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IMPORTANCE OF ASPECT RATIO IN THE ANALYSIS AND DESIGN OF A 15 STORIED BUILDING USING ETABS CONSIDERING SEISMIC ZONES

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Abstract
When it comes to population and economic growth, India is unrivalled. Large commercial/office space is needed in densely populated cities where the price of land is high and horizontal expansion is difficult due to a lack of available land. When land is at a premium, building upwards is the only option.

In the process the first step is architectural planning based on the requirement and later is the structural design based on the architectural intent. Generally, in India, during the architectural concept & planning the architects and structural engineers do not coordinate at the early stages. Architectural designs are generally finalised without giving much importance to the structural framing of the building. The structural engineers get involved only after finalizing the complete architectural layout plans and designs. Structural engineers do not have any option but just follow the final architectural plans and work on the same to develop structural drawings with lot of constraints, which will result in uneconomical designs. If the structural engineer is involved from the concept stage of the architectural design's, it is possible to achieve most economical structure. Here an attempt has been made to show that most economical structure depends on the aspect ratio of a building plan due to lateral seismic forces.

A 15 storied Office space building is considered with floor-to-floor height as 3.6m, 8m x 8m grids and seismic zone II, III and IV. Three different building plan aspect ratios are considered for the building. Three final mathematical models are created with number of iterations to achieve ideal columns with optimum structural element sizes. Dead loads, live loads, imposed loads, wind loads, and seismic loads are all taken into account in Etabs modelling efforts, with reference to the requirements set forth by the IS coal provisions.

In high rise structures the vertical members generally requires high reinforcement bars when compared with other structural members, so if these vertical members are optimally designed then it is possible to achieve most economical design for the complete structure.

The primary goal of this project is to compare the consumption of steel in the vertical structural members for different building plan aspect ratios while keeping the floor area constant, and to finalise the best aspect ratio to achieve the most optimum design while also performing zone comparison for vertical structural members. This work helps to study different IS codes, learn

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mathematical modelling using Etabs software and AutoCAD software for drafting. By this project work the essential skillset that is needed for the industry will be acquired which is also one of the objectives of this project work.

Keywords: ETABS, Seismic Zones, Storied building

I. INTRODUCTION

ETABS is a dedicated piece of software for the construction industry. It gives the structural engineer everything they need to model, analyse, design, and optimise a building. The Windows-based graphical user interface that incorporates all of these features is unparalleled in its simplicity, efficiency, and power. In the field of building systems analysis and design, an ETABS update is required. ETABS's cutting-edge graphical user interface is paired with sophisticated modelling, analysis, and design tools that are all linked to a central database. For basic buildings, the process is quick and simple. Even the most intricate and extensive architectural models are no match for it. The following analyses can be performed with ETABS: Analyses of the (a)Linear (b)Nonlinear (c)Pushover (d)P Effect

The user, however, acknowledges and accepts that neither the program's creators nor its distributors make any guarantees about the program's accuracy or dependability. For verifying the soundness of concrete building designs, this programme is indispensable. The user is responsible for thoroughly grasping the program's underlying assumptions and independently validating the output. design capabilities for a wide variety of materials, along with insightful visual representations, reports, and schematics that can be read and understood by users with ease. ETABS includes the entirety of the engineering design process, from initial concept to final schematic drawings. Making models has always been a difficult process. To easily analyse and design a building, simply convert the AUTOCAD drawings into ETABS models. Structures made of steel and concrete, composite beams and columns, steel joists, concrete and masonry shear walls, and more can all pass the Design check when using e-tabs. All analysis and design output, including framing plans, schedules, details, and cross-sections, can be exported to a set of customizable reports, and the software can be used to create conceptual construction drawings in both concrete and steel.

There are many aspects of the ETABS programme that we have not had time to investigate despite our extensive coverage of their basics in this project. You have received adequate training to become proficient with the software in a short amount of time. You'll be able to model more complex buildings and perform a wider range of analyses and designs with the help of these new features.

The first step in the process is the architectural planning that is based on the requirement, and the second step is the structural design that is based on the architectural intent. In most cases throughout the architectural concept and planning stages in India, structural engineers and architects do not coordinate their efforts at the earliest stages. The majority of the time, architectural designs are finalised without giving the structural framing of the building a great deal of importance. Only after the complete architectural layout plans and designs have been finalised do structural engineers get involved in the project. Structural engineers are powerless to do anything other than follow the final architectural plans and work from those plans to develop structural drawings that contain a great deal of constraint, which will lead to designs that are not economically feasible. It is possible to achieve the most cost-effective structure if the structural engineer is involved in the architectural design process from the very beginning of the concept stage. Because of lateral seismic forces, an attempt has been made here to demonstrate that the aspect ratio of a building plan is crucial to determining which structure is the most cost-effective.

II. LITERATURE SURVEY

Arnold,C., and Reitherman, R.,[1], "Seismic Design and Building Layout," A building's earthquake response is influenced by its configuration, which is determined by factors such as the building's function (interior design), the structural system selected, and the designer's aesthetic preferences in relation to the overall urban project. Greater design flexibility often leads to compromises that have a negative impact on a building's seismic resistance. Achieving the desired level of reliability in a building requires comprehensive analyses and structural measures to prevent consequences that can lead to collapse. The regularity of a building can be evaluated, and the impact of the proposed design solution on the structural treatment can be seen, in the early stages of the design process, when the building's configuration is defined (structure analysis, dimensioning, and modelling). Designing regular structures allows for the most efficient use of resources during design and construction, as well as greater accuracy in predicting necessary seismic performances (configuration). Nevertheless, when designing irregular structures, architects must accept and incorporate necessary seismic resistance structural measures into the design to reduce the negative effects of the irregularity and still achieve the desired aesthetic qualities without compromising the building's safety.

J. S. Grossman,[2], "Thin concrete buildings are where it's at," In this article, we take a look at the unique challenges presented by very high concrete buildings, and we show how these issues become amplified in very thin structures. Open panoramic views are a necessity for the occupants of these tall, skinny buildings, but they come at a cost to construction efficiency and put pressure on the engineer to ensure sufficient serviceability while also taking into account the sense of motion. Alternative approaches to addressing these issues are discussed. Three examples of exceptionally slim buildings (10:1) are examined.

Charleason,A.W, [3], "Seismic design within architectural education", What extent to which buildings withstand earthquakes is largely a product of the architects who design them. Wang [15] has studied the aftermath of quakes in Algeria, California, and Japan to bring attention to the problem of blind adherence to fashionable architectural styles that disregard the possibility of seismic damage. She provides compelling evidence that this issue has been the primary contributor to the failure of many reinforced concrete structures. She cites the collapses of two well-known California structures to support her claim that "architectural concept may be more detrimental to the seismic survival of a building than any other design decision," the Imperial County Services Building (El Centro, 1979) and Olive View Hospital (San Fernando, 1971). To their dismay, however, seismic damage history shows that this lesson is generally not taken very seriously. There appears to be a lot of leeway given to architects to come up with design ideas that aren't well-suited to surviving earthquakes. Structural engineers may reluctantly accept these in the hope that they can be improved through careful analysis and design. Engineers do the best they can given the circumstances, which include poor architectural decisions and an awareness of commercial realities.

Snigdha A. Sanyal, [4] "Multi-Dimensional Building Planning for Safer Tomorrow", Layers of information are superimposed to create the final product of a two-dimensional architectural plan drawing. Soil types, slope analyses, weather patterns, site research, building requirements, lighting, sound, vegetation, and other factors may all be included in these layers. An additional layer of "Safety" is added to the architectural drawing plan based on inferences from the performance of buildings during previous earthquakes. Each structure is both one of a kind and extremely intricate because of all the details that go into it. This additional "safety" is not meant to clip the wings of creative planning, but rather to allow them to soar freely in a less risky atmosphere. Choosing the architectural planning phases where experts from other disciplines needs to interact is the most common difficulty in achieving seismic safety along with the desired architectural plan. The paper's focus is on sustainable structural designs that combine the knowledge of other engineering fields (such as structural engineering) with the ingenuity of architects. This paper examines some of the most fundamental flaws in planning, including: a) instances in which architects have neglected the fundamentals; b) instances in which a collaboration between an engineer and an architect yields a better and safer solution than either could have conceived alone; and c) the role this plays in altering the response of a building to strong seismic shaking.

Christopher Arnold, [5], "Building configuration: problems and solutions". It is the overall form, size, and geometry of a building that has the greatest bearing on how it will fare in an earthquake. Strength, stiffness, and inelastic deformation capacity of a building must be adequate to withstand a specific earthquake-generated force for the building to be considered earthquake-resistant. The typical means by which this is accomplished are the deliberate selection of a building's configuration and the meticulous design of its structural members. The configuration of a building is crucial to its seismic performance. The most important factors influencing seismic configuration of buildings are their overall geometry, structural systems, and load paths. The proportion of a building's slimness to its core size is a key indicator of its efficiency. In this paper, we focus on two ratios: the horizontal or plan aspect ratio (L/B ratio) and the vertical aspect ratio (H/B ratio), also known as the slenderness ratio. H = Total Height of the Building Frame, B = Base Width, and L = Length of the Building Frame for Different Floor Plans when performing a Seismic Analysis of a Multi-Story Regular R.C.C. Building. We compared four building models with varying horizontal and vertical aspect ratios (1, 4, 6, and 8) for this study (4, 16, 24, and 32 stories). There was a wide variety in building lengths, from 12 to 96 metres. We demonstrate the impact of these variables on the functionality of RCC high-rises by using the design parameters specified in IS-1893-2002-Part-1 for seismic zone-3. Here, we compile the results of an investigation into the seismic response of sixteen different building models subjected to varying loads by performing a Linear Elastic Dynamic Analysis (Response Spectrum analysis) with the ETABS software.

III. METHODOLOGY

Introduction

In order to achieve an understanding of the seismic behaviour of structures, it is absolutely necessary to be in possession of both methods for modelling and for applying the seismic load. This study was conducted with the help of software that was developed specifically for finite element modelling. This software was also utilised in the process of carrying out time history analysis (ETABS software). The procedure starts with a requirement-driven architectural plan, then moves on to a structural design that honours the original architect's goals. In India, structural engineers and architects rarely collaborate during the early stages of conceptualization and planning. Only at the very end of the design process does anyone give much thought to the building's structural framing. In most cases, structural engineers are not brought onto a project until after the final architectural layout plans and designs have been completed. Structural engineers are often hampered in their design efforts by having to work off of final architectural plans in order to create structural drawings. An efficient and economical building can only be designed with the structural engineer's input beginning at the concept stage of the architectural design process. This article argues that the aspect ratio of a building's floor plan is critical for determining which structure is most cost-effective due to the effects of lateral seismic forces.

Response Spectrum Analysis

The most likely response of a building under seismic loading is calculated using a response-spectrum analysis. In place of time-series ground motion records, this linear form of analysis makes use of response-spectrum ground-acceleration records that are tailored to the specifics of the seismic load and site conditions. This strategy is highly effective because it considers the structure's dynamical behaviour.

Aspect Ratio

An object's aspect ratio is the proportion between its length, width, and height. When a rectangle is held in the "landscape" orientation, the ratio of its longer side to its shorter side, or width to height,[1][2], is called its aspect ratio.

Sometimes a simple or decimal fraction is used, but most of the time the aspect ratio is written as two integers separated by a colon (x:y). We are not dealing with absolute widths and heights when using x and y; rather, they represent relative values.

Seismic Design Force

During an earthquake, the shaking can be both unpredictable and intermittent. However, The net effect of such random shaking is depicted in most design codes as a static lateral force, which is the equivalent of the inertia forces caused by earthquakes. In force-based earthquake-resistant building design, the Seismic Design Base Shear VB remains the most important quantity. The Seismic Zone Factor Z, which measures the potential for damage from earthquakes in a given area, directly correlates with this force.

In addition, the Importance Factor I is commonly used by codes to make such calls, which is consistent with the idea that increasing design forces will increase the building's elastic range and, in turn, reduce the damage sustained within it. Moreover, the total shaking of a structure results from the addition of the effects of the earthquake's energy at various frequencies and the structure's own natural periods. A new structural flexibility factor, Sa/g, has been included in the codes as a result. Finally, normal buildings can be built economically because design codes permit some damage to reduce cost. Buildings with a higher Response Reduction Factor R are considered more ductile, while those with a lower RRF are considered more brittle. This chapter and the ones that follow it tackle each of these issues in turn. Since the values of parameters like Z and Sa/g are subject to uncertainty, there is no definite knowledge of what the maximum allowable deformation demand on the building will be. Therefore, designing for earthquake effects is not the same as designing to withstand an earthquake. The earthquake demand is instead estimated using probability of exceedance concepts, and the design of earthquake effects is known as earthquake resistant design relative to the likely value of the demand.

Code Books

IS 1893 – 2016 is considered for earthquake loading and conditions. For dead, live & wind loads IS 875 – part I, II & III are considered and taken as loads as per the code.

- Earthquake loads – IS 1893 – 2016
- Dead, Live & Wind loads – IS 875 (Part I, II & III)

IV RESULTS & DISCUSSION

For 15-storied building total height of 56m, the time periods of different aspect ratios is calculated. In this project total three aspect ratios are considered. Aspect ratios have same area and same grid size.

Table 1: Dimensions & Aspect ratio

DIMENSION / ASPECT RATIO	X-Direction	Y-Direction
Aspect ratio 1	48 m	48 m
Aspect ratio 2.25	72 m	32 m
Aspect ratio 4	96 m	24 m

For these dimensions the specific time periods are tabulated below.

Table 2: Time Periods

Direction	Aspect ratio 1	Aspect ratio 2.25	Aspect ratio 4
X -Direction	0.727 sec	0.594 sec	0.514 sec
Z -Direction	0.727 sec	0.89 sec	1.029 sec

ZONE COMPARISON:

Aspect ratios of 1, 2.25, and 4 were considered. Taking all structural dimensions as the same for all seismic zones. We can see the behaviour of one economically designed building in different zones. At the end, we can compare the percentage of steel in vertical members for zone II, III & IV.

Table 3: Structural Details

Contents	Aspect ratios – 1 ,2.25 & 4
No. of stories	15
Floor to Floor height	3.6 m
Foundation Height	2 m
Total height	56 m
Grade of Concrete	M30
Rebar	Fe 415 & Fe 500
Slab Thickness	250 mm
Beam size	300x750 mm
Column sizes	EDGE GF-05 ---- 750X750 mm 06-TER ---- 600X600 mm CENTER GF -03 ----975X975 mm 04-07 ----825X825 mm 08-TER ----675X675 mm
Live load	4 KN/m^2
Finishes	GF – 14TH = 1.5 KN/m^2 TERRACE = 3.6 KN/m^2
Wall load	GF – 14TH = 9.5 KN/m TERRACE = 6 KN/m
Seismic Zone Factor	Zone II – 0.10 Zone III – 0.16 Zone IV – 0.24
Site Type	II
Importance Factor	1
Response Reduction Factor	5
Wind load	ZONE II - BANGALORE = 33 m/s ZONE III - CHENNAI (MADRAS) = 50 m/s ZONE IV - DELHI = 47 m/s

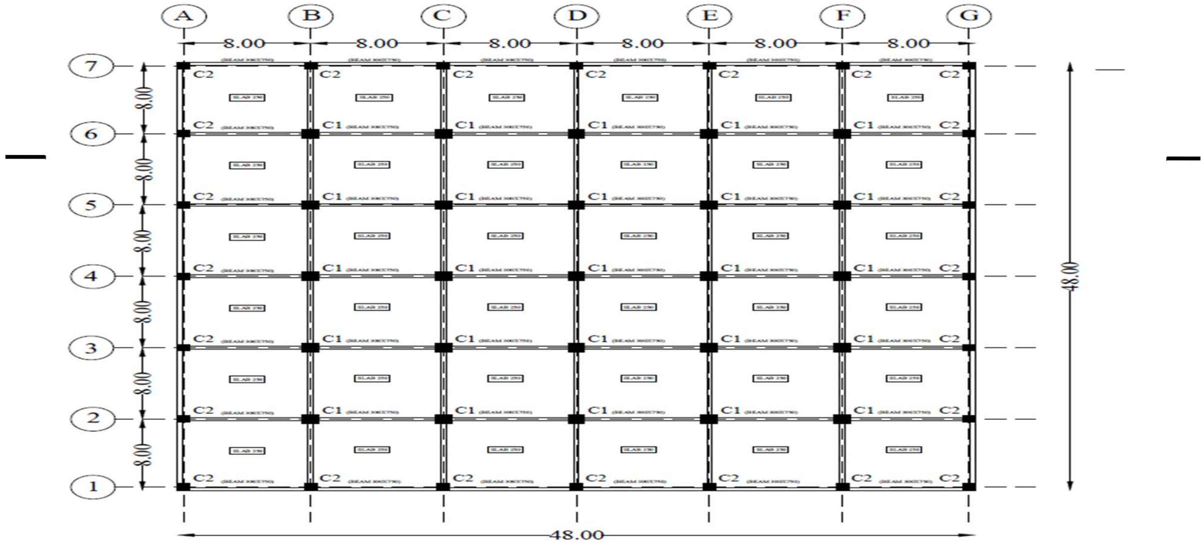
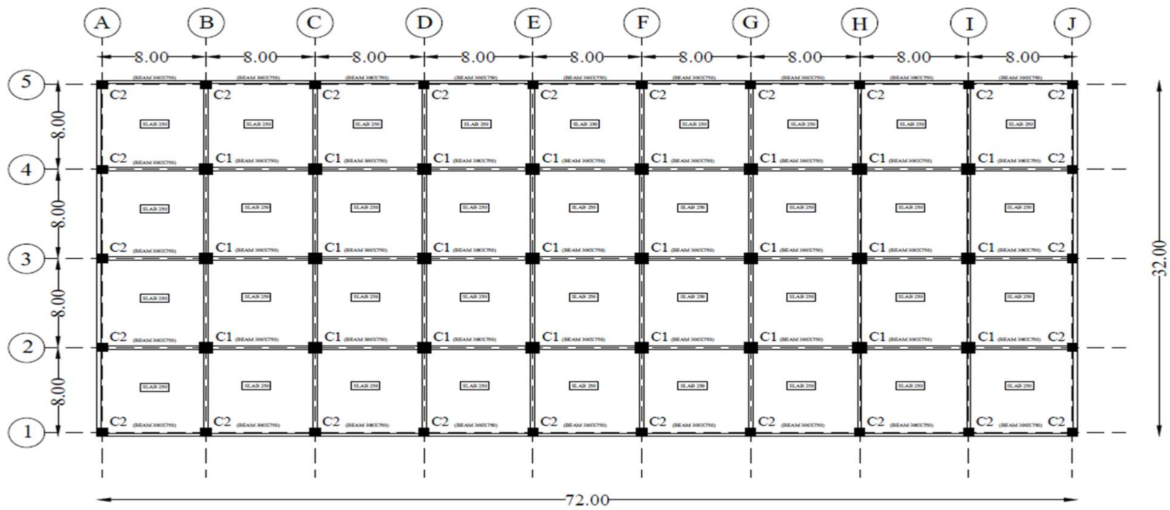


Figure 1: Structural Plan of Model-4 & Aspect ratio – 1

Figure 2: Structural Plan of Model-5 & Aspect ratio – 2.25



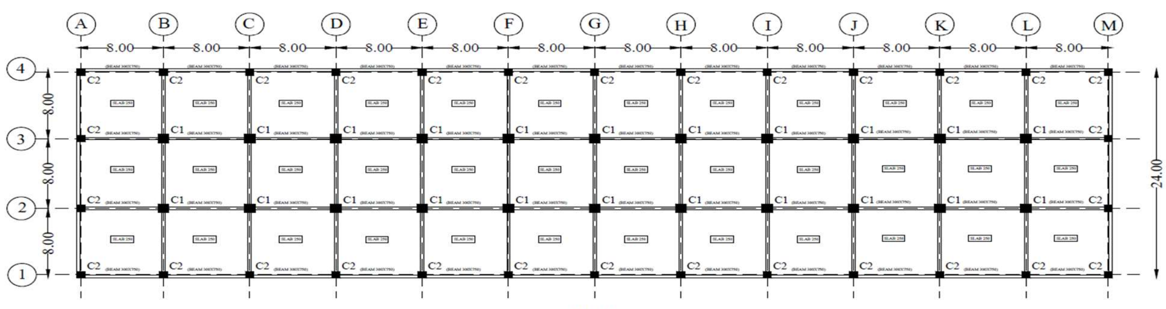


Figure 3: Structural Plan of Model-6 & Aspect ratio – 4

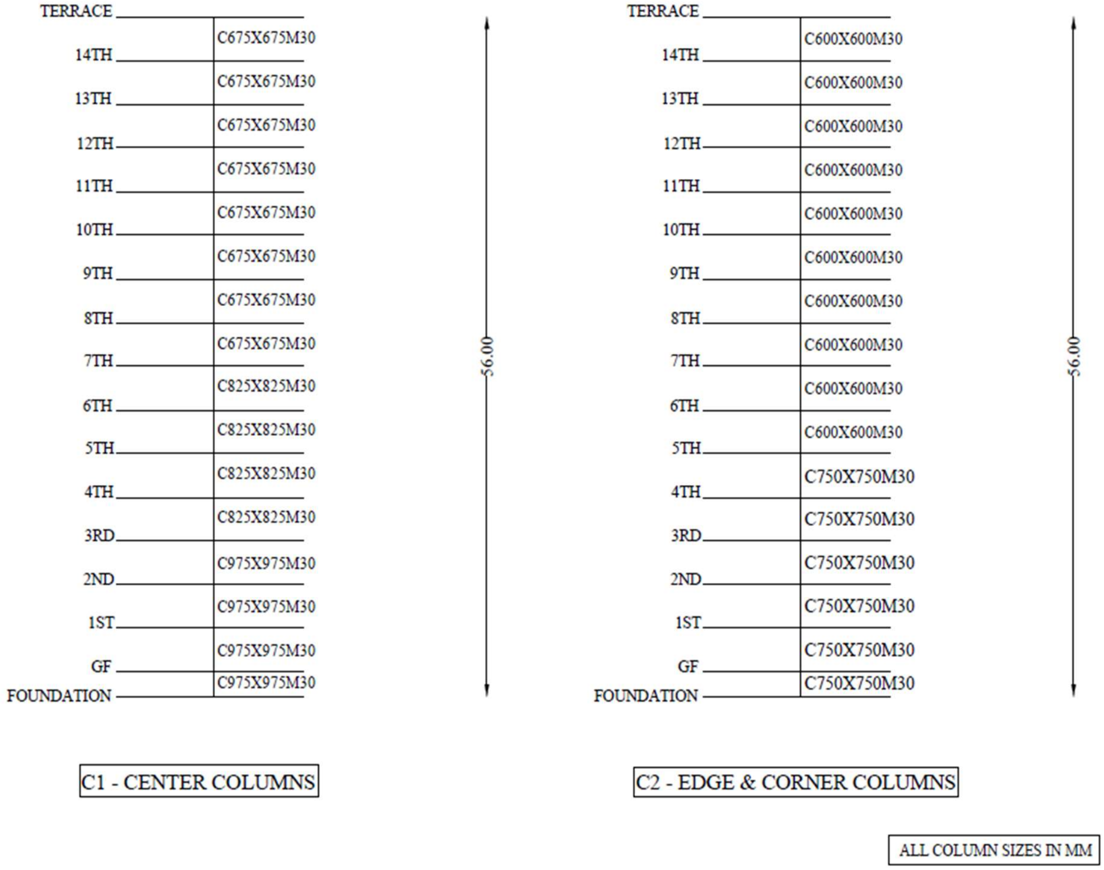
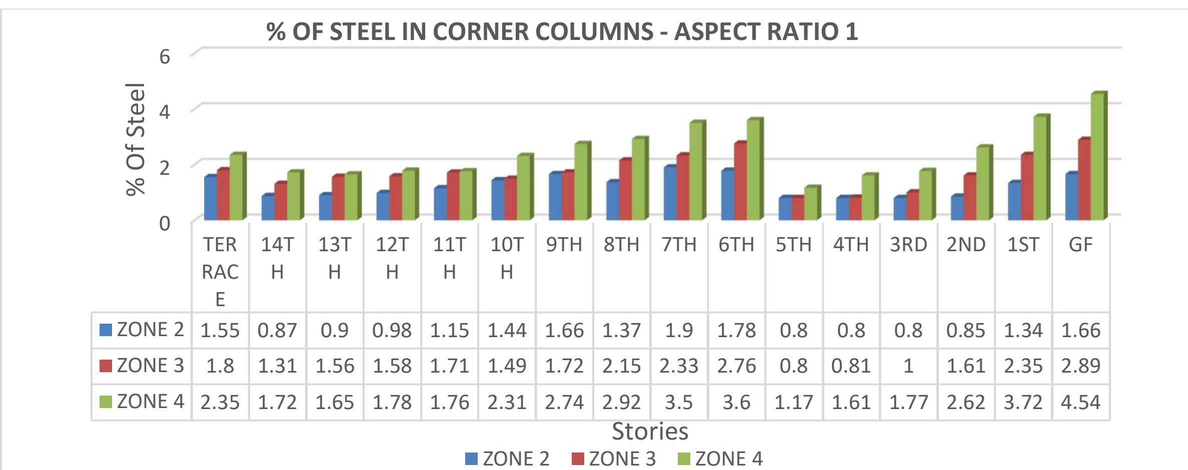


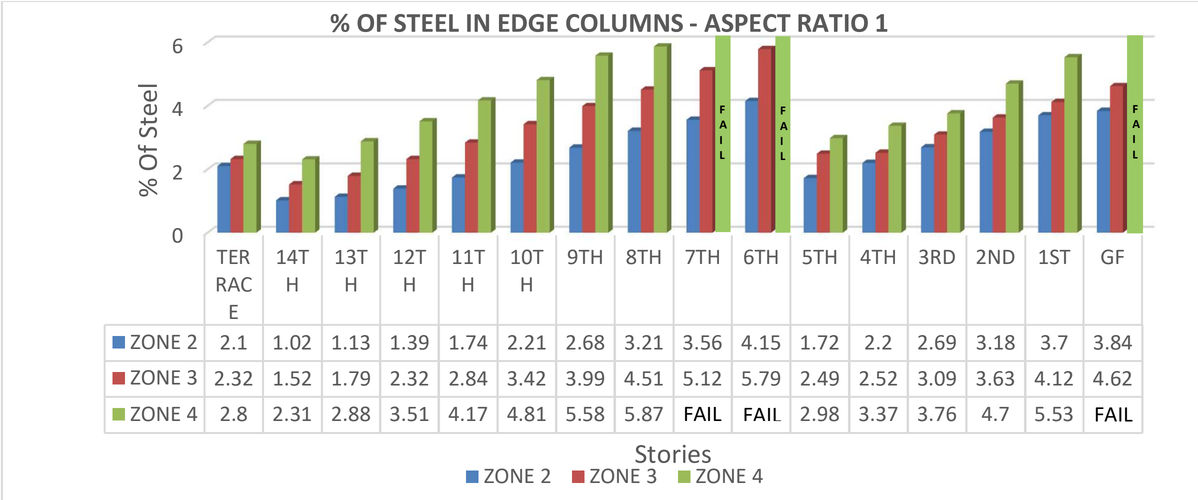
Figure 4: Foundation to Terrace plan

ZONE COMPARISON - ASPECT RATIO 1



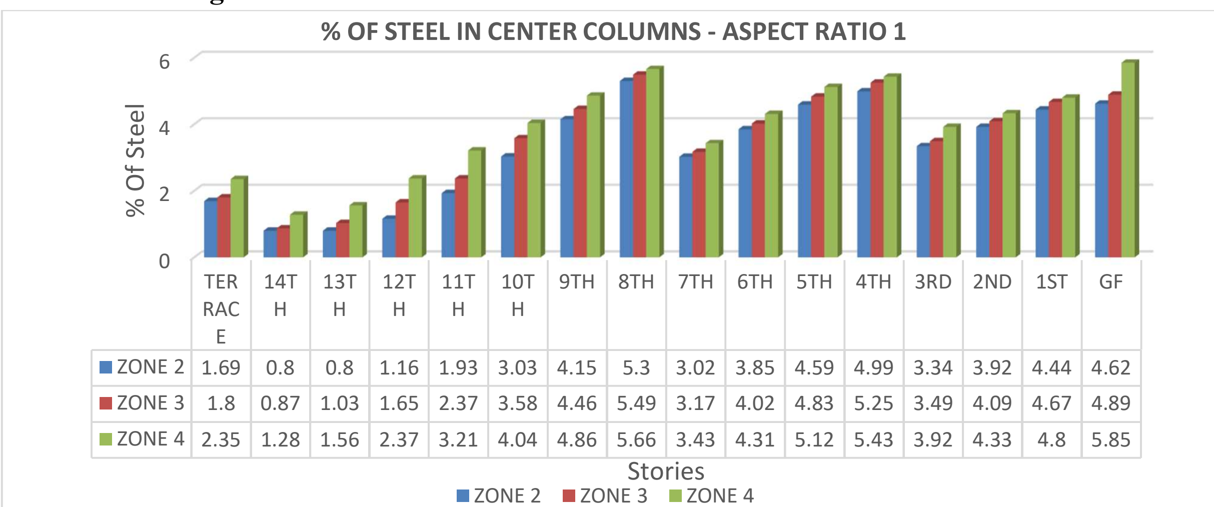
	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
ZONE 2	1.55	0.87	0.9	0.98	1.15	1.44	1.66	1.37	1.9	1.78	0.8	0.8	0.8	0.85	1.34	1.66
ZONE 3	1.8	1.31	1.56	1.58	1.71	1.49	1.72	2.15	2.33	2.76	0.8	0.81	1	1.61	2.35	2.89
ZONE 4	2.35	1.72	1.65	1.78	1.76	2.31	2.74	2.92	3.5	3.6	1.17	1.61	1.77	2.62	3.72	4.54

Figure 5: % Of STEEL IN CORNER COLUMNS-ASPECT RATIO-1



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
ZONE 2	2.1	1.02	1.13	1.39	1.74	2.21	2.68	3.21	3.56	4.15	1.72	2.2	2.69	3.18	3.7	3.84
ZONE 3	2.32	1.52	1.79	2.32	2.84	3.42	3.99	4.51	5.12	5.79	2.49	2.52	3.09	3.63	4.12	4.62
ZONE 4	2.8	2.31	2.88	3.51	4.17	4.81	5.58	5.87	FAIL	FAIL	2.98	3.37	3.76	4.7	5.53	FAIL

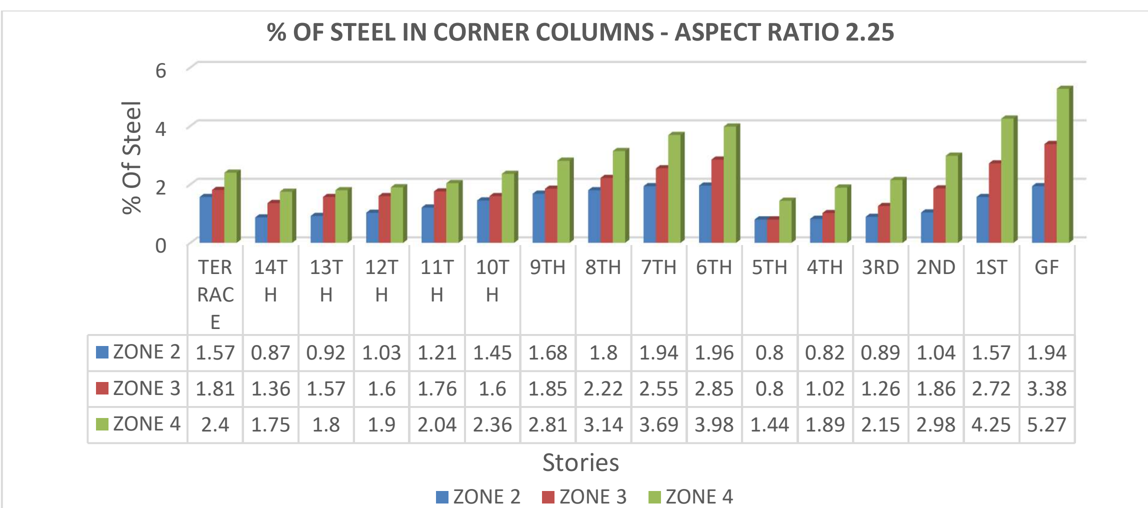
Figure 6: % Of STEEL IN EDGE COLUMNS-ASPECT RATIO-1



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
ZONE 2	1.69	0.8	0.8	1.16	1.93	3.03	4.15	5.3	3.02	3.85	4.59	4.99	3.34	3.92	4.44	4.62
ZONE 3	1.8	0.87	1.03	1.65	2.37	3.58	4.46	5.49	3.17	4.02	4.83	5.25	3.49	4.09	4.67	4.89
ZONE 4	2.35	1.28	1.56	2.37	3.21	4.04	4.86	5.66	3.43	4.31	5.12	5.43	3.92	4.33	4.8	5.85

Figure 7: % Of STEEL IN CENTER COLUMNS-ASPECT RATIO-1

ZONE COMPARISON - ASPECT RATIO 2.25



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
ZONE 2	1.57	0.87	0.92	1.03	1.21	1.45	1.68	1.8	1.94	1.96	0.8	0.82	0.89	1.04	1.57	1.94
ZONE 3	1.81	1.36	1.57	1.6	1.76	1.6	1.85	2.22	2.55	2.85	0.8	1.02	1.26	1.86	2.72	3.38
ZONE 4	2.4	1.75	1.8	1.9	2.04	2.36	2.81	3.14	3.69	3.98	1.44	1.89	2.15	2.98	4.25	5.27

Figure 8: % Of STEEL IN CORNER COLUMNS-ASPECT RATIO-2.25

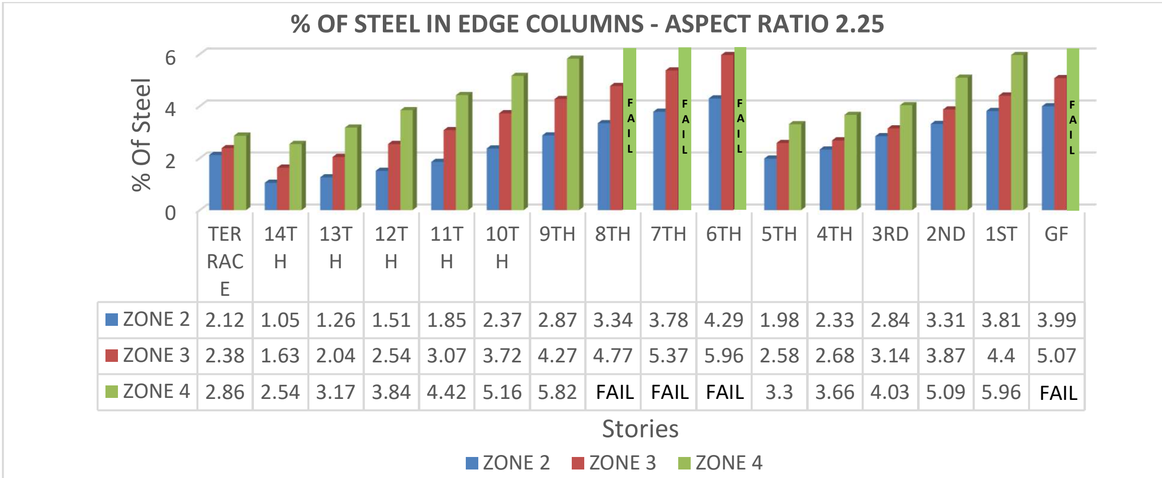


Figure 9: % Of STEEL IN EDGE COLUMNS-ASPECT RATIO-2.25

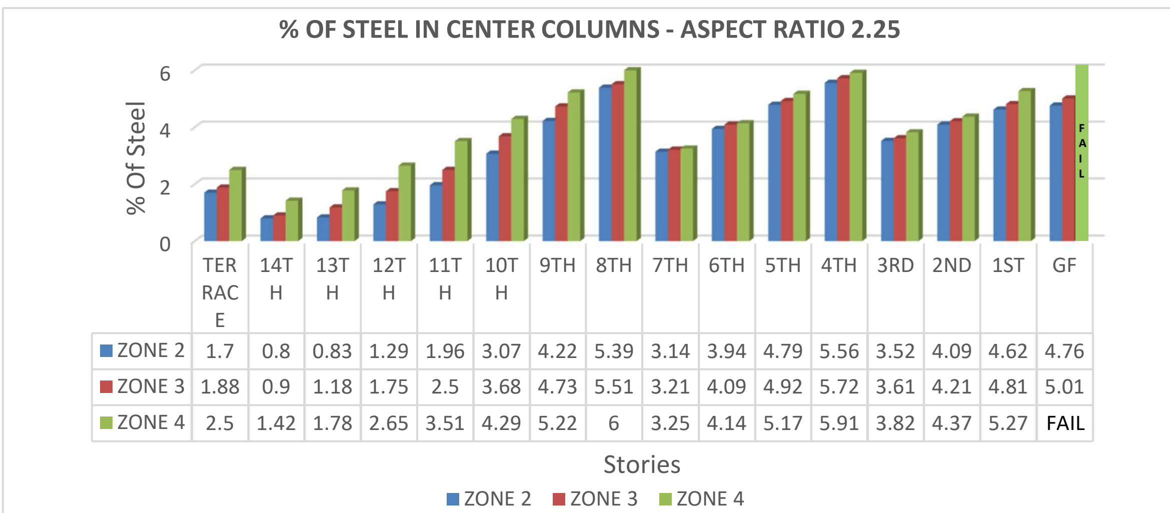
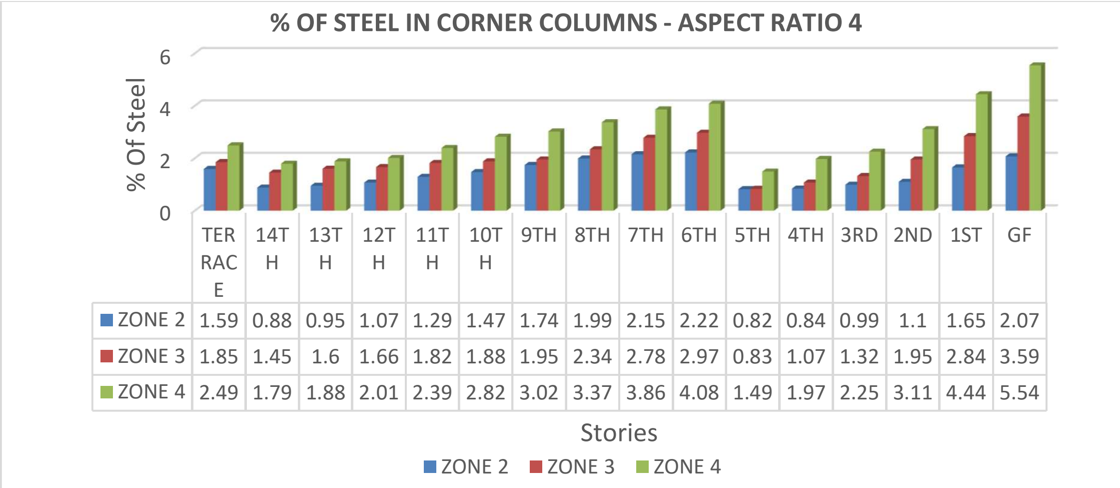


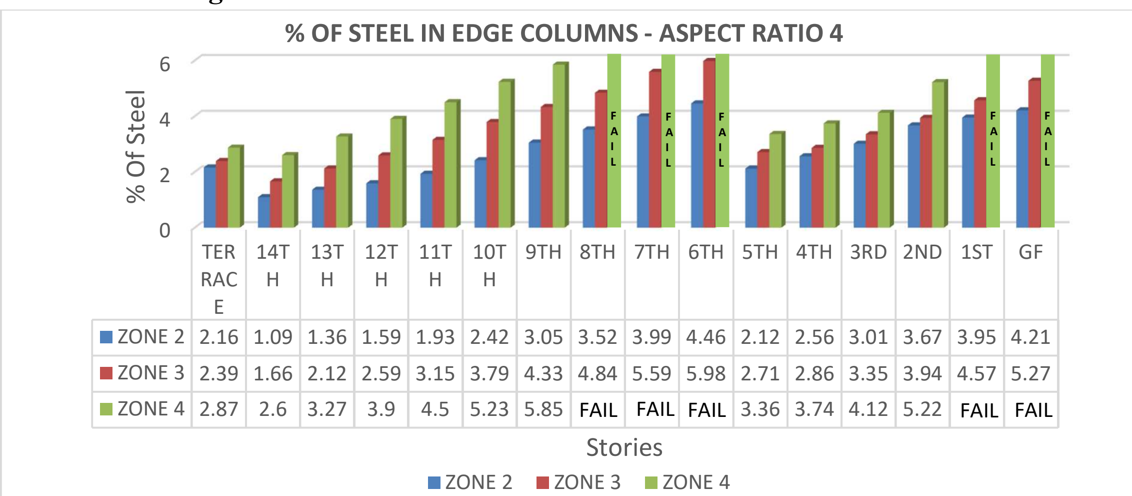
Figure 10: % Of STEEL IN CENTER COLUMNS-ASPECT RATIO-2.25

ZONE COMPARISON - ASPECT RATIO 4



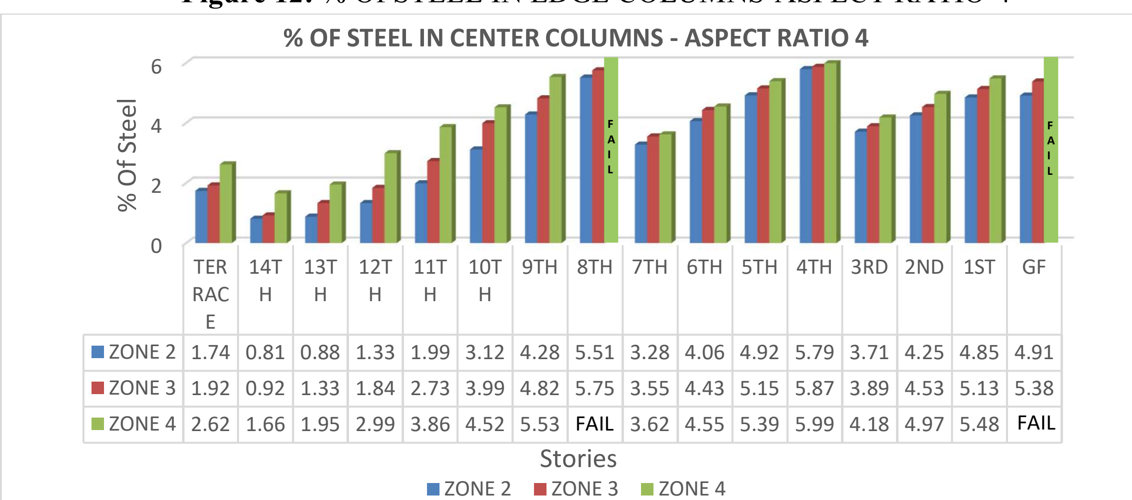
	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
ZONE 2	1.59	0.88	0.95	1.07	1.29	1.47	1.74	1.99	2.15	2.22	0.82	0.84	0.99	1.1	1.65	2.07
ZONE 3	1.85	1.45	1.6	1.66	1.82	1.88	1.95	2.34	2.78	2.97	0.83	1.07	1.32	1.95	2.84	3.59
ZONE 4	2.49	1.79	1.88	2.01	2.39	2.82	3.02	3.37	3.86	4.08	1.49	1.97	2.25	3.11	4.44	5.54

Figure 11: % Of STEEL IN CORNER COLUMNS-ASPECT RATIO-4



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
ZONE 2	2.16	1.09	1.36	1.59	1.93	2.42	3.05	3.52	3.99	4.46	2.12	2.56	3.01	3.67	3.95	4.21
ZONE 3	2.39	1.66	2.12	2.59	3.15	3.79	4.33	4.84	5.59	5.98	2.71	2.86	3.35	3.94	4.57	5.27
ZONE 4	2.87	2.6	3.27	3.9	4.5	5.23	5.85	FAIL	FAIL	FAIL	3.36	3.74	4.12	5.22	FAIL	FAIL

Figure 12: % Of STEEL IN EDGE COLUMNS-ASPECT RATIO-4



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
ZONE 2	1.74	0.81	0.88	1.33	1.99	3.12	4.28	5.51	3.28	4.06	4.92	5.79	3.71	4.25	4.85	4.91
ZONE 3	1.92	0.92	1.33	1.84	2.73	3.99	4.82	5.75	3.55	4.43	5.15	5.87	3.89	4.53	5.13	5.38
ZONE 4	2.62	1.66	1.95	2.99	3.86	4.52	5.53	FAIL	3.62	4.55	5.39	5.99	4.18	4.97	5.48	FAIL

Figure 13: % Of STEEL IN CENTER COLUMNS-ASPECT RATIO-4

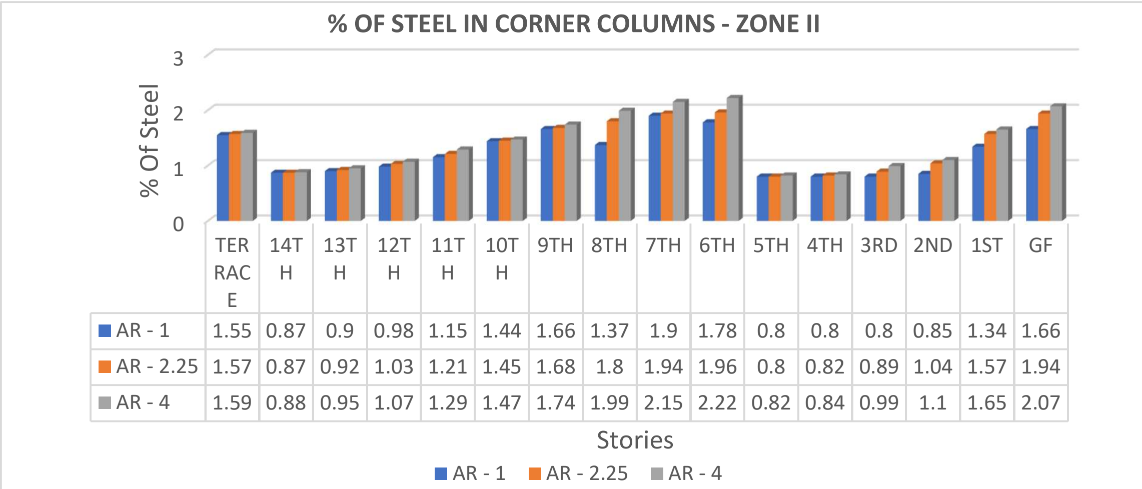
ASPECT RATIO COMPARISON:

Previously, seismic zones were compared by considering individual aspect ratios. Now, we are comparing aspect ratios in individual seismic zones. A comparison of the percentage of steel in columns with different aspect ratios. The following aspect ratios are captured: 1, 2.25, and 4.

ZONE II – (BANGLORE):

Table 4: Structural Details ZONE-II (BANGALORE = 33 m/s)

Contents	Aspect ratios – 1 ,2.25 & 4
No. of stories	15
Floor to Floor height	3.6 m
Foundation Height	2 m
Total height	56 m
Grade of Concrete	M30
Rebar	Fe 415& Fe 500
Slab Thickness	250 mm
Beam size	300x750 mm
Column sizes	EDGE GF-05 ---- 750X750 mm 06-TER ---- 600X600 mm CENTER GF -03 ----975X975 mm 04-07 ----825X825 mm 08-TER ----675X675 mm
Live load	4 KN/m^2
Finishes	GF – 14TH = 1.5 KN/m^2 TERRACE = 3.6 KN/m^2
Wall load	GF – 14TH = 9.5 KN/m TERRACE = 6 KN/m
Seismic Zone Factor	Zone II – 0.10 Zone III – 0.16 Zone IV – 0.24
Site Type	II
Importance Factor	1
Response Reduction Factor	5
Wind load	ZONE II - BANGALORE = 33 m/s



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
AR - 1	1.55	0.87	0.9	0.98	1.15	1.44	1.66	1.37	1.9	1.78	0.8	0.8	0.8	0.85	1.34	1.66
AR - 2.25	1.57	0.87	0.92	1.03	1.21	1.45	1.68	1.8	1.94	1.96	0.8	0.82	0.89	1.04	1.57	1.94
AR - 4	1.59	0.88	0.95	1.07	1.29	1.47	1.74	1.99	2.15	2.22	0.82	0.84	0.99	1.1	1.65	2.07

% Of Steel in Columns- ZONE II (BANGALORE)

Figure 14: % Of STEEL IN CORNER COLUMNS-ZONE-II

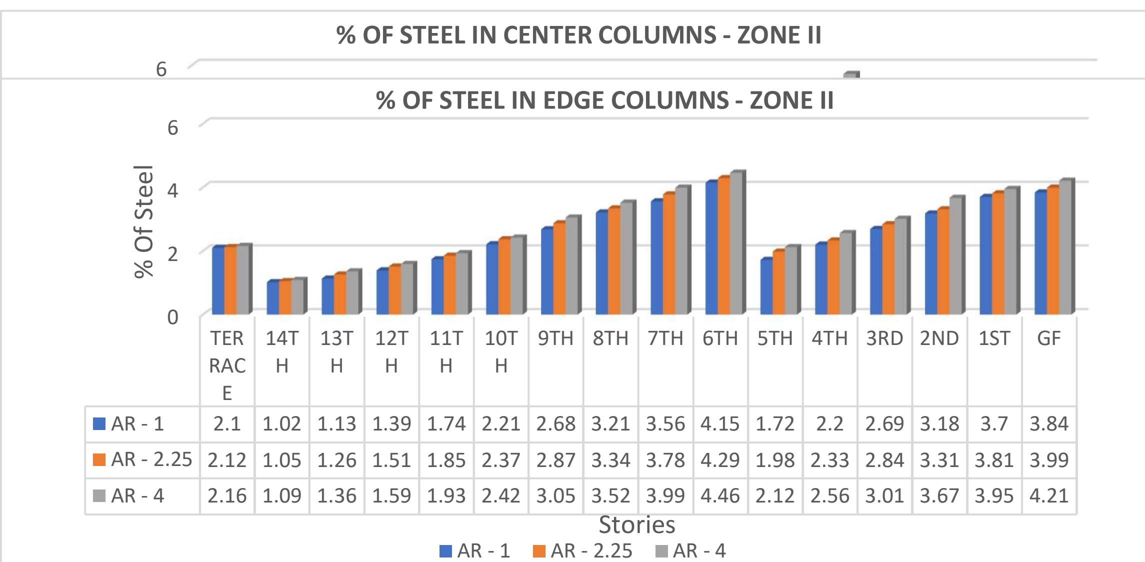
Figure 15: % Of STEEL IN EDGE COLUMNS-ZONE-II

Figure 16: % Of STEEL IN CENTER COLUMNS-ZONE-II

ZONE III – (CHENNAI):

Table 5: Structural Details ZONE-III (CHENNAI (MADRAS) = 50 m/s)

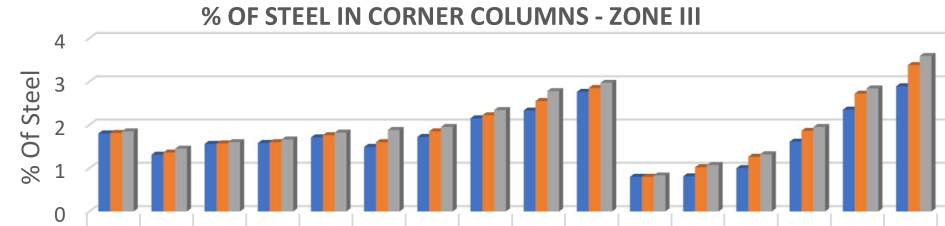
Contents	Aspect ratios – 1 ,2.25 & 4
No. of stories	15
Floor to Floor height	3.6 m
Foundation Height	2 m
Total height	56 m



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
AR - 1	2.1	1.02	1.13	1.39	1.74	2.21	2.68	3.21	3.56	4.15	1.72	2.2	2.69	3.18	3.7	3.84
AR - 2.25	2.12	1.05	1.26	1.51	1.85	2.37	2.87	3.34	3.78	4.29	1.98	2.33	2.84	3.31	3.81	3.99
AR - 4	2.16	1.09	1.36	1.59	1.93	2.42	3.05	3.52	3.99	4.46	2.12	2.56	3.01	3.67	3.95	4.21

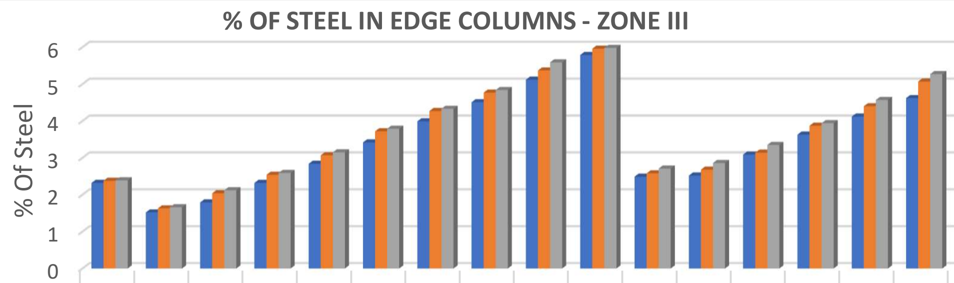
Grade of Concrete	M30
Rebar	Fe 415 & Fe 500
Slab Thickness	250 mm
Beam size	300x750 mm
Column sizes	EDGE GF-05 ---- 750X750 mm 06-TER ---- 600X600 mm CENTER GF -03 ----975X975 mm 04-07 ----825X825 mm 08-TER ----675X675 mm
Live load	4 KN/m^2
Finishes	GF – 14TH = 1.5 KN/m^2 TERRACE = 3.6 KN/m^2
Wall load	GF – 14TH = 9.5 KN/m TERRACE = 6 KN/m
Seismic Zone Factor	Zone II – 0.10 Zone III – 0.16 Zone IV – 0.24
Site Type	II
Importance Factor	1
Response Reduction Factor	5
Wind load	ZONE III - CHENNAI (MADRAS) = 50 m/s

% Of Steel in Columns- ZONE III (CHENNAI)



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
AR - 1	1.8	1.31	1.56	1.58	1.71	1.49	1.72	2.15	2.33	2.76	0.8	0.81	1	1.61	2.35	2.89
AR - 2.25	1.81	1.36	1.57	1.6	1.76	1.6	1.85	2.22	2.55	2.85	0.8	1.02	1.26	1.86	2.72	3.38
AR - 4	1.85	1.45	1.6	1.66	1.82	1.88	1.95	2.34	2.78	2.97	0.83	1.07	1.32	1.95	2.84	3.59

Figure 17: % Of STEEL IN CORNER COLUMNS-ZONE-III



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
AR - 1	2.32	1.52	1.79	2.32	2.84	3.42	3.99	4.51	5.12	5.79	2.49	2.52	3.09	3.63	4.12	4.62
AR - 2.25	2.38	1.63	2.04	2.54	3.07	3.72	4.27	4.77	5.37	5.96	2.58	2.68	3.14	3.87	4.4	5.07
AR - 4	2.39	1.66	2.12	2.59	3.15	3.79	4.33	4.84	5.59	5.98	2.71	2.86	3.35	3.94	4.57	5.27

Figure 18: % Of STEEL IN EDGE COLUMNS-ZONE-III

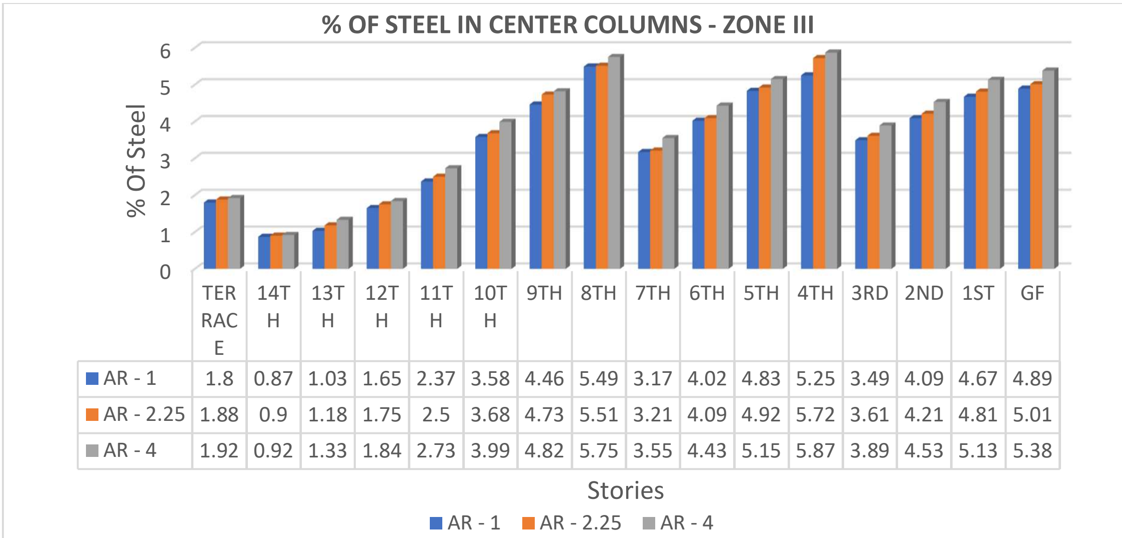


Figure 19: % Of STEEL IN CENTER COLUMNS-ZONE-III

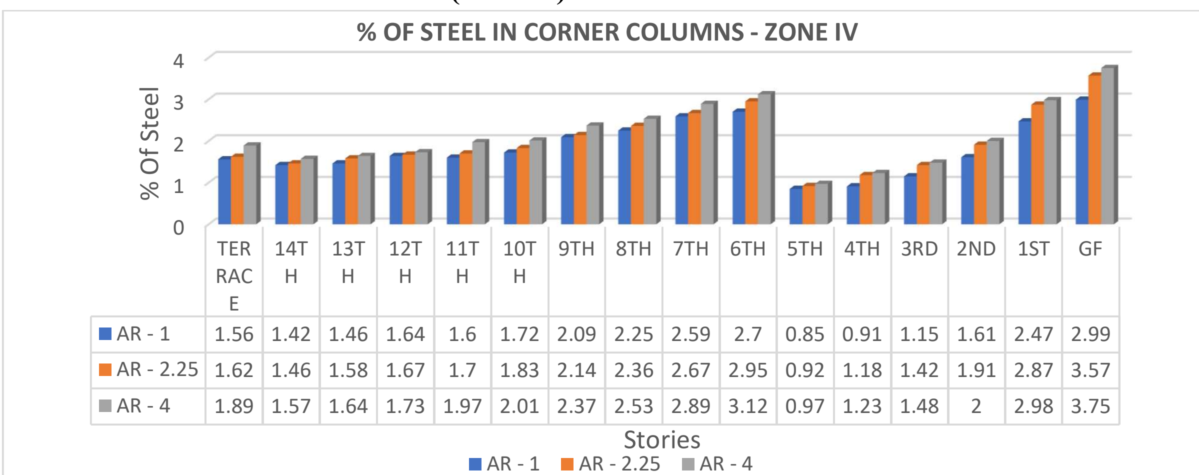
ZONE IV – (DELHI):

Table 6: Structural Details ZONE-IV (DELHI = 47 m/s)

Contents	Aspect ratios – 1 ,2.25 & 4
No. of stories	15
Floor to Floor height	3.6 m
Foundation Height	2 m
Total height	56 m
Grade of Concrete	M30
Rebar	Fe 415 & Fe 500
Slab Thickness	250 mm
Beam size	300x750 mm
Column sizes	EDGE GF-05 ---- 750X750 mm 06-TER ---- 600X600 mm CENTER GF -03 ----975X975 mm 04-07 ----825X825 mm 08-TER ----675X675 mm
Live load	4 KN/m^2
Finishes	GF – 14TH = 1.5 KN/m^2 TERRACE = 3.6 KN/m^2
Wall load	GF – 14TH = 9.5 KN/m TERRACE = 6 KN/m
Seismic Zone Factor	Zone II – 0.10 Zone III – 0.16

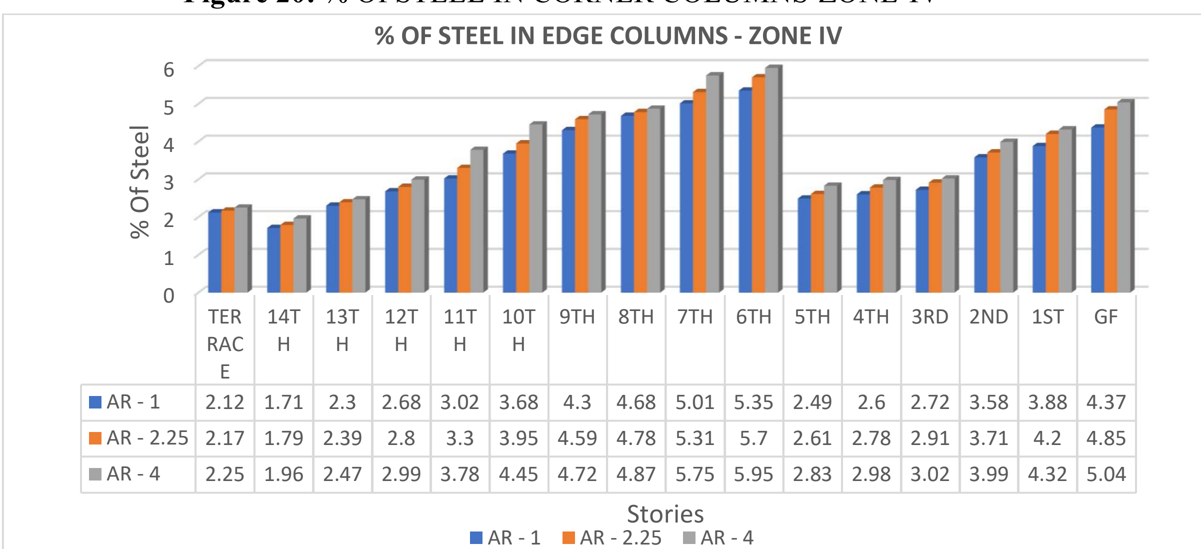
	Zone IV – 0.24
Site Type	II
Importance Factor	1
Response Reduction Factor	5
Wind load	ZONE IV - DELHI = 47 m/s

% Of Steel in Columns- ZONE IV (DELHI)



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
AR - 1	1.56	1.42	1.46	1.64	1.6	1.72	2.09	2.25	2.59	2.7	0.85	0.91	1.15	1.61	2.47	2.99
AR - 2.25	1.62	1.46	1.58	1.67	1.7	1.83	2.14	2.36	2.67	2.95	0.92	1.18	1.42	1.91	2.87	3.57
AR - 4	1.89	1.57	1.64	1.73	1.97	2.01	2.37	2.53	2.89	3.12	0.97	1.23	1.48	2	2.98	3.75

Figure 20: % Of STEEL IN CORNER COLUMNS-ZONE-IV



	TERRACE	14TH	13TH	12TH	11TH	10TH	9TH	8TH	7TH	6TH	5TH	4TH	3RD	2ND	1ST	GF
AR - 1	2.12	1.71	2.3	2.68	3.02	3.68	4.3	4.68	5.01	5.35	2.49	2.6	2.72	3.58	3.88	4.37
AR - 2.25	2.17	1.79	2.39	2.8	3.3	3.95	4.59	4.78	5.31	5.7	2.61	2.78	2.91	3.71	4.2	4.85
AR - 4	2.25	1.96	2.47	2.99	3.78	4.45	4.72	4.87	5.75	5.95	2.83	2.98	3.02	3.99	4.32	5.04

Figure 21: % Of STEEL IN EDGE COLUMNS-ZONE-IV

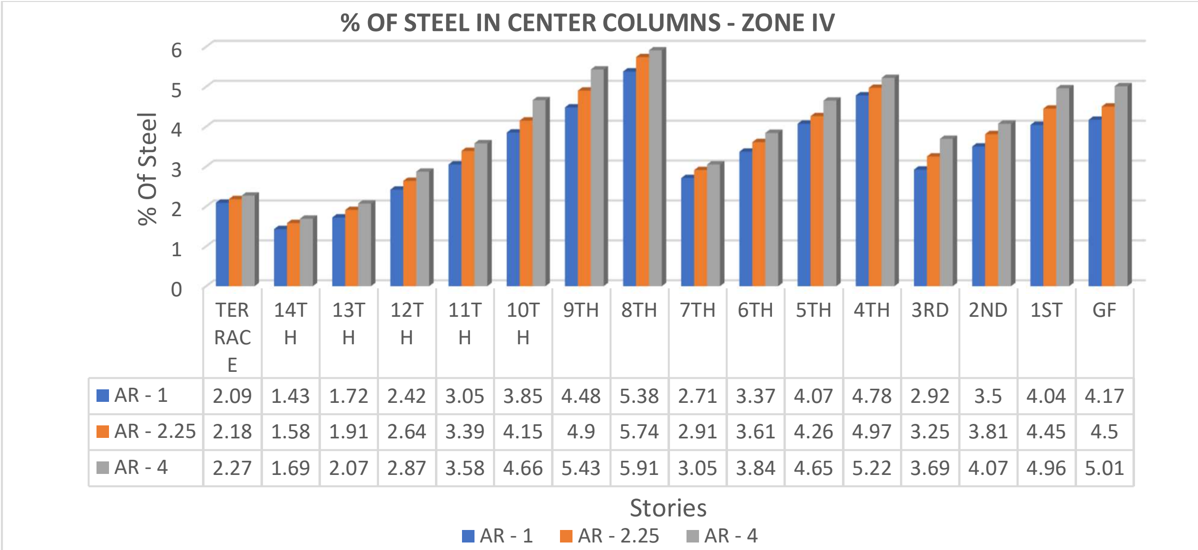


Figure 22: % Of STEEL IN CENTER COLUMNS-ZONE-IV

As a final point, the region is experiencing an increase in the prevalence of steel. The end result is the same regardless of the dimensions. The percentage of steel increases as one travels deeper into the zone. Analysis of the relative sizes of regions with varying aspect ratios. Specifically, 1, 2.25, and 4 aspect ratios were recorded. An increase in aspect ratio necessitates a corresponding rise in steel content. The ratio of the field of view in Zones II, III, and IV is compared. Steel use in edge, corner, and central columns is clearly higher in aspect ratios 2.25 & 4 than in aspect ratio 1. Vertical members with greater aspect ratios use more steel overall.

For the most economical structure better to opt aspect ratio 1 and nearer.

The overall percentage of steel in vertical members is found to rise with increasing aspect ratio. As a result, we see that, relative to aspect ratio 1, the amount of steel in **edge, corner, and centre** columns rises with increasing aspect ratios. A higher aspect ratio requires a greater percentage of steel. The percentage of steel increases along with the zone.

V. CONCLUSION

- Comparative analysis is performed on the zones that result from a number of different aspect ratios. During the course of the investigation, the following aspect ratios were utilized: 1, 2.25, and 4.
- As the seismic zone increases, the percentage of steel in vertical members (columns) increases.
- When compared to the aspect ratio, the percentage of steel that was used increases in proportion to the growth of the aspect ratio. [Case in point:]
- In this section, a comparison of the aspect ratios of Zones II, III, and IV is carried out.

- As a direct result of this, it is noticed that the quantity of steel that is present in the edge, corner, and center columns increases in higher aspect ratios when compared with aspect ratio 1.
- When looking at the structure as a whole, it has been noticed that the proportion of steel used in the vertical members rises as the aspect ratio rises. This is something that should be taken into consideration. When looking at the building in its entirety, this was one of the things that was observed in this study.

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