

Evaluation And Design Of Foundations Under Earthquake Forces As Per Indian And Euro Codes

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Abstract- The present study focuses on the analytical evaluation and design of footings subjected to seismic forces using both Indian Standard and Eurocode provisions with the aid of STAAD.Pro software. A G+10 storey building is modeled in STAAD.Pro V8i, and pad footings are designed considering two soil conditions, namely hard and medium soils. Further, a comparative assessment between Indian and Euro standards is carried out using STAAD Foundation software to understand the influence of different code provisions on foundation behavior under seismic loading. The analysis aims to examine how various foundation systems respond to earthquake forces and to identify efficient and economical design approaches. Understanding the effect of soil conditions and code-based design differences plays a crucial role in ensuring structural safety and performance. Structural design and analysis are largely influenced by geographical conditions, as natural hazards vary from region to region. Among these, seismic forces are one of the most critical factors responsible for structural damage, leading to significant economic losses and threats to human life. Therefore, engineers must possess a strong understanding of different design codes and apply them effectively to develop safe, economical, and long-span structures. In developing countries, construction plays a vital role in infrastructure growth. Each country adopts its own set of design codes that guide engineers in designing key structural components such as beams, columns, slabs, and foundations, ensuring safety, reliability, and standardization in construction practices.

Keywords: Isolated footing, stadd pro v8i, Indian standard code, Euro standard code

I. INTRODUCTION

Designing and modeling of any structure crosses most of the two engineering disciplines. There is the structural engineer who designs the structure and the geotechnical engineer who is concerned with the geotechnical aspects of the soil. The strength of building and foundation are two things to be considered while analyse the behaviour of the structure . Foundation is basic part of structure that transmit loads from

structure in to the sub-soil. The objective of this paper is to study the types of foundation their analysis and design according to different country codes and soil condition under seismic forces.

India is divided into different seismic zones. As per IS 1893:1984 Code India is divided from Zone I to Zone V. But as per IS 1893:2002 Code is has been divided from Zone II to Zone V. Zone I has been discarded.

1.1 Load calculation

Load calculations are carried out based on various Indian Standards such as IS: 875(Part – 1)-1987 for Dead loads (Unit weight of Building materials), IS: 875(Part –2)-1987 for Imposed loads and IS: 1893(Part 1)-2016 for Seismic loads , and Euro Standard code

1.2 Model formulation

Assumed Data for Models

Building	=	G + 10 Storey
Slab Thickness	=	0.15 m
Live Load	=	3000 N/m ²
Floor Finish	=	1500 N/m ²

Sr. No.	Element	Notation	Size (m)
1	Column	C1	0.6 X 0.6
2	Beam	B1	0.3 X 0.4

TABLE1:SIZEOFELEMENT

ConcreteGrade	=	M20
ConcreteDensity	=	25000N/m ³
SteelGrade	=	Fe500
SteelDensity	=	7850N/m ³
SeismicZone	=	II,III
Zonefactor,Z	=	0.1,0.16
Importance factor, I=		1.00
Responsereductionfactor,R=		3.00
Damping factor =		0.05

The load cases considered in the seismic analysis are as per IS 1893 – 2016.

II. METHODOLOGY

2.1 Provisions of Design Codes

Table 2: Zone Factor, Z

Seismic Zones	II	III	IV	V
Seismic intensity	Low	Moderate	Severe	Very Severe
Z	0.1	0.16	0.24	0.36

(As per IS 1893:2002 Clause 6.4.2)

Ensuring that Established the security by the codes against possible failure due to punching shear is based on the shear force acting in the critical section is greater than or equal to the reduced shear strength of the concrete. For the study's experimental analysis, strength reduction factors for the material were taken as one (1.0) in each regulation.

2.2 Seismic analysis

In earthquake engineering seismic analysis is a tool which is used to understand building response due to seismic excitations in a regular manner. In few decades back, the buildings had designed just for gravity loads while seismic analysis is a recent development. It is part of structural analysis and design where earthquake relevant.

The structural model has been selected, it is possible to do analysis to find the forces in the structure induced due to earthquake. There are various methods of analysis which provide different degree of accuracy. The analysis process can be categorized on the basis of three factors:

Type of external load application

Structure/structural element causing different behavior Selected structural model

2.2.1 Analysis methods

Seismic analysis is a one of the part of structural analysis and the structural comments such as building response calculation of earthquake. It is the part of the process of structural design earthquake engineering or structural assessment in region where earthquake are prevalent . A building has the potential to wave back and forth during an earthquake (or even a several wind storm). This is fundamental mode and is the minimum frequency of building response most building, however higher modes of response, which are precisely activated during earthquake.

2.2.2 Linear Analysis

The linear static analysis can only used for regular structure with limited height. In general, linear procedures are applicable when structure is expected to remain elastic for the level of ground motion or result is in nearly uniform distribution of nonlinear response through the structure. Linear analysis consists of two method i.e. Equivalent static analysis (Static) and Response spectrum analysis (Dynamic). The significant difference between linear static and linear dynamic analysis is the level of force and their distribution along the height of structure.

2.2.2.1 Equivalent Static Analysis:

The equivalent static analysis procedure is essentially an elastic design technique. It is, however, simple to apply than the multi- model response method, with the absolute simplifying assumptions being arguably more consistent with other assumptions absolute elsewhere in the design procedure. The equivalent static analysis procedure consists of the following steps:

Estimate the first mode response period of the building from the design response spectra.

Use the specific design response spectra to determine that the lateral base shear of the complete building is consistent with the level of post-elastic (ductility) response assumed. Distribute the base shear between the various lumped mass levels usually based on an inverted triangular shear distribution of 90% of the base shear commonly, with 10% of the base shear being imposed at the top level to allow for higher mode effects.

2.2.2.2 Non-Linear Analysis

Nonlinear analysis is classified as nonlinear static analysis and nonlinear dynamic analysis. The static analysis is done by using Pushover analysis method while dynamic is done by using Time history analysis method.

2. Characteristic Strengths of Reinforcement

Characteristic strengths of reinforcement are given in BS4449, BS4482 and BS4483 and are as shown in Table 4. Design may be based on the appropriate characteristic strength or a lower value if necessary to reduce deflection or control cracking.

DESINATION	SPECIFIC CHARACTERISTIC STRENGTH N/M ²
HOTROLLED MILD STEEL	250X10 ⁶
HIGH YIELD STEEL	460X10 ⁶

TABLE3:STRENGTH OF REINFORCEMENT

2.4 BS8110-1:1997

In ULS design of the whole or any part of a structure each of the combinations of loading given in Table 3 should be considered and the design of cross-sections based on the most severe stresses produced

Load Combination	Load Type					
	Dead		Imposed		Earth And Water	Wind
	Adverse	Beneficial	Adverse	Beneficial		
Dead And Imposed	1.4	1.0	1.6	0	1.4	-
Dead And Wind	1.4	1.0	-	-	1.4	1.4
Dead Wind And Imposed	1.2	1.2	1.2	1.2	1.2	1.2

Table 4: Load combinations and values of $\frac{3}{4}f$ for the ultimate limit state

III. FORMULATION OF PRESENT WORK

For the analysis following load combinationsspecified by theIS1893:2016are used.Thebasicload combinations given by the code as per clause 6.3.4.1 are as follows

- LOAD COMB 201 1.5(DL +LL)
- LOAD COMB 202 1.2[DL+IL+(ELX+0.3ELZ)]
- LOAD COMB 203 1.2[DL+IL-(ELX-0.3ELZ)]
- LOAD COMB 204 1.2[DL+IL+(ELZ+0.3ELX)]
- LOAD COMB 205 1.2[DL+IL-(ELZ-0.3ELX)]
- LOAD COMB 206 1.5[DL+(ELX+0.3ELZ)]
- LOAD COMB 207 1.5[DL-(ELX-0.3ELZ)]
- LOAD COMB 208 1.5[DL+(ELZ+0.3ELX)]
- LOAD COMB 209 1.5[DL-(ELZ-0.3ELX)]
- LOAD COMB 210 0.9DL+1.5(ELX+0.3ELZ)
- LOAD COMB 211 0.9DL-1.5(ELX-0.3ELY)
- LOAD COMB 212 0.9DL+1.5(ELZ+0.3ELX)
- LOAD COMB 213 0.9DL-1.5(ELZ-0.3ELX)

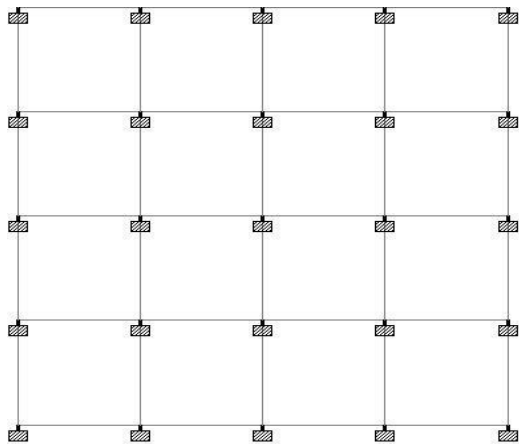


Figure3.1: Typical Plan of Modeled Building

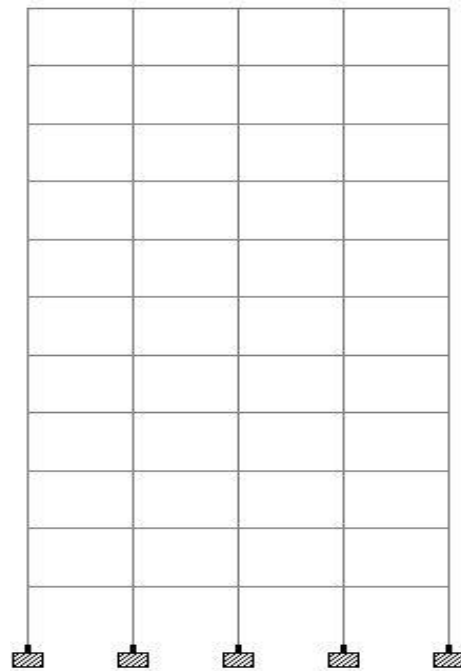


Figure3.2:2D Plan of Modeled Building

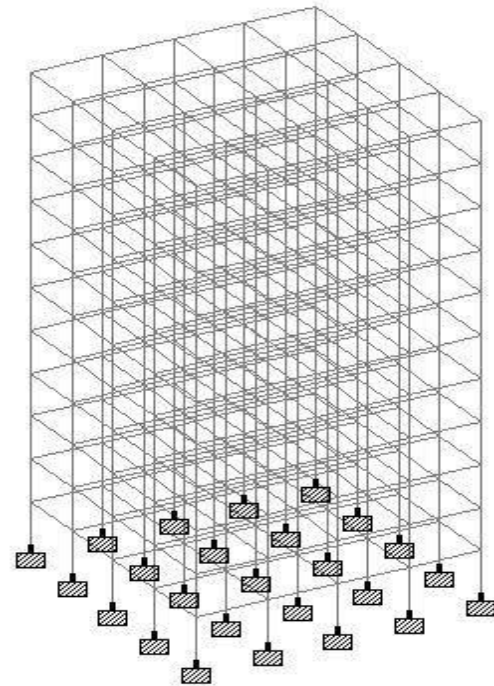
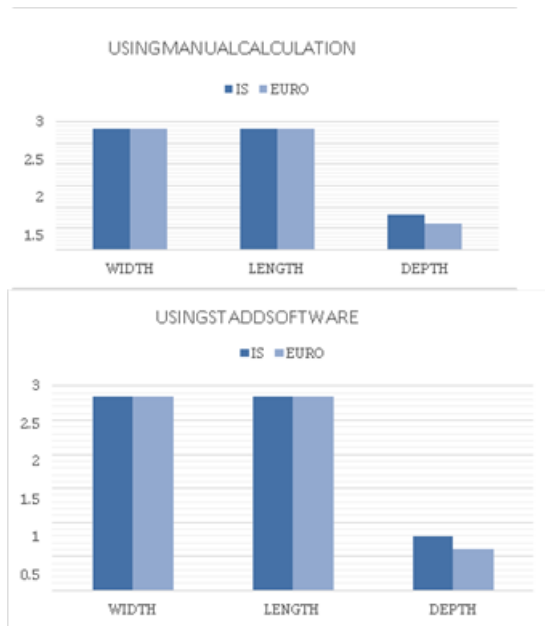


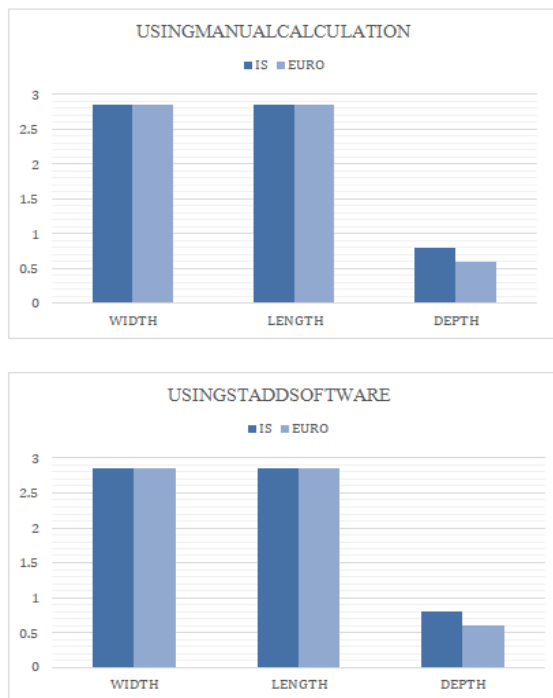
Figure3.2:3D Plan of Modeled Building

IV. RESULTS

1. FORHARD SOIL



2. FORMEDIUMSOIL



V. CONCLUSION

- It can be observed from the results and comparison that variation in values of depth of footing is according to the codes and soil condition.
- Euro code is slightly better than IS code to design with reference to depth of footing.
- Result of IS code is economical than Euro code with reference to area of steel required.
- The depth of footing in Euro code is less than IS code.

- According to the climatic condition and soil condition both the code are reliable and economic.

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