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Comparative Seismic Analysis of Intz Tank with Change in Seismic Severity

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Abstract: ***A 10lac liters of Intz type water tank is considered for this thesis work. The structural size was decided on the basis of the various literates studied and considering practical site considerations. For this purpose, types of loads and their intensities were considered as per the particular Indian code such as IS 875 part-01 and 02 for dead load and live load and IS 1893 part 01 for seismic loading on water tank. As these loading and loading combinations undergoes a tedious manual calculations structural design software Staad Pro. will be used for analysis and design. After detailed analysis it is found that Values of base reactions in horizontal direction due to seismic action increases drastically with 260 % from 53.93 in Zone II to 194.22 in Zone V, representing very high significance of change in seismic severity. Values of base reactions in vertical direction increases gradually with 52.57 % from 1957.08 Kn in Zone II to 2986.02 Kn in Zone IV, representing moderate significance of change in seismic severity. Values of base moments shows again shows drastic increase of 257.62 % from 139.74 Kn.m in Zone II to 499.74 Kn.m in Zone IVin horizontal direction. Whereas there is no such major change found in moments in vertical directions.***
Keywords: STAAD pro., seismic zones, base shear, displacement

I. INTRODUCTION

A water tank is used to store water to tide over the daily requirement. In the construction of concrete structure for the storage of water and other liquids the imperviousness of concrete is most essential. The permeability of any uniform and thoroughly compacted concrete of given mix proportions is mainly dependent on water cement ratio. The increase in water cement ratio results in increase in the permeability. The decrease in water cement ratio will therefore be desirable to decrease the permeability, but very much reduced water cement ratio may cause compact ion difficulties and prove to be harmful also. Design of liquid retaining structure has to be based on the avoidance of cracking in the concrete having regard to its tensile strength.

II. LITERATURE REVIEW

Nupur Gautam et al 1 In this present work efforts were taken to study the effect of IS code revision in relation with seismic considerations. In which it is found that most water tanks are designed according to the old IS: 3370- 1965 without taking into account earthquakes. And after a long time, BIS released the revised version of IS 3370 (part 1 and 2) from its version of 1965 in 2009. And after the earthquake of January 26, 2001 in the earthquake zone of Gujarat has also changed. So in a contemporary water tank requires designed strength according to IS: 3370-2009 considered to be earthquake forces.. Anurag Bajpai et al 2 In this research paper, the capacity 250m3 intze tank have been designed and analyzed by response spectrum method. Seismic response such as Base Shear, Base Moment, Tank displacement under empty and fill condition in different seismic zones II, III, IV and V have been calculated. After analysis it was found that, Lateral force is more in tank full condition when compared to tank empty condition hence tank full case is considered for seismic analysis. Also it is observed that base shear, base moment and displacement obtained from full condition is greater than empty condition. Anurag Bajpai et al 3 The main aim of this study was to understand the behavior of supporting system which is more effective in different seismic zones under Response Spectrum Method. After performing analysis by Response Spectrum Method using SAP2000 v21 software and comparisons it was found that as seismic zones increase from zone II to Zone V, base shear and base moment values for simple brace are less then cross brace and radial brace. Base shear and base moment values in seismic zone V are less for simple brace. Ankita D. Katkar et al 4 In this paper analysis was conducted as per the specifications of IS 3370, IS 800:2002, IS 875, IS 1893. Designoftank by the dome, Ring beam supporting the dome, Cylindrical walls, Ring beam at the junction of the cylindrical walls and the conical wall , Conical slab, Floor of the tank, The ring girder, Columns, Tower with bracings, Foundations as per IS 3370 -Part III will be done by using 2-Dimensional STAAD model for different 2,50,000 Litres capacity tank .Different loads such as Dead Load, Live Load, Wind load, Earthquake Load will be applied on STAAD model at appropriate location as per codes used for Loading. All the results obtain from STADD are compared with the help of Excel sheets.

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With the standard dimensions of the Intze reservoir to be modeled be safe for wind loads, seismic loads. At the end it was found that There is an increase in moment when the height of the structure increases. When using fix joint at the base its remarkable reduction in base settlement. Hemish kumar Patel et al 5 This paper is an application of optimization method to the structural Analysis and design of Intze elevated water tanks, considering the total economy of the tank as an objective function with the properties of the tank that are tank capacity, width and length of tank in rectangular, water depth in circular, unit weight of water and tank floor slab thickness, as design variables. A computer program has been developed to solve numerical examples. The results shows that the tank capacity taken up the minimum economy for Intze tank. The tank floor slab thickness taken up the minimum economy for tanks. The unit weight of water in tank taken up the minimum economy for Intze tank

III.METHODOLOGY

Various aspects which are to be considered in this work for optimum analysis and the required work glow is as mentioned below

A. General Data Collection

Before starting and deciding the actual work path some general data related to types of water tank, types of framing systems, types of design methods, various types of seismic analysis methods were collected and studied. Based on the above said collected data various parameters will be decided in the further chapters.

B. Literature Study

After collecting basic data various literatures were collected and studied to decide the case consideration and variable to be compared to get the most efficient model with varying seismicity. Various literatures were studied related to effect of seismic zone, capacity of tank, effect of staging pattern, effect of software used, from which it is found that capacity of tank and its shape has severe effect on behavior of water tank during seismic action., which are to be action in consideration to save the lives during any earthquake damage.

C. Materials and Model

To get the future fruitful results which will help the society from making lives more safe during occurrence of earthquake various combinations will be tried to get the most reliable material, framing and also shape and capacity of water tank according to seismic zones. A 10 lac liters of Intz type water tank is considered for this thesis work. General structural parameters were considered with help of respective IS codes for analysis and permissible material stress limits. The structural size was decided on the basis of the various literates studied and considering practical site considerations.

D. Loading and Analysis

For the detail study of work, it is required to consider all possible and important loads which are likely to be acting on water tank during gravity and seismic action. For this purpose, types of loads and their intensities will be considered as per the particular Indian code such as IS 875 part-01 and 02 for dead load and live load and IS 1893 part 01 for seismic loading on water tank. All loadings and their combinations will be studied as load combinations make more significant effect on the seismic loading and behavior of water tank. As these loading and loading combinations will be tedious will manual calculations structural design software Staad Pro. will be used for analysis and design.

E. Method of Analysis

As per the prevailing Indian code Is 1893, IS 11682: 1985, IS 3370 (part2) : 2009 there are two basic types of analysis method 1) Equivalent Static or seismic coefficient method and 2) Dynamic analysis. In dynamic analysis there are two more options 1) response spectrum and 2) Time history analysis. In the present work all models will be analyzed using seismic coefficient method according to the guidelines given in code as it is fund from the literature review that maximum damage is caused due to static lateral for action.

F. Result comparison and conclusions

After analyzing all models comparative charts and tables will be plotted to study the details behavior of every model and comparative study will be focused to find the most efficient storey level irregularity.

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IV. CASE CONSIDERATION AND MODELLING

A. Model Details

Tank is designed for capacity of 10,000,00.00 lit capacity

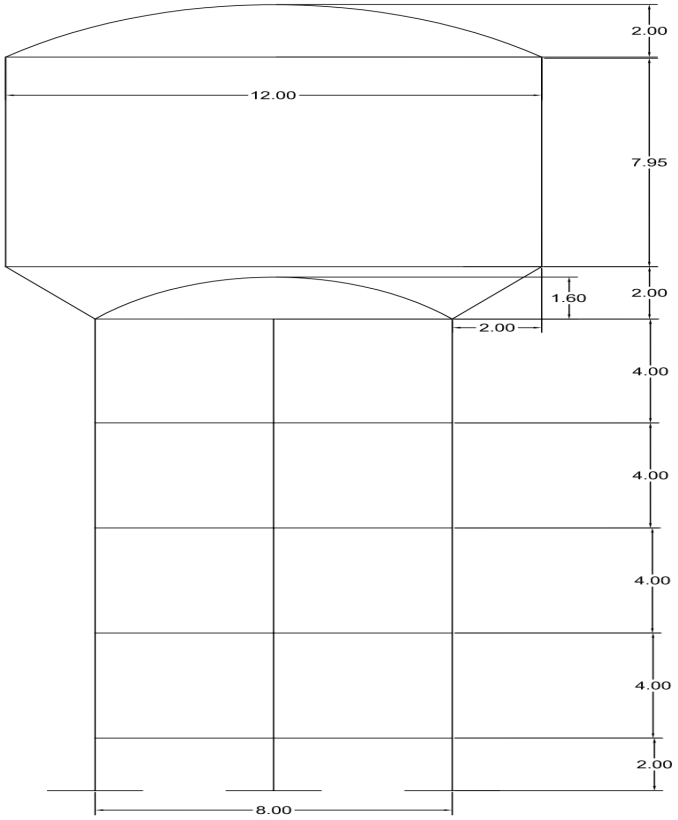

Fig 4.1 Salient dimensions of Intz tank

Table 4.1 structural parameters for models

Sr. No.	Structural Component	Value
01	Concrete	M30
02	Structural Steel	FE-500
03	Zone	II/III/IV/V
04	Response Reduction Factor	5.0 (SMRF)
05	Importance factor	1.0
06	Type of Soil	Medium Stiff
07	Size of bracing Beam	500mm x 500mm
08	Size of column	650 mm diameter
09	Thickness of Side wall	400 mm at bottom and 200mm at top
10	Thickness of Top dome	100mm
11	Thickness of Bottom dome	300mm
12	Staging Height	4.00m
13	Depth of Foundation	2.0m
14	Top Ring beam	300 mm x 300 mm
15	Bottom ring beam	1200 mm x 600 mm
16	Bottom dome beam	600 mm x 1200 mm
17	Diameter of Cylindrical wall	12.00 m

Table 4.2 Model Nomenclature

Sr. No	Model Details	Labels
01	Intz type water tank in Zone-II	I-01
02	Intz type water tank in Zone-III	I-02
03	Intz type water tank in Zone-IV	I-03
04	Intz type water tank in Zone-V	I-04

B. Models of Various Shapes of Tank

Fig 4.2 Staad Pro. model

V. RESULTS AND DISCUSSIONS

A. Maximum Reaction Comparison for all Models

Table 5.1 below shows the various values of Maximum base reactions comparison of all models in X, Y and Z directions

Table 5.1 Maximum Reaction comparison for all models

Sr No	Model No.	Reaction in X direction (KN)	Reaction in Y direction (KN)	Reaction in Z direction (KN)
01	I-01	53.93	1957.08	54.58
02	I-02	86.30	2194.53	86.97
03	I-03	130.16	2511.13	129.43
04	I-04	194.22	2986.02	194.22

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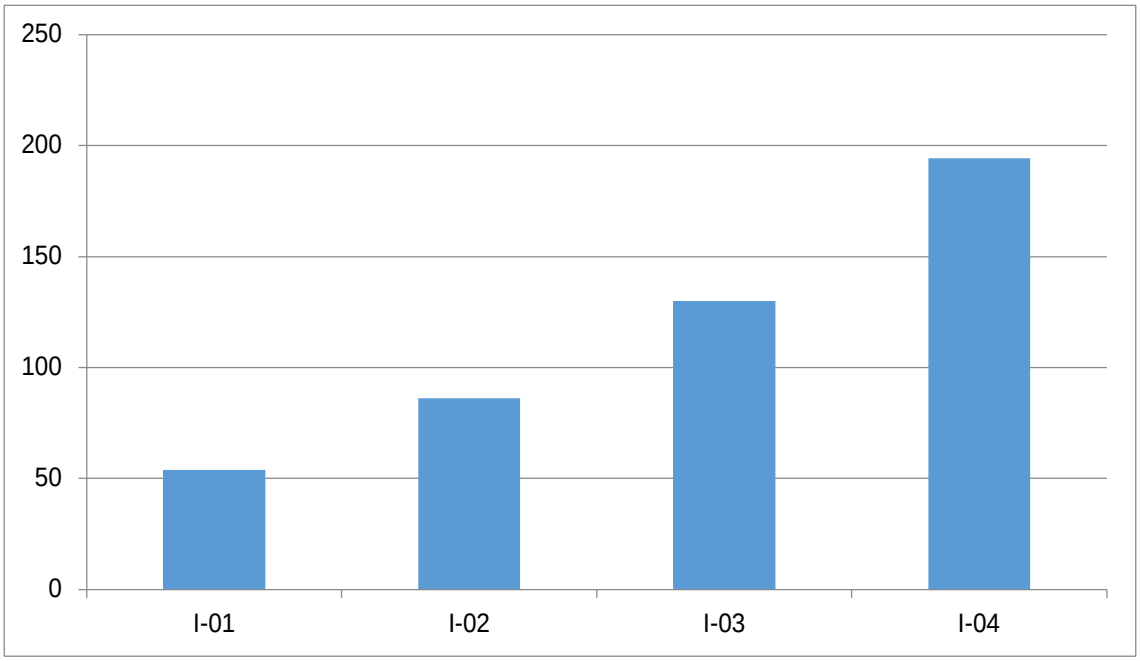
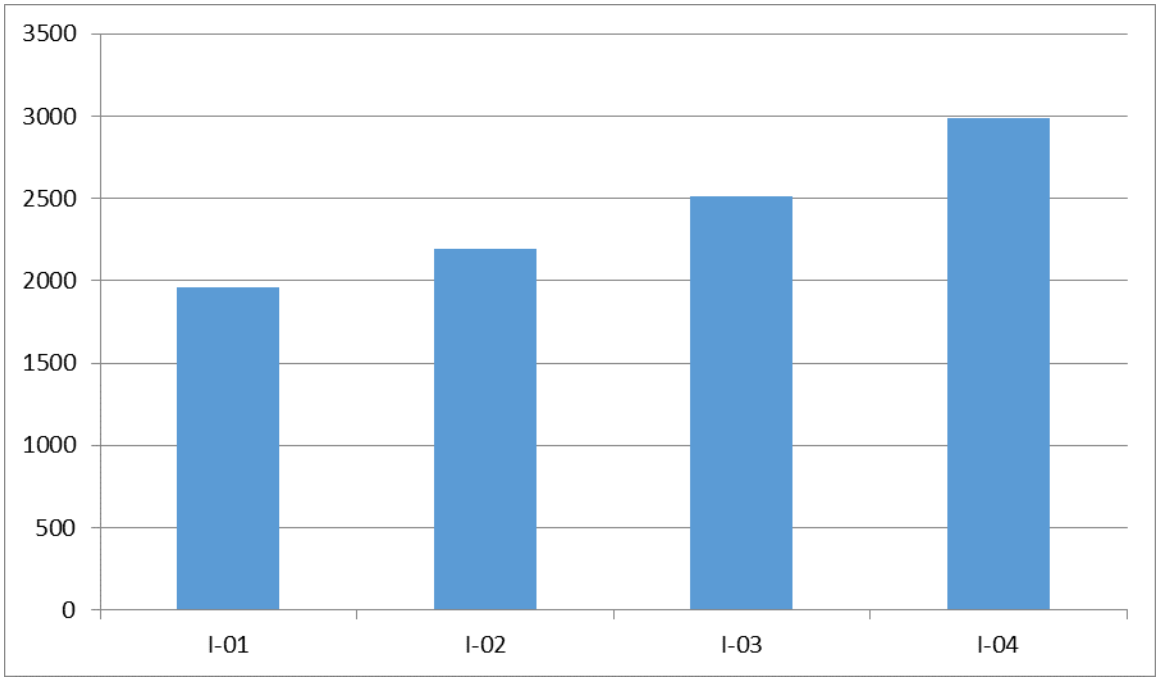
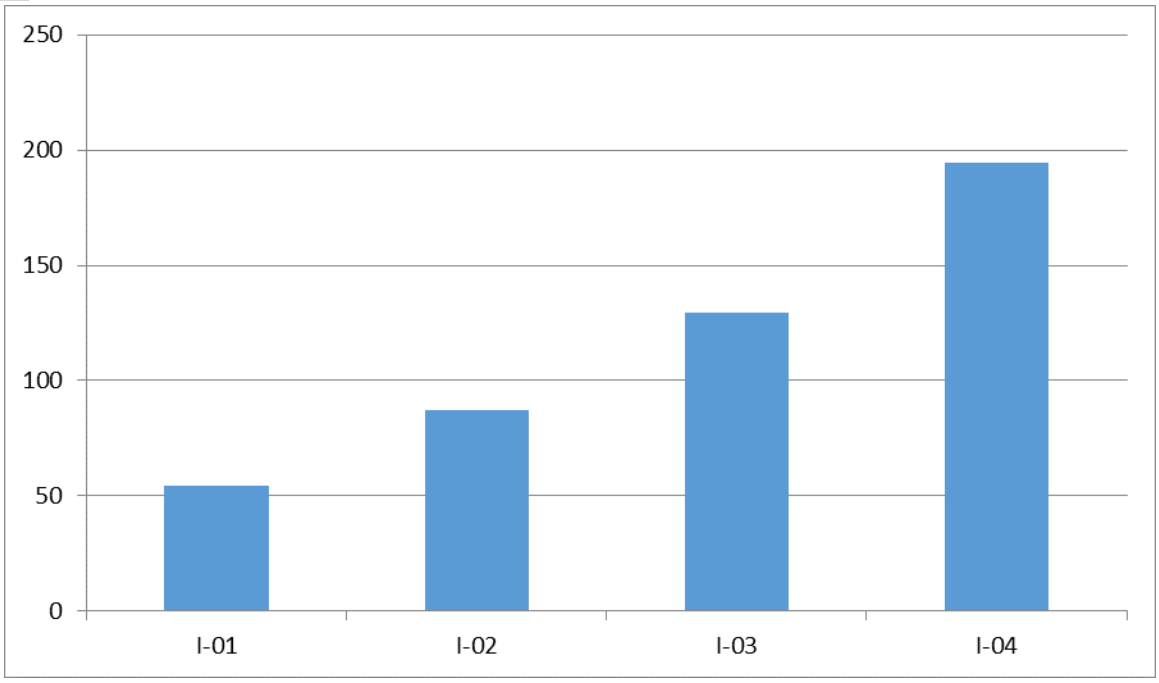


Graph 5.1 Maximum Reaction comparison in X- direction for all models



Graph 5.2 Maximum Reaction comparison in Y- direction for all models



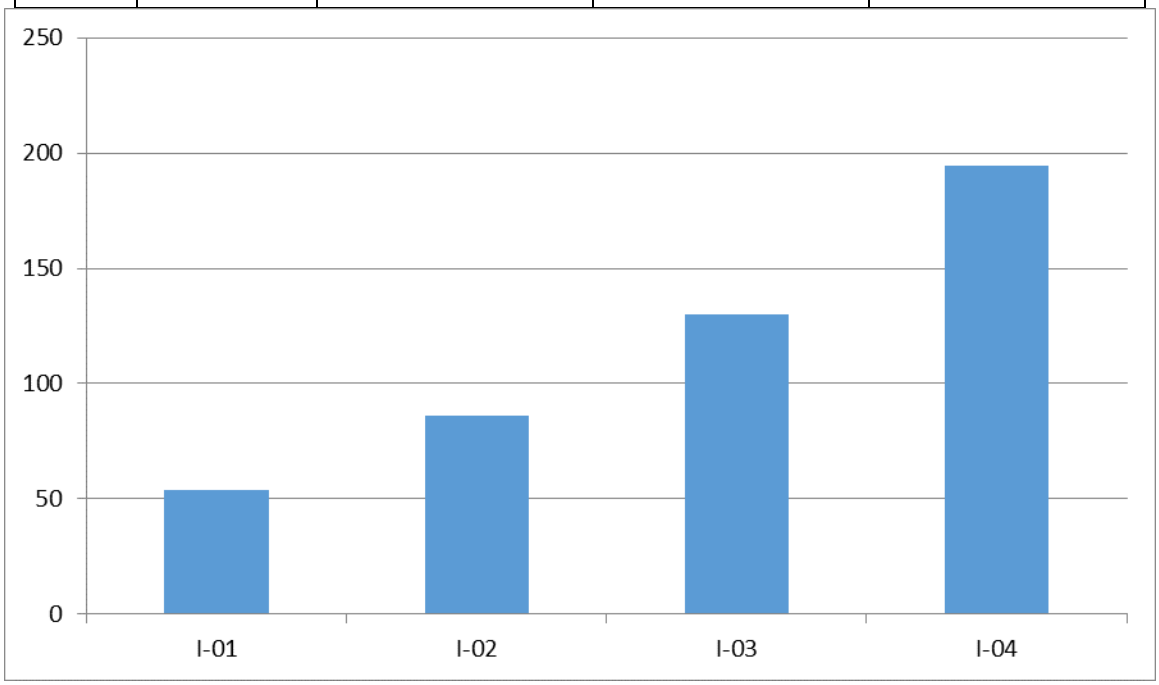
Graph 5.3 Maximum Reaction comparison in Z- direction for all models

B. Maximum Moment Comparison for all models

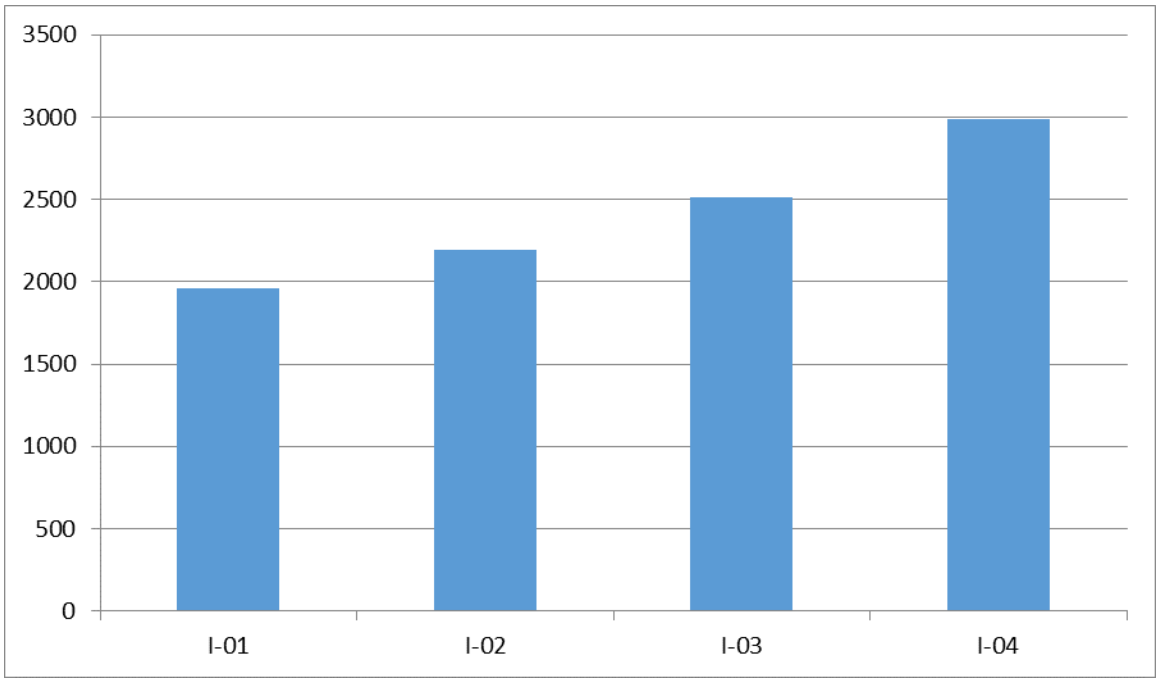
Table 5.2 below shows the various values of Maximum moment comparison of all models in X, Y and Z directions

Table 5.2 Maximum moment comparison for all models

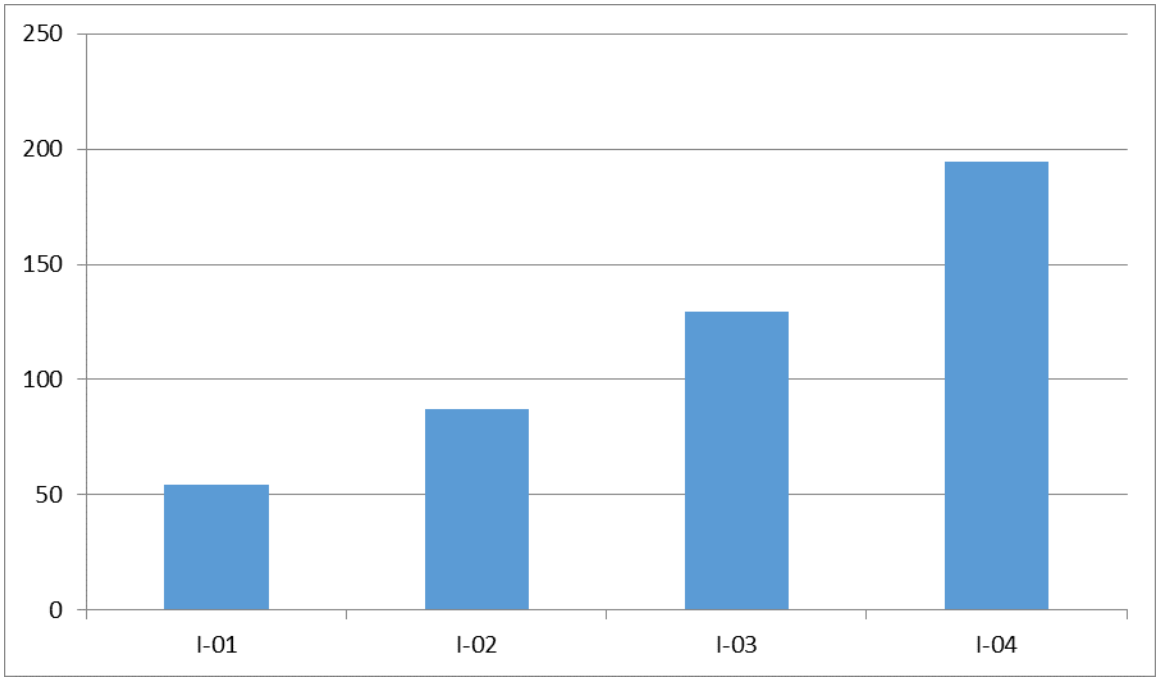
Sr No	Model No.	Moment in X direction (KN.M)	Moment in Y direction (KN.M)	Moment in Z direction (KN.M)
01	I-01	139.74	0.33	138.81
02	I-02	222.10	0.39	223.07
03	I-03	333.16	0.47	334.17
04	I-04	499.74	0.59	500.82



Graph 5.4 Maximum Moment comparison in X- direction for all models



Graph 5.5 Maximum Moment comparison in Y- direction for all models



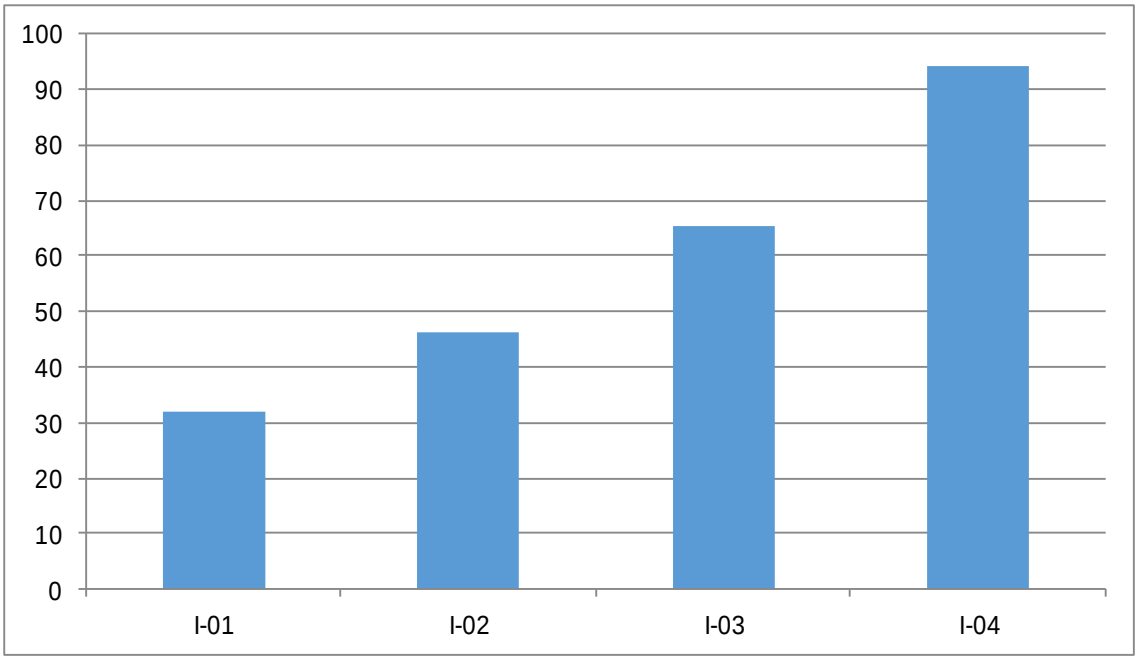
Graph 5.6 Maximum Moment comparison in Z- direction for all models

C. Maximum Displacement Comparison for all models

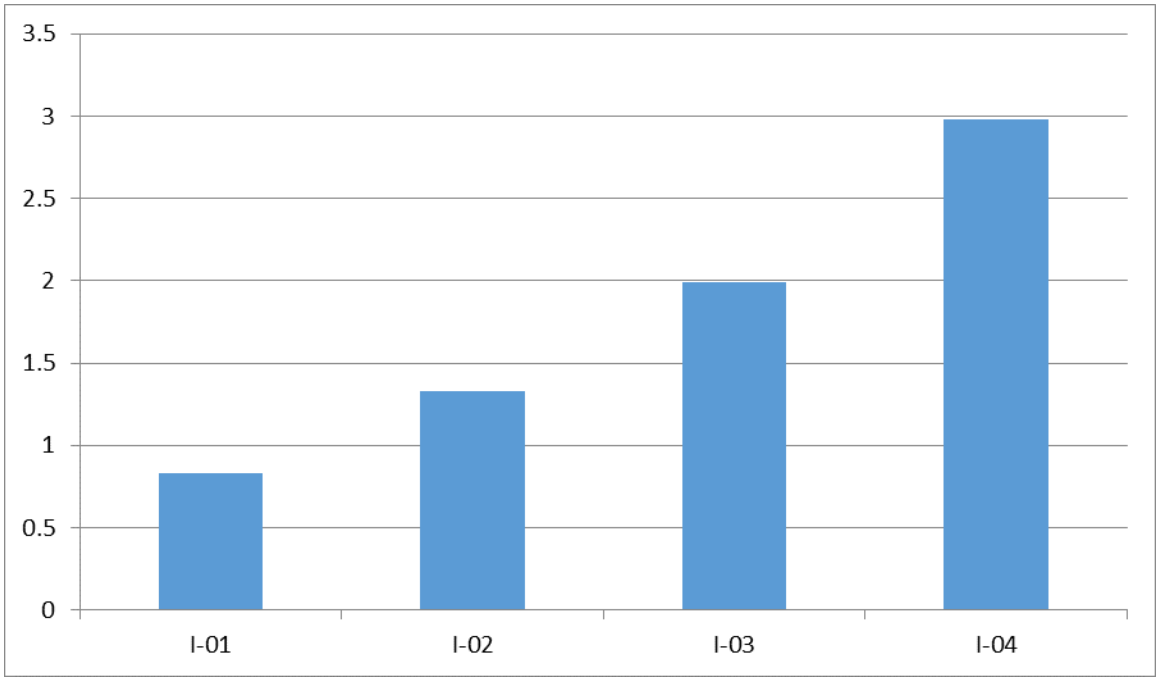
Table 5.3 below shows the various values of Maximum displacement comparison of all models in X, Y and Z directions

Table 5.3 Maximum displacement comparison for all models

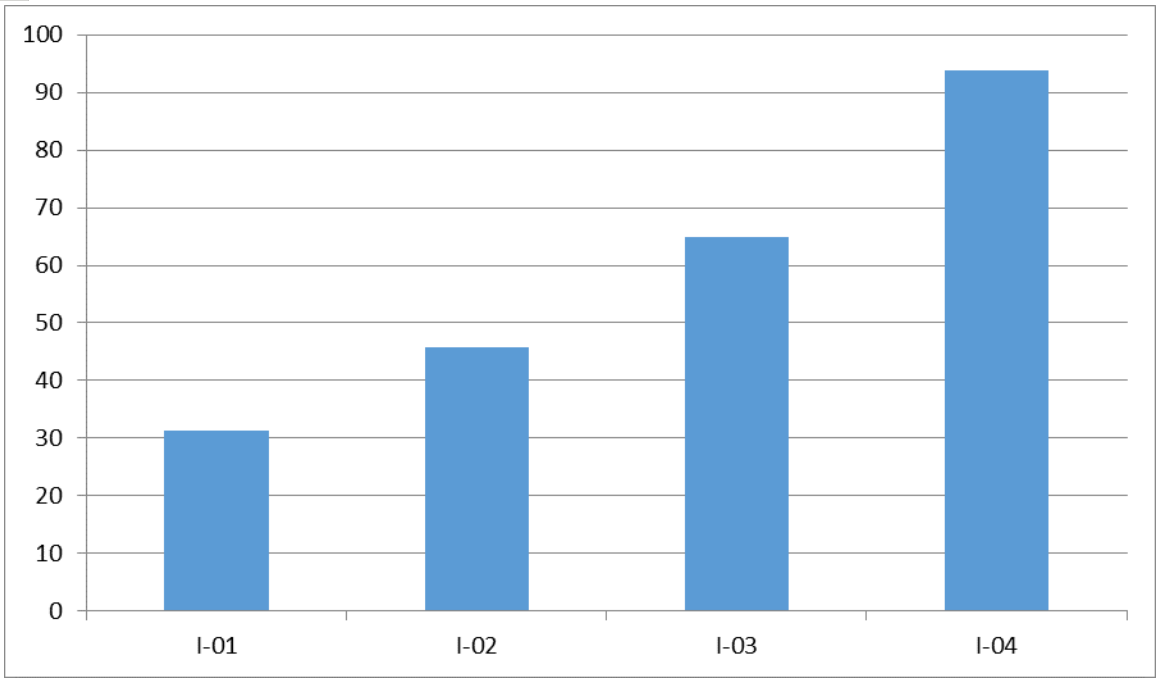
Sr No	Model No.	Displacement in X direction (MM)	Displacement in Y direction (MM)	Displacement in Z direction (MM)	Resultant Displacement (MM)
01	I-01	31.76	0.83	31.24	46.73
02	I-02	46.19	1.33	45.67	56.79
03	I-03	65.42	1.99	64.89	72.52
04	I-04	94.28	2.98	93.72	98.50



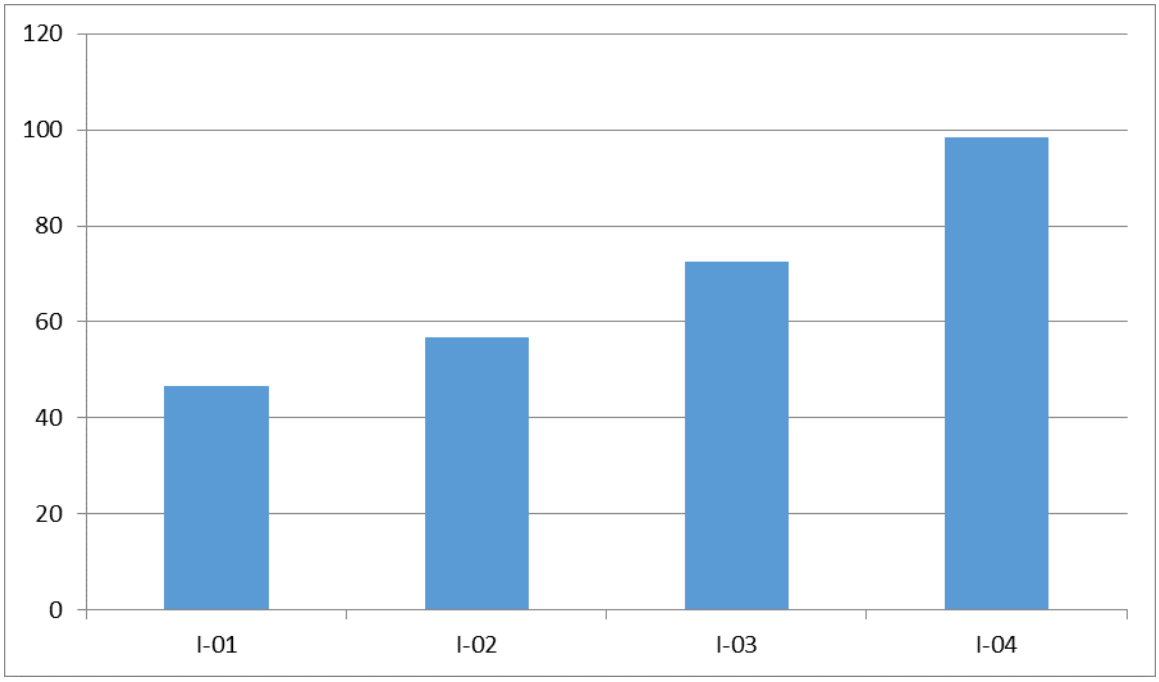
Graph 5.7 Maximum Displacement comparison in X- direction for all models



Graph 5.8 Maximum Displacement comparison in Y- direction for all models



Graph 5.9 Maximum Displacement comparison in Z- direction for all models



Graph 5.10 Maximum Resultant Displacement comparison for all models

VI. CONCULSIONS

1) Values of base reactions in horizontal direction due to seismic action increases drastically with 260 % from 53.93 in Zone II to 194.22 in Zone V, representing very high significance of change in seismic severity.

2) Values of base reactions in vertical direction increases gradually with 52.57 % from 1957.08 Kn in Zone II to 2986.02 Kn in Zone IV, representing moderate significance of change in seismic severity.

3) Values of base moments shows again shows drastic increase of 257.62 % from 139.74 Kn.m in Zone II to 499.74 Kn.m in Zone IVin horizontal direction. Whereas there is no such major change found in moments in vertical directions.

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4) As the severity of seismic zone increases the values of horizontal displacement goes on increasing order of 45.43 % from Zone II to Zone III, 41.63 % from Zone III to Zone IV, and 44.11 % from Zone IV to Zone V resulting in a drastic change of 196.85 % from Zone II to Zone IV

VII. ACKNOWLEDGMENT

It gives me great pleasure on bringing out the report entitled.
"*Comparative seismic analysis of Intz Tank with Change in Seismic Severity*"
No undertaking of the magnitude involved in the preparation of this project can be accomplished alone. Many have contributed till the successful acknowledge the assistance of the following individuals and would like to thank each one of them.

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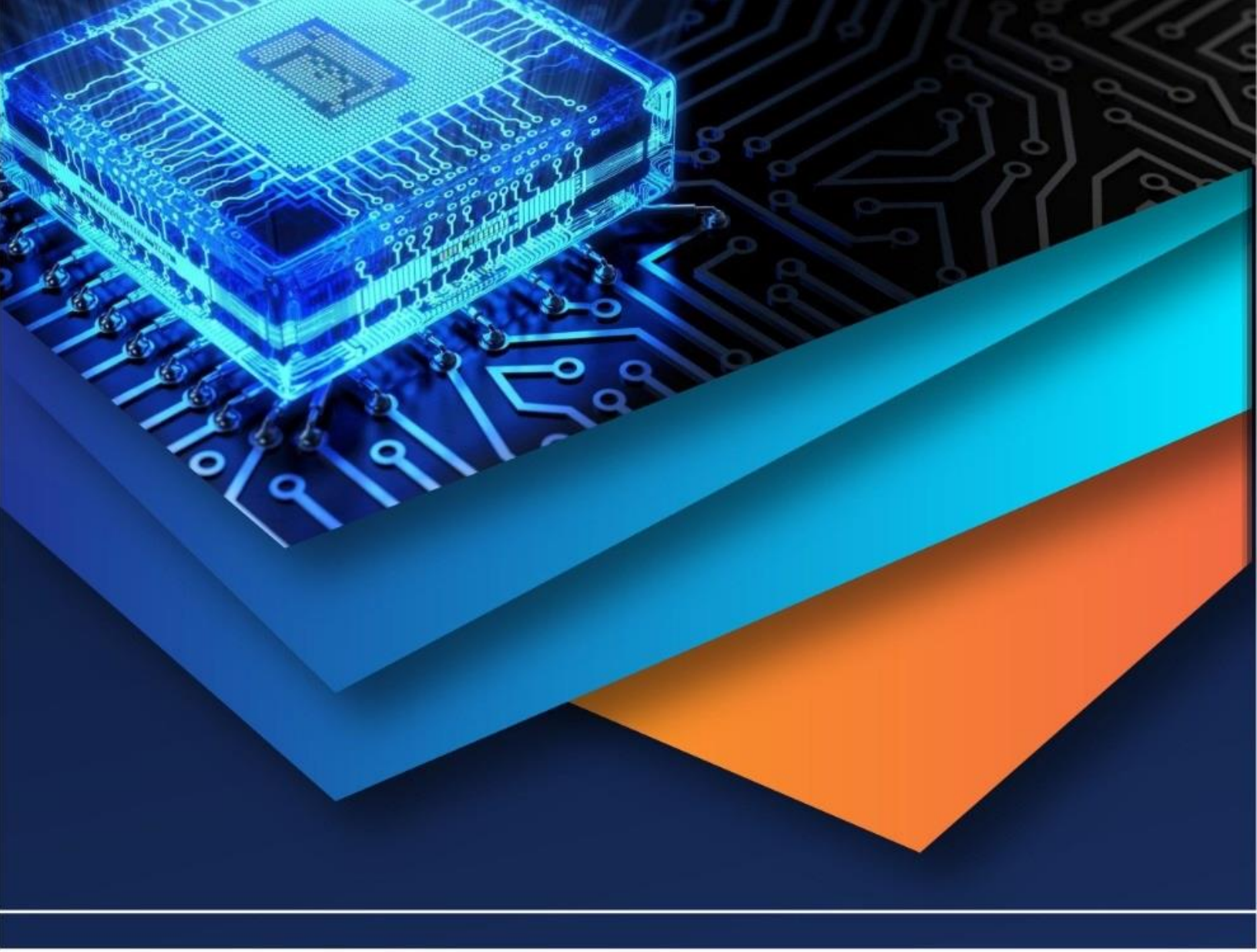

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