0.672
  Bottom (-2 Axis)          0.168      0.000      0.000      0.168

Shear Reinforcement For Shear and Torsion (Vu2, Tu)
                 Rebar      Shear      Shear      Shear      Shear
                 Asv/s         Ve         Vc         Vs         Vp
                 0.022      5.000     11.534     11.240      3.944

Torsion Reinforcement For Torsion and Shear (Tu, Vu2)
                 Rebar    Torsion      Shear       Core       Core
                Asvt/s         Tu         Vu         b1         d1
                 0.000      8.693      5.000     16.748      8.874
```

For Storey 9:

```
Indian IS 456-2000 BEAM SECTION DESIGN  Type: Ductile Frame  Units: Kip-in  (Summary)

Level        : STORY9          L=147.638
Element      : B29             D=11.811        B=19.685        bf=19.685
Section ID   : BEAM            ds=0.000        dct=1.969       dcb=1.969
Combo ID     : UDCON2          E=3600.000      fc=3.626        Lt.Wt. Fac.=1.000
Station Loc  : 4.528           fy=60.191       fys=60.191

Gamma(Concrete): 1.500
Gamma(Steel)    : 1.150

Factored Forces and Moments
              Factored   Factored   Factored   Factored
                   Mu3         Tu        Vu2         Pu
             -1169.703    108.889     22.620      0.000

Design Moments, Mu3
              Factored    Torsion   Positive   Negative
                Moment         Mt     Moment     Moment
             -1169.703    102.484      0.000  -1272.186

Longitudinal Reinforcement For Moment and Torsion (Mu3, Tu)
                         Required    +Moment    -Moment    Minimum
                            Rebar      Rebar      Rebar      Rebar
  Top    (+2 Axis)          3.091      0.000      3.091      0.773
  Bottom (-2 Axis)          1.545      0.000      0.795      1.545

Shear Reinforcement For Shear and Torsion (Vu2, Tu)
                 Rebar      Shear      Shear      Shear      Shear
                 Asv/s         Ve         Vc         Vs         Vp
                 0.022     22.620     21.222     11.240     25.458

Torsion Reinforcement For Torsion and Shear (Tu, Vu2)
                 Rebar    Torsion      Shear       Core       Core
                Asvt/s         Tu         Vu         b1         d1
                 0.033    108.889     22.620     16.748      8.874
```

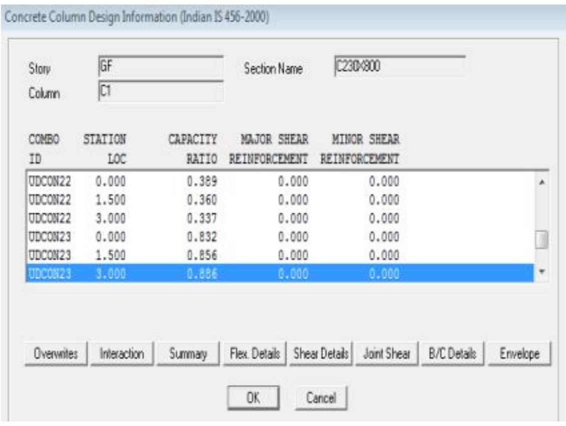
For Storey 20:

```
Indian IS 456-2000 BEAM SECTION DESIGN  Type: Ductile Frame  Units: Kip-in  (Summary)

Level        : STORY20         L=196.850
Element      : B124            D=11.811        B=19.685        bf=19.685
Section ID   : BEAM            ds=0.000        dct=1.969       dcb=1.969
Combo ID     : UDCON2          E=3600.000      fc=3.626        Lt.Wt. Fac.=1.000
Station Loc  : 192.323         fy=60.191       fys=60.191

Gamma(Concrete): 1.500
Gamma(Steel)    : 1.150

Factored Forces and Moments
              Factored   Factored   Factored   Factored
                   Mu3         Tu        Vu2         Pu
              -270.057    226.603      9.402      0.000

Design Moments, Mu3
              Factored    Torsion   Positive   Negative
                Moment         Mt     Moment     Moment
              -270.057    213.274      0.000   -491.331

Longitudinal Reinforcement For Moment and Torsion (Mu3, Tu)
                         Required    +Moment    -Moment    Minimum
                            Rebar      Rebar      Rebar      Rebar
  Top    (+2 Axis)          1.049      0.000      1.049      0.672
  Bottom (-2 Axis)          0.525      0.000      0.000      0.525

Shear Reinforcement For Shear and Torsion (Vu2, Tu)
                 Rebar      Shear      Shear      Shear      Shear
                 Asv/s         Ve         Vc         Vs         Vp
                 0.027      9.402     14.144     13.676      5.702

Torsion Reinforcement For Torsion and Shear (Tu, Vu2)
                 Rebar    Torsion      Shear       Core       Core
                Asvt/s         Tu         Vu         b1         d1
                 0.037    226.603      9.402     16.748      8.874
```

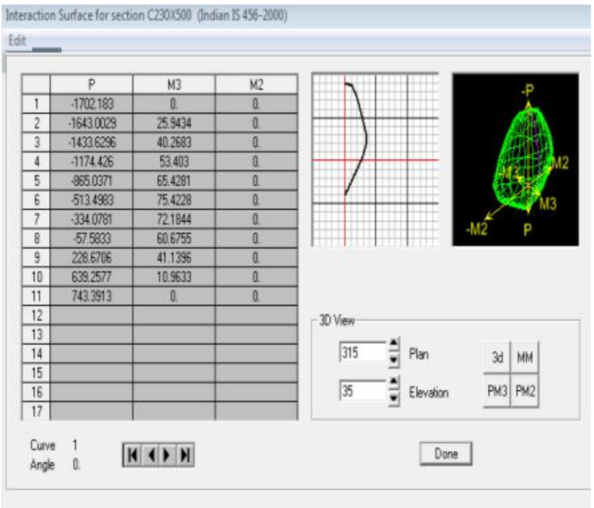
Zone V

Column Reinforcement Details:

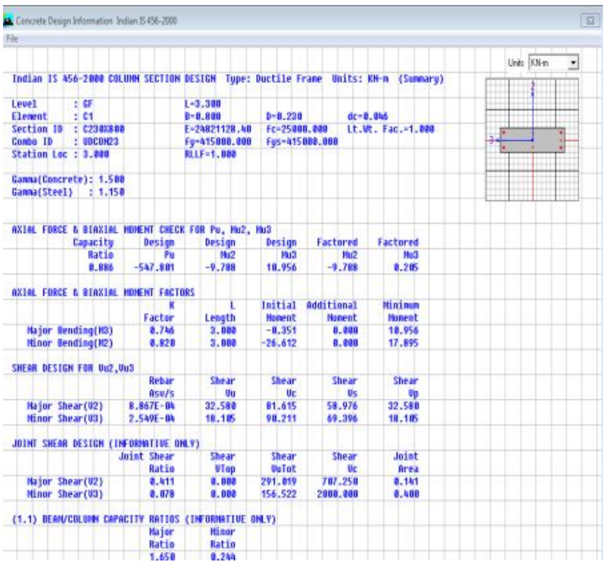
For Storey GF

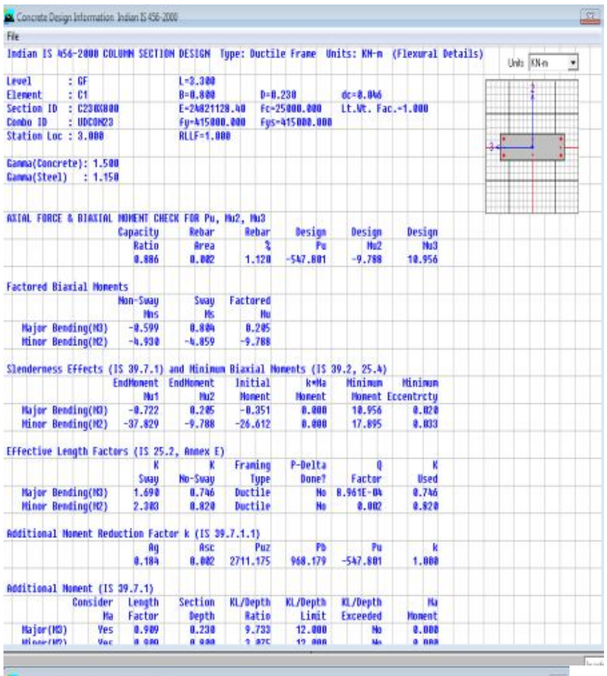


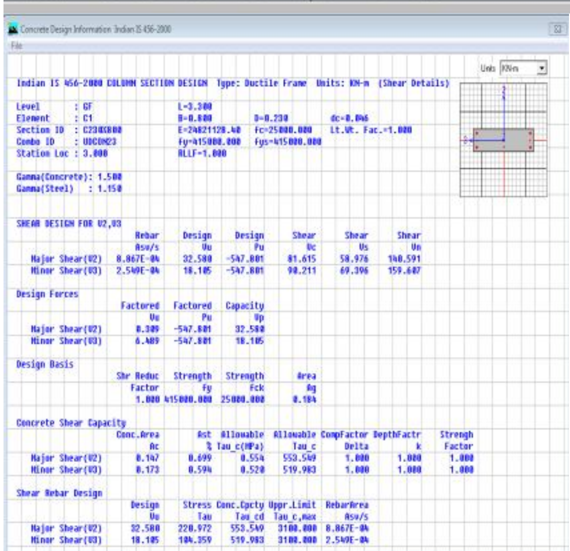
COMBO ID	STATION LOC	CAPACITY RATIO	MAJOR SHEAR REINFORCEMENT	MINOR SHEAR REINFORCEMENT
UDCON22	0.000	0.389	0.000	0.000
UDCON22	1.500	0.360	0.000	0.000
UDCON22	3.000	0.337	0.000	0.000
UDCON23	0.000	0.832	0.000	0.000
UDCON23	1.500	0.856	0.000	0.000
UDCON23	3.000	0.886	0.000	0.000



	P	M3	M2
1	-1702.183	0	0
2	-1643.0029	25.9434	0
3	-1433.6296	40.2683	0
4	-1174.426	53.403	0
5	-865.0371	65.4281	0
6	-513.4983	75.4228	0
7	-334.0781	72.1844	0
8	-57.5833	60.6755	0
9	228.6706	41.1396	0
10	639.2577	10.9633	0
11	743.3913	0	0
12			
13			
14			
15			
16			
17			

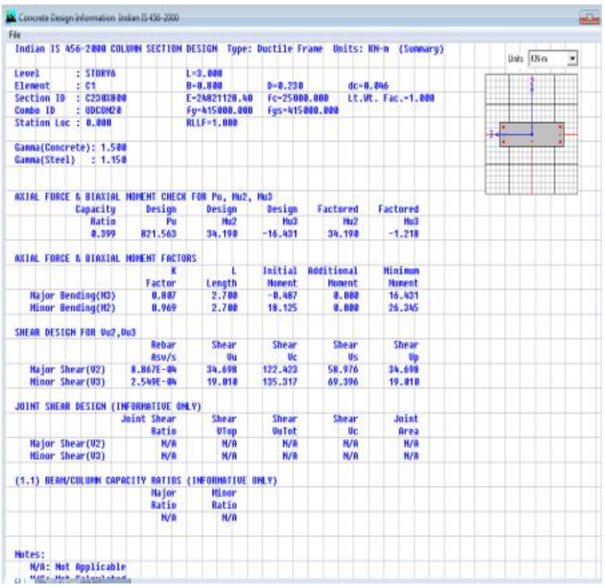






For Storey 6

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 07 Issue 02
February 2020



Concrete Design Information Indian IS 456-2000

File

Indian IS 456-2000 COLUMN SECTION DESIGN Type: Ductile Frame Units: KN-m (Summary)

Units: KN-m

Level : STORY6 L=3.000
Element : C1 B=0.800 D=0.230 dc=0.046
Section ID : C230X800 E=24821128.40 Fc=25000.000 Lt.Wt. Fac.=1.000
Combo ID : UDCON20 Fy=415000.000 Fys=415000.000
Station Loc : 0.000 RLLF=1.000

Gamma(Concrete): 1.500
Gamma(Steel) : 1.150

AXIAL FORCE & BIAXIAL MOMENT CHECK FOR Pu, Mu2, Mu3

Capacity Ratio	Design Pu	Design Mu2	Design Mu3	Factored Mu2	Factored Mu3
0.399	821.563	34.190	-16.431	34.190	-1.218

AXIAL FORCE & BIAXIAL MOMENT FACTORS

	K Factor	L Length	Initial Moment	Additional Moment	Minimum Moment
Major Bending(M3)	0.807	2.700	-0.487	0.000	16.431
Minor Bending(M2)	0.969	2.700	10.125	0.000	26.345

SHEAR DESIGN FOR Vu2,Vu3

	Rebar Asv/s	Shear Vu	Shear Vc	Shear Vs	Shear Vp
Major Shear(V2)	8.867E-04	34.698	122.423	58.976	34.698
Minor Shear(V3)	2.549E-04	19.010	135.317	69.396	19.010

JOINT SHEAR DESIGN (INFORMATIVE ONLY)

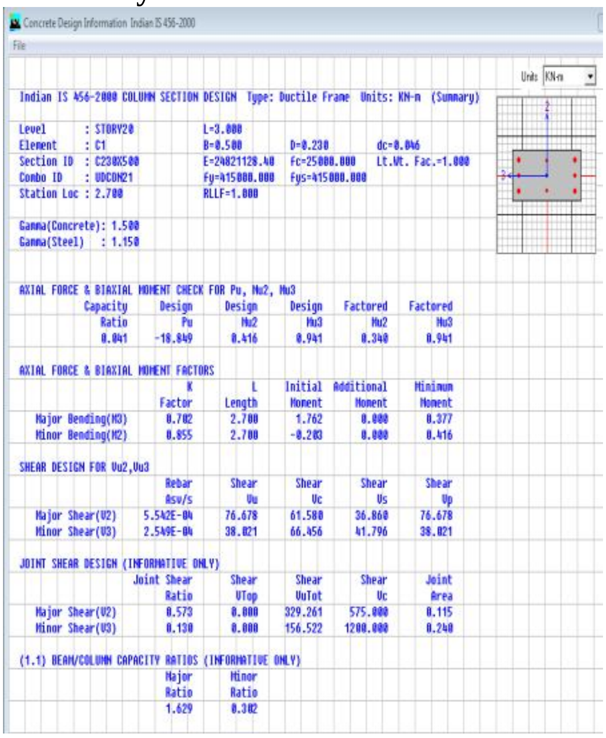
	Joint Shear Ratio	Shear VTop	Shear VuTot	Shear Vc	Joint Area
Major Shear(V2)	N/A	N/A	N/A	N/A	N/A
Minor Shear(V3)	N/A	N/A	N/A	N/A	N/A

(1.1) BEAM/COLUMN CAPACITY RATIOS (INFORMATIVE ONLY)

Major Ratio	Minor Ratio
N/A	N/A

Notes:
N/A: Not Applicable

For Storey 20



Concrete Design Information Indian IS 456-2000

File

Units: KN-m

Indian IS 456-2000 COLUMN SECTION DESIGN Type: Ductile Frame Units: KN-m (Summary)

Level : STORY20 L=3.000
Element : C1 B=0.500 D=0.230 dc=0.046
Section ID : C230X500 E=24821128.40 Fc=25000.000 Lt.Wt. Fac.=1.000
Combo ID : UDCON21 Fy=415000.000 Fys=415000.000
Station Loc : 2.700 RLLF=1.000

Gamma(Concrete): 1.500
Gamma(Steel) : 1.150

AXIAL FORCE & BIAXIAL MOMENT CHECK FOR Pu, Mu2, Mu3

Capacity Ratio	Design Pu	Design Mu2	Design Mu3	Factored Mu2	Factored Mu3
0.041	-18.849	0.416	0.941	0.340	0.941

AXIAL FORCE & BIAXIAL MOMENT FACTORS

	K Factor	L Length	Initial Moment	Additional Moment	Minimum Moment
Major Bending(M3)	0.702	2.700	1.762	0.000	0.377
Minor Bending(M2)	0.855	2.700	-0.203	0.000	0.416

SHEAR DESIGN FOR Vu2,Vu3

	Rebar Asv/s	Shear Vu	Shear Vc	Shear Vs	Shear Vp
Major Shear(V2)	5.542E-04	76.678	61.580	36.860	76.678
Minor Shear(V3)	2.549E-04	38.021	66.456	41.796	38.021

JOINT SHEAR DESIGN (INFORMATIVE ONLY)

	Joint Shear Ratio	Shear VTop	Shear VuTot	Shear Vc	Joint Area
Major Shear(V2)	0.573	0.000	329.261	575.000	0.115
Minor Shear(V3)	0.130	0.000	156.522	1200.000	0.240

(1.1) BEAM/COLUMN CAPACITY RATIOS (INFORMATIVE ONLY)

Major Ratio	Minor Ratio
1.629	0.302

CONCLUSIONS

The behavior of high rise structure for both the scheme is studied in present paper. In this paper we got the results from mathematical model for models. The graph clearly shows the storey drift, lateral displacement and time period. It is also observed that the results are more conservative in Static analysis as compared to the dynamic method resulting uneconomical structure. Because of the Box effect of modular type scheme, it is increasing overall stiffness of the building thus, reducing the sway problem in the structure. As building is in irregular the behavior in both directions is not similar. Further, the comparison between regular and modular type indicates the overall feasibility of the scheme without affecting its stability in gravity as well as lateral loads.

1. In zone II soils from the table 2, graph 1 and table 3, graph 2 it clearly shows that the storey drift x and storey drift y are higher in earth quake than the spectrum.
2. As we compared in zone II and zone V from table 20, graph 19 and table 21, graph 20 the storey drift is higher in zone V than zone II.
3. From table 22, graph 21 and table 23, graph 22 the storey shear is higher in zone V than zone II.
4. Designing by Software's like ETABS reduces of your time in design work.
5. Details of every and each member will be obtained by ETABS.
6. All the List of unsuccessful beams will be obtained and conjointly higher Section is given by the software.
7. Accuracy is improved by using software.

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