

Comparative Study of Analysis and Design of Requirement of Steel Percentage Quantity for G+15 RCC Building in Seismic Zone III, IV & V with Hard Soil Condition

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ABSTRACT: Earthquake is a natural phenomenon which can generate the most destructive forces on structures. Buildings should be made safe for lives by proper design and detailing of structural members in order to have a ductile form of failure. The percentage of steel in terms of area of steel or weight of steel is not given in any IS Code for change in seismic zone. This report comprises of seismic analysis and design of a G+15 storied RCC building by using STAAD Pro software. Building with symmetrical plan in different seismic zones with hard soil conditions. The building is modeled, analyzed using STADD-Pro software and Response Spectrum method. The Response Spectra as per IS 1893 (Part 1): 2002 for hard soil is used.

KEYWORDS: Base shear, Area of steel, Weight of steel, STADD Pro software

I.INTRODUCTION

An earthquake is a natural phenomenon that leads to the vast devastation of engineered systems and facilities. The present study mainly focuses on determining the variation in reinforcement percentage for various seismic zones of India. The current IS code for seismic design that is IS1893-2002 PART 1 suggest that maximum reinforcement should be provided for higher seismic zones, but it does not provide clear information, how much percentage of reinforcement can be used for various seismic zones. In this project work attempt is made to find the percentage of steel required for various seismic zones for the study an unsymmetrical building plan is used with 15 storied and analyzed and designed by using structure analysis software tool STAAD-Pro.

OBJECTIVES

- To study and analyze the bending moment and shear force for various seismic zones.
- To determine base shear force for various seismic zones.
- To determine the variation in percentage of steel from zone III, VI and V.
- To determine the variation in percentage of weight of steel from zone III, IV and V.
- To determine Area of steel factor for zone III, IV and V.
- To determine weight factor for zone III, IV and V.

II.LITERATURE REVIEW

I. Salahuddin Shakeeb S M1, Prof BrijBhushan S2, Prof Maneeth P D3, Prof. Shaikh Abdula. “COMPARATIVE STUDY ON PERCENTAGE VARIATION OF STEEL IN DIFFERENT SEISMIC ZONES OF INDIA” In this work attempt is made to find the percentages required for various seismic zones by considering the effects of infill and without infill. For the study a symmetrical building plan is used with 13 storeys and analyzed and designed by using structure analysis software tool ETABS-2013. The study also includes the determination of base shear, displacement, moment and shear and the results are compared between gravity loads and various seismic zones.

II.P. Vijay Kumar & P. PrabhuTeja“ VARIATION IN PERCENTAGE OF STEEL FOR A BUILDING DESIGNED IN VARIOUS SEISMIC ZONES” This paper mainly gives the variations in the percentage of the reinforcement when the building (G+4) designed as per IS 456 and when the building is designed in different earthquake zones considering earthquake force as per IS 1893:2002.

III.Akash Panchal, Ravi Dwivedi “ANALYSIS AND DESIGN OF G+6 BUILDING IN DIFFERENT SEISMIC ZONES OF INDIA” In this paper a G+6 existing RCC framed structure has been analyzed and designed using STAAD Pro V8i. The building is designed as per IS 1893(Part 1):2002 for earthquake forces in different seismic zones. They are to compare the variation of steel percentage, maximum shear force, maximum bending moment, and maximum deflection in different seismic zone. Variations are drastically higher from zone II to zone V.

IV. Tiriveedhi Sai Krishna, V. Srinivasarao“EARTHQUAKE ANALYSIS AND DESIGN OF MULTI-STORIED BUILDING FOR DIFFERENT ZONES IN INDIA” This project report gives the STAAD Pro. Design of Multistoried building without considering the earthquake effect and gives how to calculate the seismic weights and base shear for a multistoried structure manually and also gives the STAAD Pro analysis and design of multistoried building in considering different seismic zones (II, III,IV,V) in India (as per IS1893(part-1):2002)in the point of steel quantity for all design load combinations.

III. METHODOLOGY

In this paper we have considered building plan area (12mX9m) for G+15 storey building with seismic zone III, IV, & V with hard soil condition. The loading is done with referring to the code IS 1893:2002(Part-I). The modeling and analysis is done using STADD-Pro software for G+15 building for zone III, IV, V for hard soil condition.

Table No.1 Description of building model-

| Sr. no. | Particulars | Details |
|---------|-----------------------|--|
| 1. | Type of structure | Ordinary moment resisting frame (OMRF) |
| 2. | Number of floors | G+15 |
| 3. | Plan dimension | 12m X 9m |
| 4. | Number of bays | 3 bays of 4m in X direction 3 bays of 4m in Z direction |
| 5. | Width of each bay | 4m & 3m |
| 6. | Size of Beam | 0.54 m X 0.35m (Upto 7 th Floor) 0.40mX0.30m (8 th to 15 th floor) |
| 7. | Size of Column | 0.95m X 0.90m (Upto 7 th Floor) 0.70m X 0.65m (8 th to 15 th floor) |
| 8. | Thickness of slab | 0.120 m |
| 9. | Thickness of wall | 0.230 m |
| 10. | Height of each storey | 3.0 m |
| 11. | Depth of foundation | 1.2m |

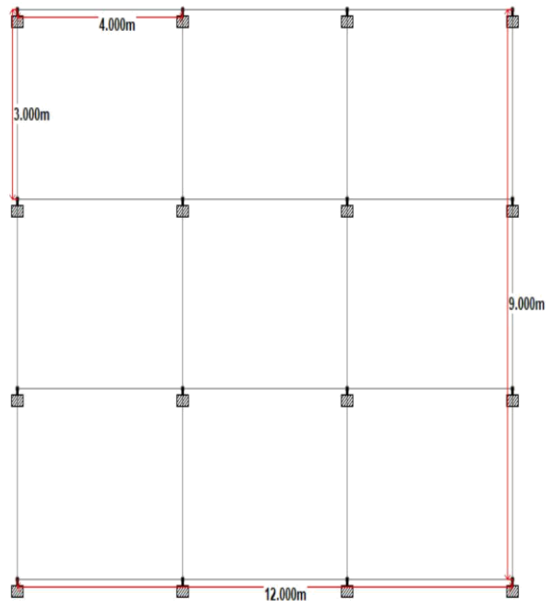


Fig. 1 Plan area

IV.RESULTS AND DISCUSSION

Table 2: Manual value of base shear(V_b) in (KN)

| ZONE | BASE SHEAR IN X DIRECTION | BASE SHEAR IN Z DIRECTION |
|------|---------------------------|---------------------------|
| III | 1493.19 | 1396.34 |
| IV | 2256.59 | 1943.02 |
| V | 3383.02 | 2941.53 |

Table No:3Area of steel for beam, column and footing

| Sr. No. | ZONE | AST OF BEAM (mm^2) | AST OF COLUMN (mm^2) | AST OF FOOTING (mm^2) |
|---------|------|-------------------------------|---------------------------------|----------------------------------|
| 1 | III | 727638.1 | 1862698.2 | 2613761.1 |
| 2 | IV | 1183689.3 | 2194081.2 | 3021296.88 |
| 3 | V | 1983975.1 | 2525464.3 | 3888051.62 |

Table No:4Area of steel for building in different zone

| Sr.No. | ZONE | AST OF BUILDING (mm^2) |
|--------|------|-----------------------------------|
| 1 | III | 3341399.24 |
| 2 | IV | 6399367.52 |
| 3 | V | 8397491.10 |

Table No:5 Percentage variation of steel for beam, column and footing

| Sr. No. | ZONE | % VARIATION IN AST OF BEAM | % VARIATION IN AST OF COLUMN | % VARIATION IN AST OF FOOTING |
|---------|-----------|----------------------------|------------------------------|-------------------------------|
| 1 | III TO IV | 63% | 18% | 16% |
| 2 | IV TO V | 68% | 15% | 29% |
| 3 | III TO V | 173% | 36 | 49% |

Table shows the percentage variation in steel reinforcement for columns. As we go from zone III to IV percentage of steel increases by 18% and from zone III to V percentage of steel increases by 36%. The percentage variation in steel reinforcement for beams. As we go from zone III to IV percentage of steel increases by 63% and from zone III to V percentage of steel increases by 173%. The percentage variation in steel reinforcement for footing. As we go from zone III to IV percentage of steel increases by 16% and from zone III to V percentage of steel increases by 49%.

Table No:6 Total variation % for area of steel

| Sr. No. | ZONE | PERCENTAGE OF STEEL |
|---------|-----------|---------------------|
| 1 | III TO IV | 92% |
| 2 | IV TO V | 31% |
| 3 | III TO V | 151% |

Table shows the percentage variation in total steel reinforcement for G+15 RCC building. As we go from zone III to IV percentage of steel increases by 92% and from zone III to V percentage of steel increases by 151%.

Table No:7 Area of steel factor

| Sr. No. | ZONE | FACTOER AST |
|---------|-----------|-------------|
| 1 | III TO IV | 0.915 |
| 2 | IV TO V | 0.312 |
| 3 | III TO V | 1.513 |

Table shows the factor for calculated Area of steel. From analysis of percentage variation of steel we proposed a factor for calculating Area of steel from zone III to IV is 0.915 and zone III to V 1.513.

Table No:8 Weight of column, beam and footing

| Sr. No. | ZONE | WEIGHT OF BEAM (KG) | WEIGHT OF COLUMN (KG) | WEIGHT OF FOOTING (KG) |
|---------|------|---------------------|-----------------------|------------------------|
| 1 | III | 33272.67 | 61937.95 | 78818.79 |
| 2 | IV | 54359.34 | 73374.92 | 97418.11 |
| 3 | V | 91390.69 | 84273.79 | 144098.42 |

Table No.9 Weight of steel for building

| Sr. No. | ZONE | WEIGHT OF STEEL FOR BUILDINNG (KG) | WEIGHT OF STEEL FOR BUILDING (TON) |
|---------|------|------------------------------------|------------------------------------|
| 1 | III | 174029.41 | 174.03 |
| 2 | IV | 225152.37 | 225.15 |
| 3 | V | 319762.90 | 319.76 |



Table No:10Percentage variation of weight of steel for beam

| Sr.No. | ZONE | % VARIATION OF STEEL |
|--------|-----------|----------------------|
| 1 | III TO IV | 63% |
| 2 | IV TO V | 68% |
| 3 | III TO V | 175% |

Table No:11Percentage variation of weight of steel for column

| Sr.No. | ZONE | % VARIATION OF STEEL |
|--------|-----------|----------------------|
| 1 | III TO IV | 18% |
| 2 | IV TO V | 15% |
| 3 | III TO V | 36% |

Table No:12 Percentage variation of weight of steel for footing

| Sr.No. | ZONE | % VARIATION OF STEEL |
|--------|-----------|----------------------|
| 1 | III TO IV | 24% |
| 2 | IV TO V | 48% |
| 3 | III TO V | 83% |

Table No:13 Percentage variation of weight of steel for beam, column & footing

| Sr.No. | ZONE | % VARIATION OF STEEL |
|--------|-----------|----------------------|
| 1 | III TO IV | 29% |
| 2 | IV TO V | 42% |
| 3 | III TO V | 84% |

As we go from zone III to IV percentage of steel increases by 29 % and from zone III to V percentage of steel increases by 84%.

Table No:14 weight factor

| Sr.No. | ZONE | WEIGHT FACTOR |
|--------|------|---------------|
| 1 | III | 0.294 |
| 2 | IV | 0.420 |
| 3 | V | 0.873 |

From analysis of percentage variation of weight of steel we proposed a factor for calculating weight of steel from zone III to IV is 0.294 and zone III to V is 0.873

V.CONCLUSION

- The base shear value goes on increasing from zone III to zone IV.
- The deflection of beams increases as we go to upper floor and after applying earthquake loading bending moment become maximum at support.
- The percentage of steel required for G+15 building from zone III to zone IV has increased by 92% and from zone III to zone V has increased by 151% and from analysis of percentage variation of steel we proposed a factor for calculating Area of steel from zone III to IV is 0.915 and zone III to V 1.513

- The percentage of weight of steel required for G+15 building from zone III to zone IV has increased by 29% and from zone III to V has increased by 84% and from analysis of percentage variation of weight of steel we proposed a factor for calculating weight of steel from zone III to IV is 0.294 and from zone III to V is 0.873

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