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Seismic Analysis and Design of Foundation Using Different Country Codes on Different Soil Conditions

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Abstract-Settlement under the foundation is caused by poor soil compaction, incorrect footing design, limited bearing capacity of the soil and an incorrect load estimate from the superstructure and so on. The superstructure carries the entire load. As a result, the most important part of a structure's foundation is its foundation. Structure's most vital and crucial component There are numerous options. There are various sorts of foundations, each of which has a particular level of strength. depending on the soil conditions. The main focus of this work is to create the isolated footing by experimenting with different code on various platforms. the state of the soil. The terms "geotechnical" and "structural" are used interchangeably. Engineering disciplines are employed in the analysis and design of a variety of products fooling. This aids in comprehending the behaviour of isolated individuals a foundation that is built on empirical rules, as well as the rules of Shear force is demonstrated using beam theory The model proposed in this research examines the relationship between the provision of dimension anticipated country codes (IS 456:2000, IS 1893 (part 1): 2002, and BS 8110-1:1997, Euro code 2, with checks applied using software stadd pro V8i

Keywords* — *Empirical rules, Beam theory, Different Country Codes, Isolated footing, Stadd pro Vi8

I. INTRODUCTION

the core engineering discipline that is used to build and model the structure is divided into two categories. Any structural member or building's design phase is crucial. monitored by a structural engineer, and the structural stability The geotechnical engineer is concerned about a member. soil characteristics and structural features are of interest. Any construction is supported by the foundation, which is the most basic aspect of it. This transports all things from the superstructure and forwards them it down to the subsoil The purpose of this research is to investigate the Distinct countries have different sorts of foundations and designs. Codes and the state of the soil in the event of a seismic event. India is a divided country. Seismic zones come in a variety of shapes and sizes. That is, according to ancient code. IS: 1893-1984, India is divided into two parts. India is divided into five zones, ranging from Zone I to Zone V. However, the new IS:1893-2002 code is divided into four zones, namely Zones II through V. In addition, the initial zone has been deleted (Zone I). The foundation is a fundamental component of any structure. Substructure is what it's known as. It basically carries the entire load. as a result of beams, columns, slabs, and other dead loads A seismic load is also a moving load. This is where the entire load will be transferred. ground. The weight is distributed evenly to avoid excessive settlement. delivered to the earth, in order to provide a solid foundation. It is necessary to use measurements that are adequate. The weight of In comparison to the safe bearing, the superstructure is minimal. soil's capacity, although it for various types of structures on diverse soil conditions, numerous forms of footings are considered. Settlement of the soil can potentially lead to structural failure. Shear failure is the most common cause of failure. Basically, a footing has. Face punching shear failure is studied in several ways. ways that make use of the relevant codal provisions the failure of subcontracting structural impacts the structure's overall life and also causes the Overturning of the structure, resulting in financial and human losses.

This is the most important consideration while creating and analysing the system. accuracy in the foundation the majority of the two engineering disciplines are involved in the design and modelling of any structure. The structural engineer is in charge of the structure's design, whereas the geotechnical engineer is in charge of the soil's geotechnical issues. When analysing the behaviour of a structure, the building's strength and foundation are two factors to examine. The foundation is a crucial component of every project. structure that transfers loads from the structure to the subsoil the purpose of this research is to investigate the

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different types of foundations available. study and design in accordance with various nation standards and soil conditions subjected to seismic factors

A. Load calculation

Load calculations are done using Indian Standards like 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, as well as Euro Standard code.

Assuring that the security provided by the codes against probable punching shear failure is dependent on the shear force exerted in the critical section being greater than or equal to the concrete's decreased shear strength. Strength reduction factors for the material were taken as one (1.0) in each regulation for the study's experimental analysis.

B. Seismic investigation

Seismic analysis is a tool used in earthquake engineering to understand building reaction to seismic excitations. In a consistent manner Buildings were planned solely for gravity loads a few decades ago, but seismic analysis is a relatively new concept development. When earthquakes are a factor, it's part of the structural study and design process

During an earthquake (or even a series of wind storms), a building's foundation might sway back and forth. This is the fundamental mode and the lowest frequency of building reaction for most buildings; nevertheless, there are higher modes of response that are precisely engaged during an earthquake.

C. Linear Analysis

Only regular structures with limited height can be subjected to linear static analysis. In most cases, linear techniques are appropriate. For the level of ground motion, the structure is predicted to stay elastic, or the consequence is a roughly uniform distribution of nonlinearities. response by way of the structure Equivalent static analysis (Static) and Response linear analysis are the two methods used in linear analysis. Analysis of the spectrum (Dynamic). The level of force is a significant distinction between linear static and linear dynamic analysis

II. OBJECTIVE

To analyse the effect lateral deflection response of building on foundation. To do comparative study of performance of footing by using IS code and Euro code under seismic forces. To analyse of accuracy of both the code. To analyse and design their foundation under different soil conditions.

To compare design parameter of Indian Standard and Euro standard. To do comparative Analysis and design of foundation using manual calculation and application of checks by using Staad software.

III. METHODOLOGY

Factors that because earthquakes include: The Mercally intensity scale and the Richter scale are both used to determine the magnitude of an earthquake respectively in terms of intensity and magnitude. The magnitude scale is as follows:

Originally, this formula was employed to compute the force and impact of a collision. Earthquake damage to the soil One of the scales that can be used is the Richter scale.

Calculate the earthquake's magnitude.

The following are some of the factors that influence earthquake forces:

A. The seismic zone factor (Z)

India is classified into four seismic zones. The diverse earthquake zones each have their unique worth zone determinants, the value of the zone factor is determined by soil conditions and the magnitude of the earthquake in a specific area of the country. As a result, the modelled computation is done on zones II and III. As a result, values are calculated.

B. Importance factor(I):

The factor value determines the structure's functionality. The financial importance, as well as the age of this element, are the results of the structure that defines its earthquake value, and so forth. The larger the value of I, the better.

For the foundation design in zone 2, there is a 1.5 water tank. And number three, the I value taken is one.

C. Response Reduction Factor (R):

Any structure's harm. The value of R is defined by the earthquake. The fundamentals Structures that deform are brittle, as seen in concrete. Steel is both ductile and brittle. R values for many situations the size of a construction like a tank is smaller than that of a building because It is less ductile and has fewer reductant reactions. For the purpose of design Structural response factor: The value of this is determined by the amount of damping and vibration caused by seismic action with a spectrum response. This paper's main topic is to investigate the many forms of footings, as well as their analysis and design. in accordance with various country standards and soil conditions tectonic forces the G+10-story structure is designed in STAAD PRO V8i software is used to design the pad footing. The structure is supported by two types of soil: stiff and soft. soil with a medium stiffness an attempt is made to analyse. Using software, compare the INDIAN and EURO standards. STAAD is a non-profit organization.

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The following is the code clause for shear stress: The shear stress in the design vs.

v = V/bd. ....(a)

The equation above can be used to compute shear stress in a cross section as well as the value of punching shear stress on the face and at a certain distance from the face of the footing.

IV. Formulation of Present Work

Assumed Data for Models

Building = G + 10 Storey

Slab Thickness = 0.15 m

Live Load = 3000 N/m2

Floor Finish = 1500 N/m2.

Grade = M20

Concrete Density = 25000 N/m3

Steel Grade = Fe500

Steel Density = 7850 N/m3

Seismic Zone = II , III

Zone factor, Z = 0.1, 0.16

Importance factor, I=1.00

Response reduction factor, R=3.00

Damping factor = 0.05

For the analysis following load combinations specified by the IS 1893: 2016 are used. The basic load 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)

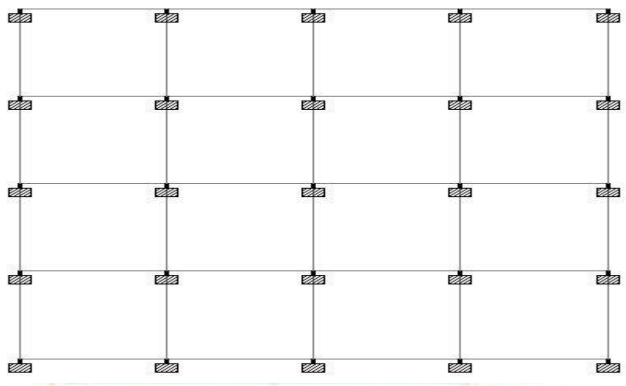

Figure 4.: Typical Plan of Modeled Building

Above figure modeled in staad software which shows the number of supports used in model.

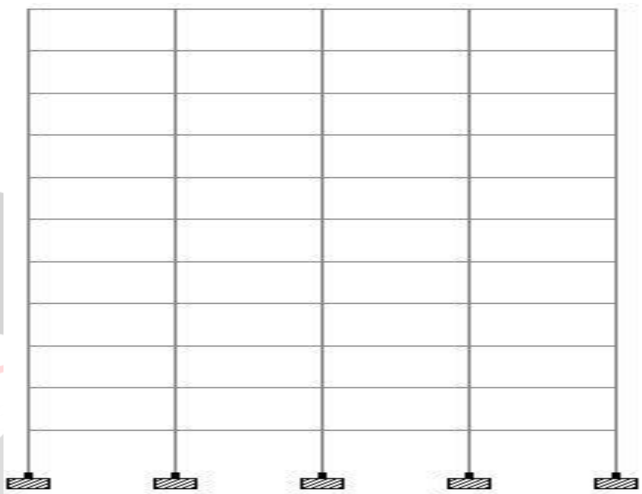

Figure 4.2: 2D Plan of Modeled

The above modeled in staad software which shows side view of structure including number of supports in one direction.

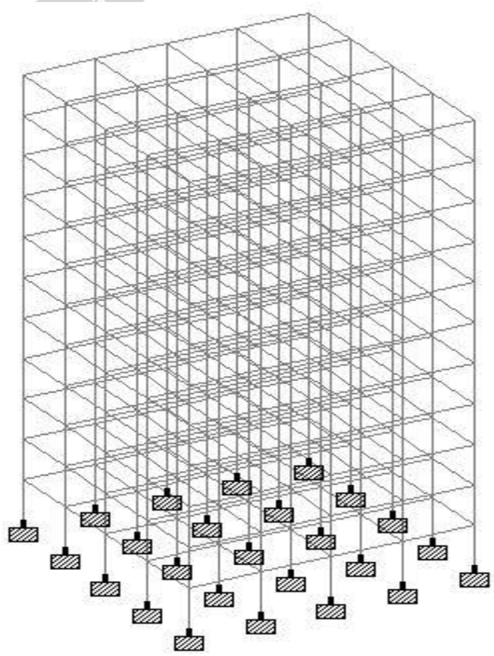

Figure 4.3: 3D Plan of Modeled Building

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Above figure modeled in staad software which shows 3D model of structure which is to be analyze with all supports.

The sample numarical is design manually by using above data to chech the dimensions of footing and are of reinforcement required in long and short direction by applications of Indian Standards guidelines.

This sample numarical helps to comparing the results calculated by using software and also precisely give idea about accuracy of codes.

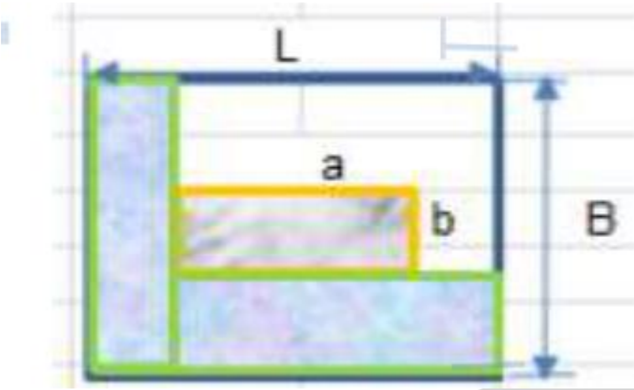

Fig 4.4 : Area showing to calculate bending moment

Above figure is useful to calculate and give clear idea about the direction of bending moment in x and y direction. It uses in all foundation design where there is requirement of calculation of bending moment.

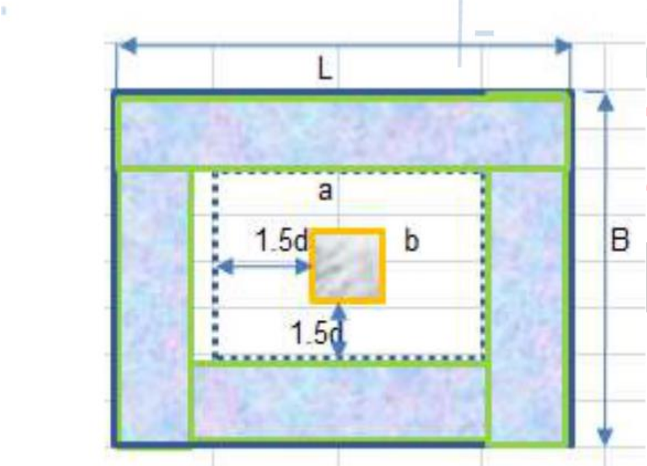

Fig 4.5 : Area showing to check two-way shear

Above figure is useful to calculate and give clear idea about the area and numerical value of punching shear. It uses in all foundation design where there is requirement of calculation of punching shear.

Design of Isolated Footing :

A. Load on Column –

Dead load (Gk) = 2399 KN

Live load (Qk) = 666 KN

Ultimate Load (Nu):-

Nu = 1.4Gk + 1.6Qk = 1.4 * 2399 + 1.6 * 666 = 4424 KN

Size of Column

Width (b) 0.6 m = 600 mm

Depth (a) 0.6 m = 600 mm

SBC of Soil (q) = 400 KN/m²

Comp. stress of concrete M -(fck) = 20 KN/m²

Tensile stress of steel (fy) = 460 KN/m²

Unit wt of concrete (ϒc) = 24 KN/m³

Clear concrete cover = 60 mm

Diameter of bar (Ø) = 12 mm

B. Depth of Footing

Assume Depth of Footing = D = 0.7 m = 700 mm

Nu = 1.4Gk + 1.6Qk = 1.4 * 2399 + 1.6 * 666 = 4424 KN

Vu=lesser(0.8∗√fck,5) = 3.6 or 5.0 = 3.6 N/mm²

Perimeter of the column = 2 * 600 + 2 * 600 = 2400 mm

v = Vu/2 = Nu / (u*d) v = 2.63 N/mm²

C. Size of Footing

Total service axial Load = 1.0Gk + 1.0Qk + Footing Weight of footing = D * ϒc * A Ns

Soil bearing pressure at service (q) = Ns / A

400 = (2399 + 666 + 0.7 * 24* A) / A

A = 8.00 m²

Length of Footing (Lf) = 2.83 m = 4.15 m

Beath of Footing (Bf) = 2.83 m = 4.15 m

D. Net Upward Pressure

Net Upward Pressure=W/(Area of footing) = 177.99 KN/m² Factored (Pu) = 256.92 KN/m²

Intensity per meter length = 256.92 * 4.15 = 1066.22 KN/m

E. Bending Moment:-

i) Bending moment in x-x direction:-

Mxx = (Pu∗((B-b)/2)^2)/2∗L = 1679.63 KNm

= 404.73 KN per m

ii) Bending moment in y-y direction:-

Myy = (Pu∗((L-b)/2)^2)/2∗B = 1679.63 KNm

= 404.73 KN per m

F. Check for One-way Shear :-

The critical section for one-way shear is to be considered at distance 'd' from each face of column.

i) Shear Force in x-x direction:-

V1 = Pu∗{[(Bf-b)/2-d]∗Lf} = 1216.6 KN

ii) Shear Force in y-y direction:-

V2 = Pu∗{[(Lf-a)/2-d]∗Bf} = 1216.6 KN

Max SF Vu = Max of i), ii) = 1216.5. KN

Vu = lesser (0.8√fck or 5) = 5 KN

V = Vu/(b∗d) = 0.46 N /mm²

Tc = (100∗As)/(b∗d)

= 100 * 6449.34/ 4150 * 634

= 0.25N/mm²

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400/d = 400 / 634 = 0.63 < 1 = 1 N/M

$Vc = 0.79*[((100*As)/((B*d))]^{0.33} [((400/d)/\gamma m)]^{0.25} = 0.47$

$v \leq Vc = 0.46 \leq 0.47$

Check for Onee-way Shear is safe

G. Check for Two-way Shear (Punching Shear :-

The critical section for two-way shear or punching shear is to be considered at distance '1.5d' from each face of column.

Critical Perimeter for shear :

u = (2a+2b) + (8*1.5*d) u

= (2*0.6 + 2*0.6) + (8*1.5*0.634)

Area within perimeter

A = (2*1.5*0.634 + 0.6) * (2*1.5*0.634 + 0.6) A = 6.26 m^2

Punching shear force

Vp = Pu * (A-Ap)

Vp = 256.92 * (17.22 - 6.26) = 2815.84 KN

Punching shear Stress

v = Vp /(u*d) V

= 2815.84 * 103 / (10010 * 634)

= 0.44 N/mm^2

Tc = (100As)/(B*d) = 100 * 6449.34 / (4150*634)

= 0.25 N/mm^2

400/d = 400/634 = 0.63 < 1 = 1

$Vc = 0.79*[((100*As)/(B*d))]^{1/3} * [((400/d)/\gamma m)]^{1/4}$

= 0.47

$v \leq Vc = 0.44 \leq 0.47$

Check for Two-way Shear is safe.

H. Area and Spacing of steel:-

i) Reinforcement Along Short Span:-

$Kxx = Mxx/ [fck*b*d]^2$

$= 1679.63 * 106 / (20* 4150* 643)^2 = 0.050 < 0.156$

$z/d = 0.5+\sqrt{(0.25- kxx /0.9)} = 0.94 \leq 0.95$

Lever Arm Z = 0.94 * d

= 0.94 * 634 = 595.96 mm

$Ast = Mxx/(0.95*fy*z)$

$= 1679.63 * 10^6 / (0.95 * 460 * 595.96)$

= 6449.34 mm^2

Min Ast = (0.13*b*D)/100 = 0.13* 4150*700/100

= 3776.50 mm^2

Max of above Ast = 6449.34 mm^2

Dia of bar = 12 mm

Spacing = 70 mm

Ast,provd = 6705.07 mm^2

Provided Reinforcement is safe.

Provide 12 mm Ø @ 70 C/C

ii) Reinforcement Along Long Span:-

$Kyy = Myy / [fck*b*d]^2$

$= 1679.63 * 106 / (20*4150*634)^2$

= 0.050 < 0.156

$z/d = 0.5 + (0.25- Kxx /0.9)^{0.5}$

$= 0.94 \leq 0.95$

Lever Arm Z = 0.94 * d

= 0.94 * 634

= 595.96 mm

$Ast = Myy/(0.95*fy*z)$

= 1679.63 * 106 /(0.95 * 460 * 595.96)

= 6449.34 mm^2

Min Ast = (0.13*b*D)/100

= 0.13* 4150*700/100 mm^2

= 3776.50 mm^2

Dia of bar = 12 mm

Spacing = 70 mm = 72.78 mm

Ast,provd = 6705.07 mm^2

Provode 12 mm Ø @ 70 C/C

SUMMARY:-

Length of Footing (L) = 4.15 m

Breadth of Footing (B) = 4.15 m

Size of Footing is safe.

Depth of Footing (Df). = 700 mm

Bars Along Short direction = 12Ø@70C/C

Provided Reinforcement is safe.

Bars Along Long direction = 12Ø@70C/C

Provided Reinforcement is safe.

V. RESULTS AND CONCLUSION

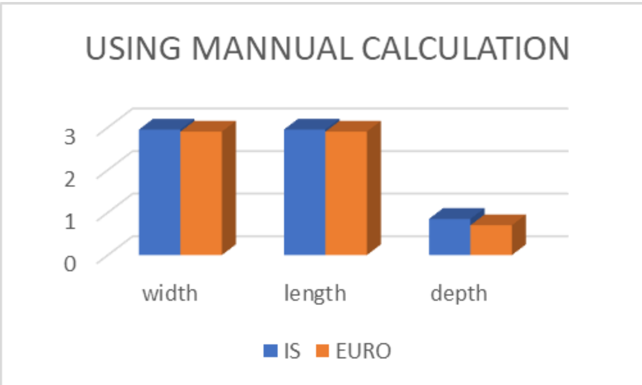
As the results shown below, calculation of footing dimensions are made manually as well as by using stadd pro v8i.

The isolated footing is design by using Indian Standard and Euro Standard on Hard Soil which having safe bearing capacity 400 KN/m^2 and also on Medium Stiff Soil which having safe bearing capacity of 200 KN/M^2.

The respective analysis and comparison is done in this paper with demonstrating accuracy of codes.

1. FOR FOOTING 124

A. FOR HARD SOIL



Above graph 5.1 shows the dimension of footing which is design manually for hard soil condion.

The results shown in above graph are concluded that for same soil condiotion which has safe bearing capacity of

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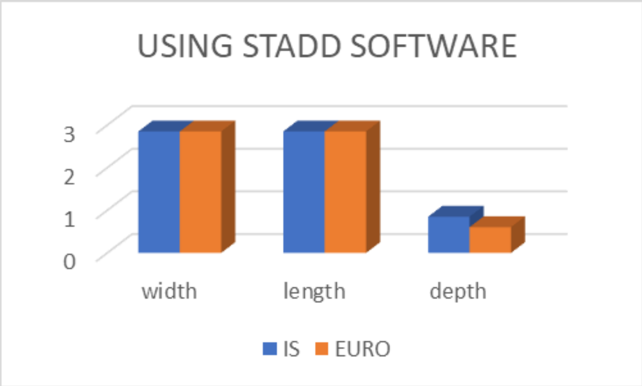
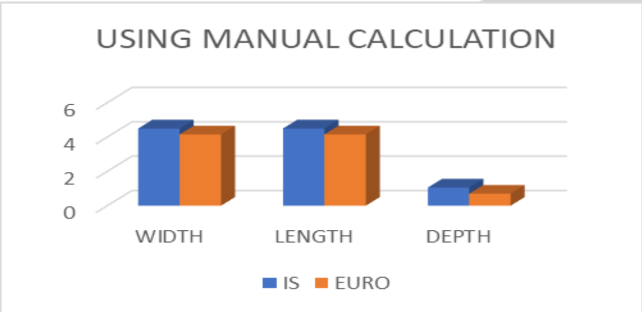
400 KN/M² the EURO Code design possesses less dimension of footing as compare to the Indian Standard.



Above graph 5.2 shows the dimension of footing which is design by using Stadd Software for hard soil condion.

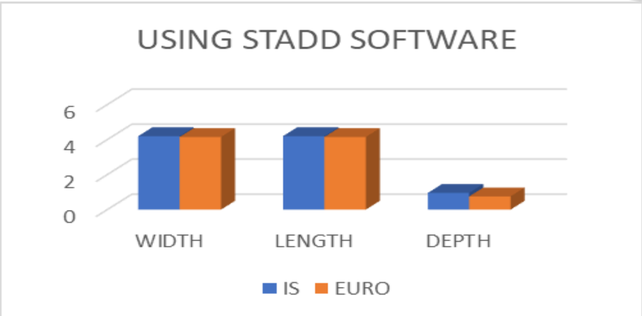
The results shown in above graph are concluded that for same soil condiotion which has safe bearing capacity of 400 KN/M² the EURO Code design possesses less dimension of footing as compare to the Indian Standard

B. FOR MEDIUM SOIL



Above graph 5.3 shows the dimension of footing which is design manually for medium soil condion.

The results shown in above graph are concluded that for same soil condiotion which has safe bearing caoacity of 200 KN/M² the EURO Code design possesses less dimension of footing as compare to the Indian Standard

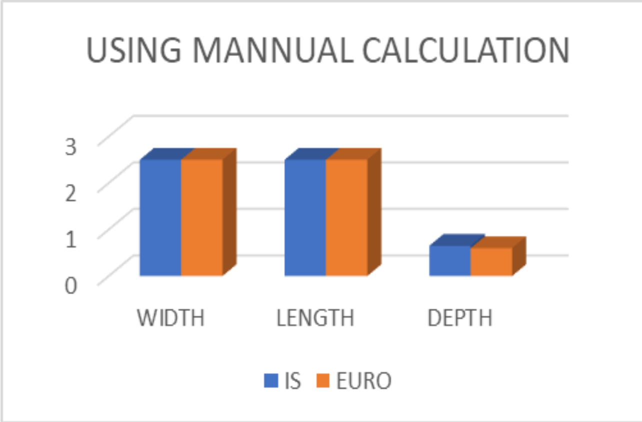


Above graph 5.4 shows the dimension of footing which is design Stadd Software for medium soil condion.

The results shown in above graph are concluded that for same soil condiotion which has safe bearing caoacity of 200 KN/M² the EURO Code design possesses less dimension of footing as compare to the Indian Standard.

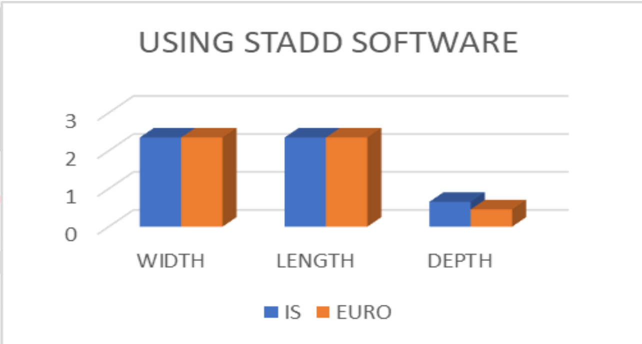
2. FOR FOOTING 244

A. FOR HARD SOIL



Above graph 5.5 shows the dimension of footing which is design manually for hard soil condion.

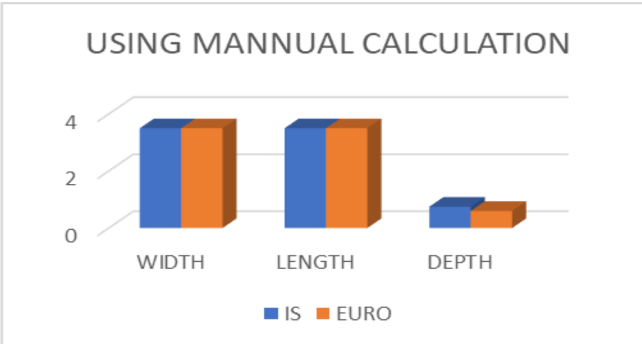
The results shown in above graph are concluded that for same soil condiotion which has safe bearing caoacity of 400 KN/M² the EURO Code design possesses less dimension of footing as compare to the Indian Standard.



Above graph 5.6 shows the dimension of footing which is design using Stadd Software for hard soil condion.

The results shown in above graph are concluded that for same soil condiotion which has safe bearing capacity of 400 KN/M² the EURO Code design possesses less dimension of footing as compare to the Indian Standard

B. FOR MEDIUM SOIL



Above graph 5.7 shows the dimension of footing which is design manually for medium soil condion.

The results shown in above graph are concluded that for same soil condiotion which has safe bearing capacity of 400 KN/M² the EURO Code design possesses less dimension of footing as compare to the Indian Standard

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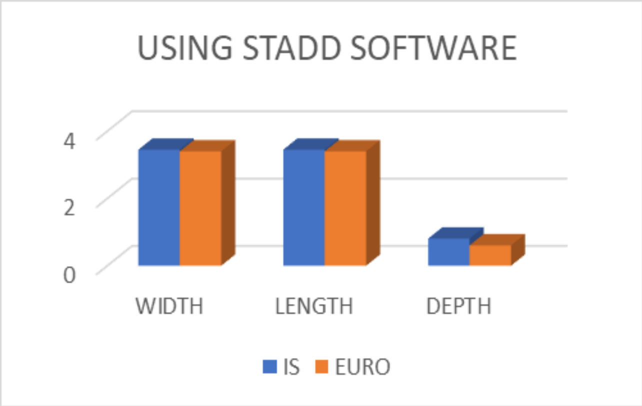
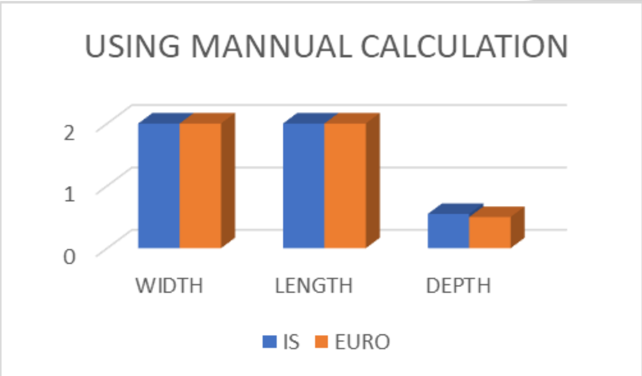


Above graph 5.8 shows the dimension of footing which is design using Stadd Software for medium soil condion.

The results shown in above graph are concluded that for same soil condiotion which has safe bearing caoacity of 200 KN/M^2 the EURO Code design possesses less dimension of footing as compare to the Indian Standard

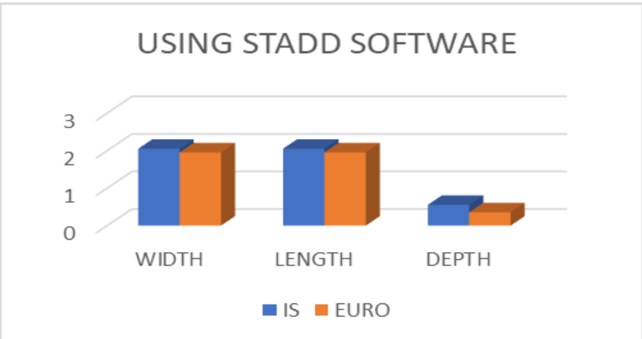
3. FOR FOOTING 246

A. FOR HARD SOIL



Above graph 5.9 shows the dimension of footing which is design manually for hard soil condion.

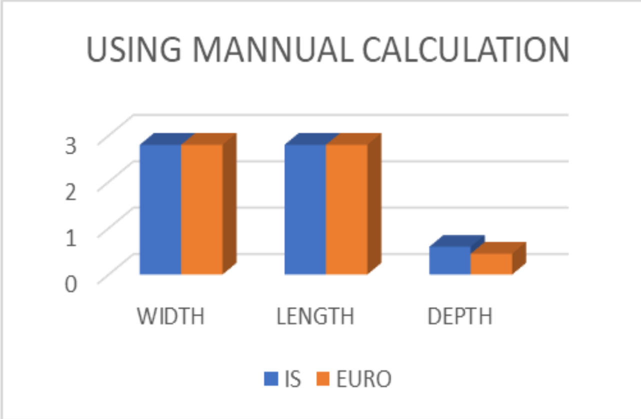
The results shown in above graph are concluded that for same soil condiotion which has safe bearing capacity of 400 KN/M^2 the EURO Code design possesses less dimension of footing as compare to the Indian Standard



Above graph 5.10 shows the dimension of footing which is design Stadd Software for medium stiff soil condion.

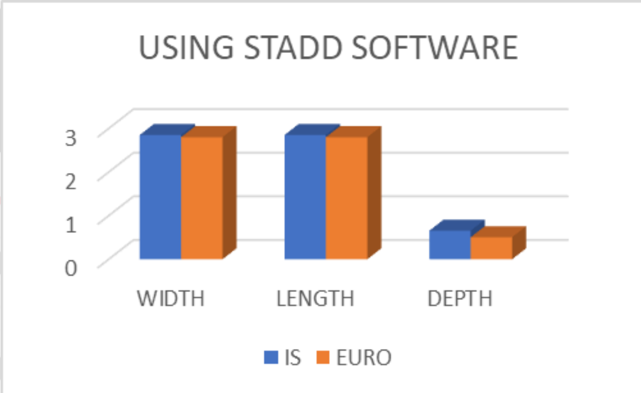
The results shown in above graph are concluded that for same soil condiotion which has safe bearing caoacity of 200 KN/M^2 the EURO Code design possesses less dimension of footing as compare to the Indian Standard

B. FOR MEDIUM SOIL



Above graph 5.11 shows the dimension of footing which is design manually for medium stiff soil condion.

The results shown in above graph are concluded that for same soil condiotion which has safe bearing caoacity of 200 KN/M^2 the EURO Code design possesses less dimension of footing as compare to the Indian Standard



Above graph 5.12 shows the dimension of footing which is design using Stadd Software for hard soil condion.

The results shown in above graph are concluded that for same soil condiotion which has safe bearing caoacity of 400 KN/M^2 the EURO Code design possesses less dimension of footing as compare to the Indian Standard

REFERENCES

[1] Tabish Izhar, Samreen Bano, Neha Mumtaz "Comparative Study on Analysis and Design of reinforced Concrete Building under Seismic Forces for Different Codal Guidelines" Volume: 3 Issue: 4 , May-Jun 2019.

[2] Kaythar Abdulwahab Ibrahim "Studying of the Effect of Soil Settlement under Different Types of Footings on Multistory Buildings" Vol.34,Part (A), No. 11,2016.

[3] Modita Kulshrestha, Altaf Usmani, Rajan Srivastava. "Comparison of Number of Piles Required for Deep Foundation Design Using Indian and European Code " isbn 978-981-13-7614- 6.

[4] Rodrigo G. Hernandez Avila "Size Optimization Of Truss Structures With Discrete Variables Using Water Wave Metaheuristics" Volume 10, Issue 12, December 2019.

[5] Asst. Prof. Mehul J. Bhavsar, Asst. Prof. Kavita N. Choksi,Asst. Prof. Sejal K. Bhatt, Shrenik K. Shah, "Comparative Study of Typical R.C. Building Using Indian Standards and Euro Standards Under

 DOI : 10.35291/2454-9150.2022.0313

Seismic Forces", International Journal of Scientific and Research Publications, Vol:04, Issue: 12, December 2014.

[6] Miss. Anjali B, Dr. Raji M. “Seismic Analysis and Soil Structure Interaction of Multistoried Building with Different Types of Footing” Vol. 4 , Issue 09, September-2015.

[7] J.Labenski, Christian Moormann “Lateral bearing behaviour of vibratory-driven monopiles: a modified p-y approach based on experimental observations of scaled model tests” vol 4, 2018.

[8] Abdelazim Makki Ibrahim, Ibrahim Malik, Omar Altaj Omar “ Pile design using Eurocode 7: A case study ” Vol. 4(3), pp. 70-80, March 2013.

[9] Mohammad Azim Eirgash “ A Comparative Study of Seismic Performance of the Building Designed using Four Major Codes ” Vol. 8, Issue 08, August-2019.

[10] Amey R. Khedikar, Mohd. Zameeruddin, P. S. Charpe (2022) “Investigation on Progression in the Damage-Based Seismic Performance Evaluation of Reinforced Concrete Structures”, Design Engineering, pp. 15094 - 15115. Available at: http://thedesignengineering.com/index.php/DE/article/view/8741

[11] Walde, N.N., Manchalwar, S. and Khedikar, A., 2015. Seismic Analysis of Water Tank Considering Effect on Time Period. International Journal of Research in Engineering and Technology.

Chandewar, L.P. and Khedikar, A.R., 2018. Seismic

[12] Control of RCC Frame Using Linear Bracing System. International Journal of Research, 5(13), pp.92-96.

Bhadange, S. and Khedikar, A.R., 2018. Study of Risk Management in Construction Projects. International Journal of Research, 5(13), pp.208-210.

[13] Ramteke, V. and Khedikar, A.R., 2018. Dynamic Respone of RCC High Rise Building for Different Types of Sub-structure System. International Journal of Research, 5(13), pp.218-223.

[14] Jayswal, M.P.K. and Khedikar, A.R., Seismic Analysis of Multistorey Building with Floating Column and Regular Column. International Journal on Recent and Innovation Trends in Computing and Communication, 6(4), pp.136-143.

[15] Agrawal, C.P. and Khedikar, A.R., 2018. Seismic Analysis of High Rise RC Structure with Different Plan Configuration. International Journal of Research, 5(13), pp.78-84.

[16] Agrawal, C.P. and Khedikar, A.R., 2018. Dynamic Analysis of High Rise RC Structure Using Etabs For Different Plan Configurations. International Journal of Research, 5(12), pp.5729-5733.

[17] Agrawal, C.P. and Khedikar, A.R., 2018. Linear and Nonlinear Dynamic Analysis of RC Structure for Various Plan Configurations Using ETABS. i-Manager's Journal on Structural Engineering, 7(2), p.70.

[18] Sayyed, N.M. and Khedikar, A., 2018. Performance of Various Parameters of Buildings Under The Composite Action of Blast Load And Earthquake. International Journal of Research, 5(13), pp.103-109.

[19] Ghonmode, A., Khedikar, A. and Bhadke, S., 2018. Critical Analysis of Vertical Tall Buildings. International Journal of Research, 5(13), pp.59-63.

[20] Panker, B. and Khedikar, A., 2018. Smart Sensor Techniques for Structural Health Monitoring of Civil Engineering Structures. International Journal of Research, 5(13), pp.71-77.

[21] Khadse, P. And Khedikar, A., 2018. Comparative Study of G+ 5r. C Building With And Without Staircase Model At Different Location. International Journal of Research, 5(13), pp.808-834.

[22] Sayyed, N.M. and Khedikar, A.R., 2018. Performance of Various Structural Parameters of Buildings under the Composite Action of Blast Load and Earthquake.

[23] Jayswal, P.K. and Khedikar, A.R., 2018. Seismic Analysis of Multistorey Building In Different Zones. International Journal of Research, 5(13), pp.131-134.

[24] Patel, H. and Khedikar, A.R., 2018. Review of Fluid Viscous Dampers In Multi-Story Buildings. International Journal of Research, 5(13), pp.85-88.

[25] Kadse, P. and Khedikar, A., 2018. Study of Staircase Effect on Seismic Performance of Multistoried Frame Structure. International Journal of Research, 5(13), pp.144-158.

[26] Pole, S.M. and Khedikar, A., 2017. Seismic Behaviour of Elevated Water Tank under Different Staging Pattern. International Journal of Engineering and Management Research (IJEMR), 7(3), pp.199-205.

[27] Navghare, S.A. and Khedikar, A., 2017. Comparative Dynamic Analysis of RCC Framed Structure for Rectangular Columns. International Journal of Engineering and Management Research (IJEMR), 7(2), pp.394-397

Ghormade, N.P. and Khedikar, A., 2018. Analysis of Multi-Storieyed Irregular RC Building Under Influence of Wind Load. International Journal of Research, 5(13), pp.113-119.

[28] Sukanta K. Shill, Md. M. Hoque, Md. Shaifullah “Punching Shear Behavior of RC Column Footing on Stabilized Ground ” September 2015, Volume 3, Special Issue.

[29] E. Hassaballa, FatheIrahman M. Adam., M. A. Ismaeil “ Seismic Analysis of a Reinforced Concrete Building by Response Spectrum Method ” Vol 3, Issue 9 (September. 2013), V3 PP 01- 09.

[30] Brajesh Kumar Tondon, Dr. S. Needhidasan “ Seismic Analysis of Multi Storied Building in Different Zones ” Volume 2, Issue 2.

[31] Dr. V.L.Shah & Late Dr. S.R.Karve, "Illustrated design of Reinforced concrete Buildings"

[32] Dr. V.L.Shah & Late Dr. S.R.Karve, "Limit State Theory And Design Of Reinforced Concrete", Structures Publication

[33] Duggal S.K., "Earthquake Resistant Design Of Structures", Oxford University

[34] EURO CODE 2: Design Of Concrete Structures

[35] IS 456:2000: Code Of Practice For Plain And Reinforced Concrete

[36] IS 1893 (Part-1):2002: Criteria For Earthquake Resistant Design Of Structures

[37]. Joseph E. Bowles, RE., S.E.; "Foundation analysis and design "; 5th Edition, McGraw-Hill International editions, 1997.

[38] A. Lu´evanos Rojas, A mathematical model for dimensioning of footings square, International Review Civil Engineering, vol.3, no.4, pp.346-350, 2012.

[39] M .S. Shetty (1892), Concrete Technology, S. Chand & Company Ltd.

[40] V. N. S.Murthy(2007), Advanced Foundation Engineering, CBS Publishers & Distributors Pvt. Ltd.

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