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Effectiveness and Efficiency of the Existing Building in Seismic Zone-III: A Case Study of Hotel Kaashi Building in Ujire

Vinay M R[1], Divyashree K S[2], M R Shivani[3], Prathiksha J N[4], Rakshitha G[5]
[1]Assistant Professor, [2,3 4, 5]B.E student, Department of Civil Engineering, Sri Dharmasthala Manjunatheshwara Institute of Technology, Ujire – 574240 and Affiliated to Visvesvaraya Technological University, Belagavi, Karnataka, India.

Abstract: Building irregularities are an important concern when they are subjected to strong earthquakes. In structures, an abrupt change in the vertical or plan configuration tends to weaken the stability. It is necessary to study how irregular structures respond to lateral loads in order to prevent failure and reduce the risk of hazards. In this case study, a G+3 storey building is modeled using the existing beam and column cross sections. In addition, models with reduced cross sectional areas of 5%, 10%, and 15% were developed and static linear analysis was performed using Etabs software in accordance with IS1893 (Part-1):2016. The parameters considered in this study are storey displacement, storey drift, and base shear. The analytical results obtained are compared with those of the existing building model.

I. INTRODUCTION

One of the most destructive natural occurrences on earth is an earthquake. Seismic waves are produced as a result of the abrupt release of energy in the earth's crust. The seismic wave moves both horizontally and vertically at the ground surface level as it approaches the foundation of the construction. Buildings, bridges, roads, dams, and other man-made infrastructure were all damaged as a result of the earthquake. In addition, it results in slope instability, liquefaction, landslides, and a general loss of life and property. It is not economically viable for structures to provide total protection against earthquakes of all magnitudes. It is important for the earthquake design to prevent fatalities and reduce property damage.

The concept of earthquake resistant design is that the building should be designed to resist the forces that arise due to a design basis earthquake, with only minor damage, and the forces that arise due to a maximum considered earthquake, with some structural damage but no collapse.

This study examines a commercial complex building as shown in fig 1. The building is designed to withstand seismic loads in accordance with IS 1893 (Part 1): 2016. The building is in a Moderate Seismic Zone (Zone III) and is a G+3 structure, although the section sizes of the structure appear to be large, increasing the project's cost.

Fig. 1 Front view of Hotel Kaashi Building

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A. Building Details

1) Total Area: 9000 sqft
2) Plinth Area: 8000 sqft.
3) SBC of Soil: 430 KN/m^2
4) Location: Hotel Kaashi is a commercial building located in Ujire, Dakshina Kannada (D).

Fig. 2 Primary beams in Ground Floor

Fig. 3 Primary and Secondary beams in First Floor

TABLE I
DESIGN DATA

Live load	4.0 kN/m^2 at typical floor 1.5 kN/m^2 on terrace
Floor finish	1.0 kN/m^2
Water proofing	2.0 kN/m^2
Terrace finish	1.0 kN/m^2
Wind load	As per IS: 875-Not designed for wind load, since earthquake loads exceed the wind loads.
Earthquake load	As per IS-1893 (Part 1) – 2016
Depth of foundation below ground	7’5”
Type of soil	Type II, Medium or stiff soil as per IS:1893
SBC of soil	430 kN/m^2
Average thickness of footing	0.9 m, isolated footings
Storey height	Typical floor: 5 m, GF: 14’5"
Floors	B.F + G.F + 3 upper floors.
Plinth level	1’5”
Walls	8” thick brick masonry walls
Total number of Beams	172
Total number of Columns	45

B. Objectives
1) To study the efficiency and effectiveness of existing structures
2) To analyse a new model with cost-effective sections using Etabs
3) To compare the results with the existing building details

II. METHODOLOGY
The following flowchart represents the methodology to be adopted for the present study

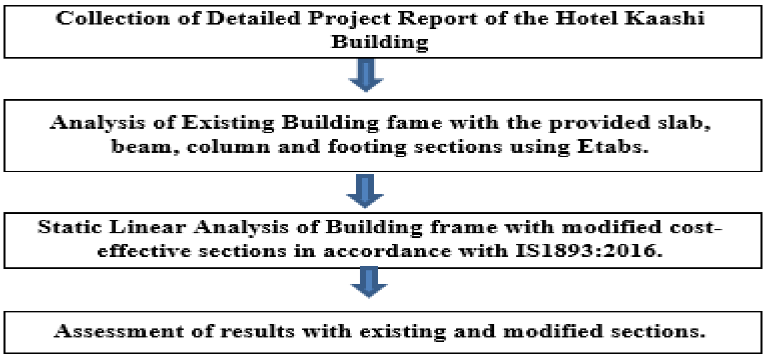

Fig. 4 Flowchart of Methodology Adopted

III. MODELLING AND ANALYSIS
A. Analysis Consideration
In this proposed project, we have studied and analysed the existing building frame details. As an attempt to make the sections economical, the beam and column cross-sections were reduced by 5%, 10%, and 15% respectively, and then all the moment resisting frames were analysed by Etabs software using static linear analysis as per IS1893:2016.

B. Material Specifications
1) Grade of concrete, (fck): 25N/mm2
2) Grade of steel (fy): 500 N/mm2
3) Density of Concrete: 2.5 g/cm3
4) Density of Steel: 7850 kg/m3

C. Load Consideration
Load acting on the structure are dead load (DL). Live load (IL) and earthquake load (EQ).
1) Roof load: 1.5 KN/m2
2) Live load: 3 KN/m2
3) Floor finish load: 1.5 KN/m2

D. Model of RCC Frame
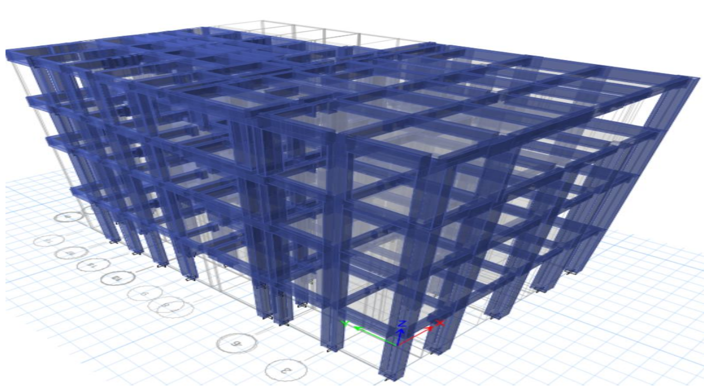
Fig. 5 Isometric View

E. Building Models

The following models have been considered

1) Model-I: Basic model with 0% reduction
2) Model-II: Model with 5% reduction in columns and beam sizes
3) Model-III: Model with 10% reduction in columns and beam sizes
4) Model-IV: Model with 15% reduction in columns and beam sizes

IV. RESULTS AND DISCUSSIONS

The results are tabulated in order to focus on the parameters such as base shear, story drift, and lateral displacements in static linear analysis.

A. Storey Drift

A storey drift was considered the point at which the junction of beam and column met. These points, where the maximum drifts occurred, were compared in this study. Storey drifts among G+3 storey building models are subjected to X and Y directions. Figs 6 and 7 indicate the plot of storey number versus storey drifts for earthquake loads.

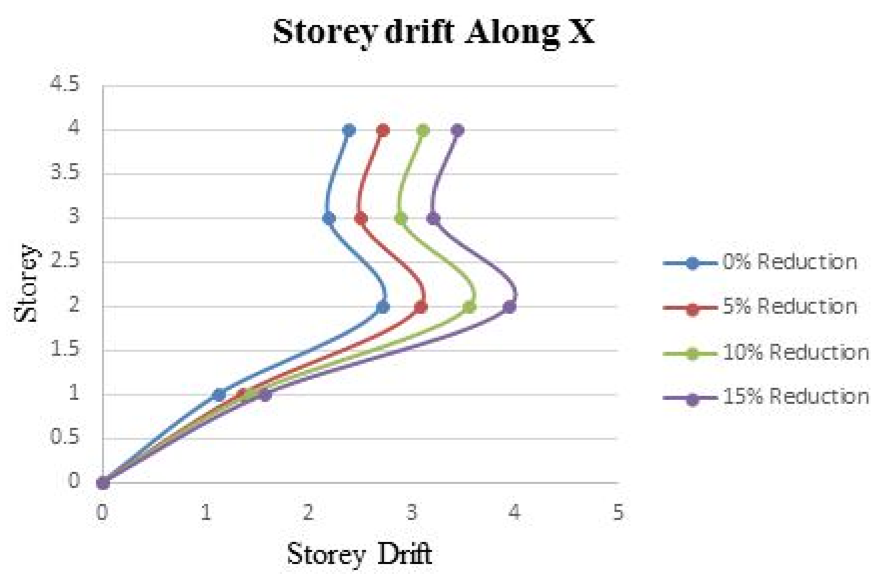

Fig. 6 Storey Drift of 0%, 5%, 10%, and 15% with 1.2 (DL + LL + EQX)

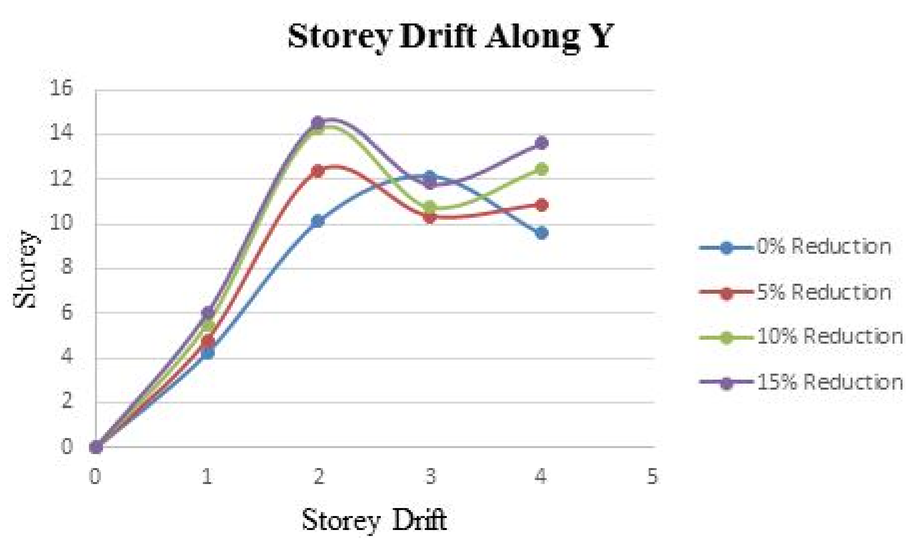

Fig. 7 Storey Drift of 0%, 5%, 10%, and 15% with 1.2 (DL + LL + EQY)

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B. Storey Displacement

A storey displacement was considered the point at which the maximum storey displacement occurred. Figs 8 and 9 indicate the plot of storey number versus storey displacement for earthquake loads.

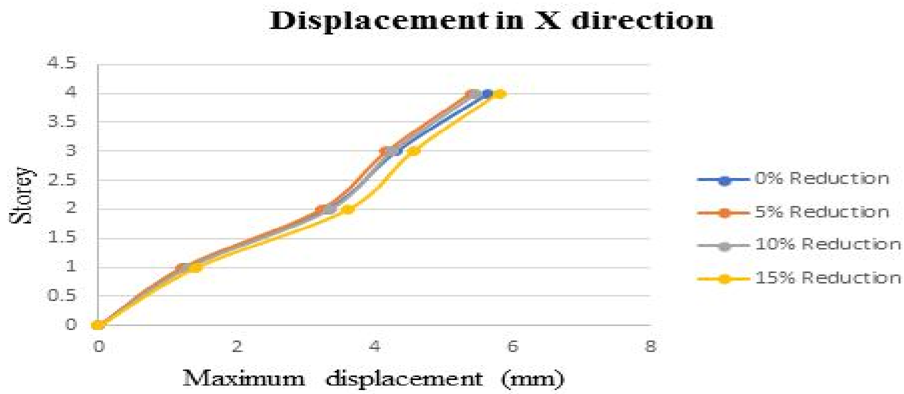

Fig. 8 Storey Displacement of 0%, 5%, 10%, & 15% in X direction

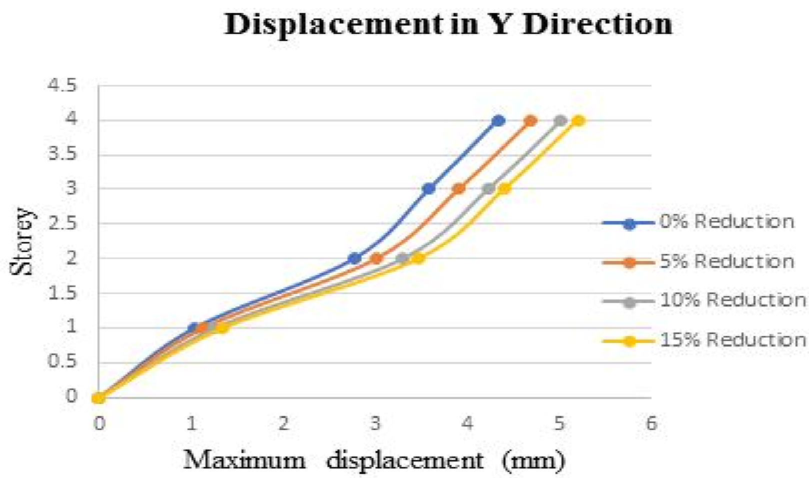

Fig. 9 Storey Displacement of 0%, 5%, 10%, & 15% in Y direction

C. Base Shear

The shear force occurred in a column at base level were compared in this study. Figs 10 and 11 indicate the plot of Base shear versus storey number for earthquake loads.

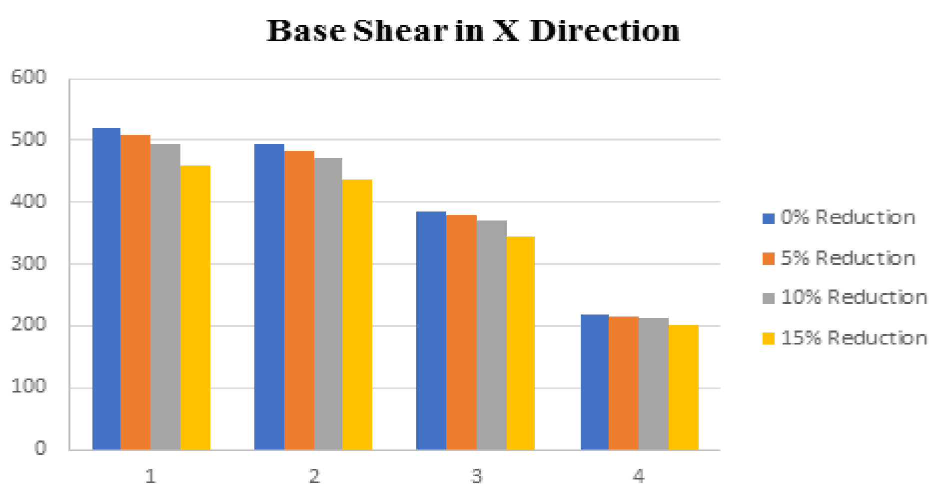

Fig. 10 Show Comparison of Base Shear of 0%, 5%, 10%, 15% in X direction

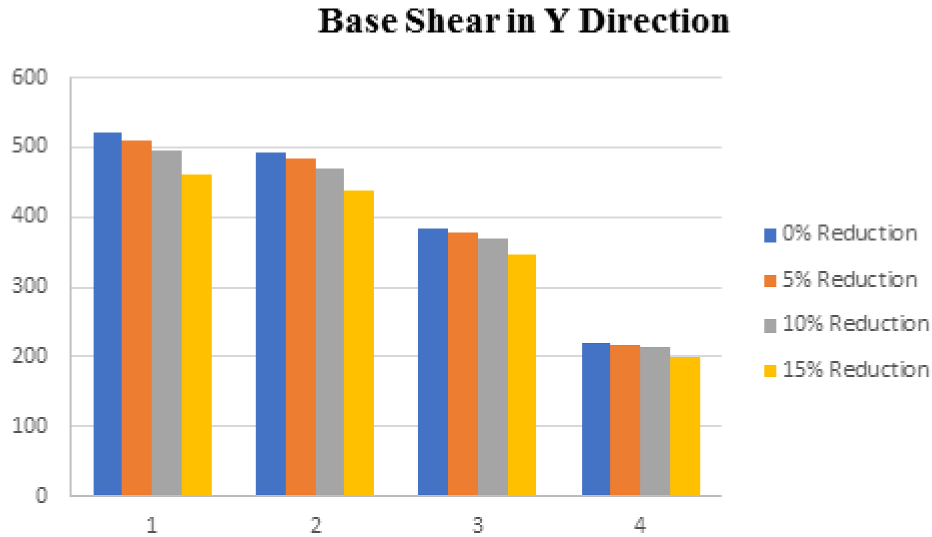

Fig. 11 Show Comparison of Base Shear of 0%, 5%, 10%, 15% in Y direction

V. CONCLUSIONS

The major conclusions drawn from the studies after seismic analysis are as follows:

1) Results show that storey drift and storey displacement increase with a decrease in cross-section from 0% to 10%
2) The second and third floors will not meet the storey drift requirements in EQY direction for a 15% reduction in cross section due to plan irregularity and stiffness irregularity.
3) Despite a drop in cross-section of 0% to 15%, the base shear only decreased by 2 to 3% respectively
4) All of the above results suggest that the existing building satisfies all the earthquake requirements with only a 10% reduction in cross sectional area due to its plan irregularity and stiffness irregularity
5) As a result, in light of the safety considerations, it is not advised to modify the specified cross-section sizes. In other words, the existing building details are adequate to satisfy the earthquake criteria as described in IS1893 (Part-1):2016

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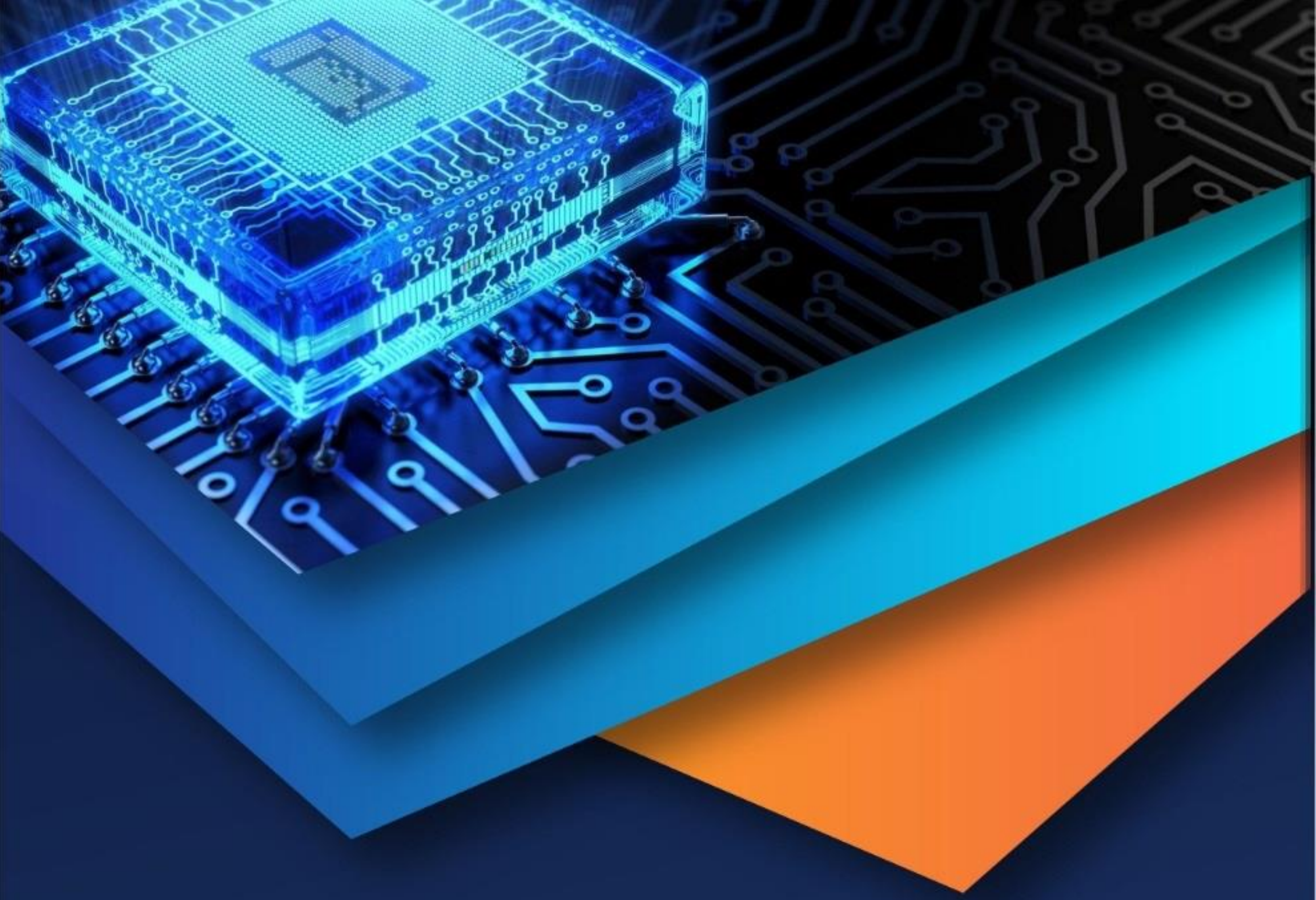

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