iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** VI **Month of publication:** June 2026

DOI: https://doi.org/10.22214/ijraset.2026.83340

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

Comparative Study on Seismic Behaviour of Multi-Storey Buildings with Composite Columns and Steel Columns

Siriginidi Sai Kumar
Lenora college of Engineering Rampachodavaram, India

Abstract: The rapid growth of multi-storey buildings in seismic regions has increased the importance of earthquake-resistant structural systems. The behaviour of structures during earthquake loading depends mainly on stiffness, strength, ductility, and stability. Therefore, selection of an efficient structural system is essential for minimizing seismic damage and ensuring structural safety. The present study investigates the seismic performance of a typical multi-storey moment resisting framed structure with steel columns and composite columns. A G+12 storey building model is analyzed using ETABS software under seismic loading conditions. The seismic analysis is carried out by adopting the equivalent static method in accordance with the provisions of IS 1893:2002 for Seismic Zone III.

Two different three-dimensional structural models are developed using different column systems, namely steel columns and concrete-filled steel tube (CFST) composite columns. Both models are subjected to identical loading and boundary conditions to evaluate their structural response during earthquake excitation. The comparison between the structural systems is performed using important seismic parameters such as base shear, storey displacement, storey drift, roof displacement, and overturning moment. The analytical results indicate that composite column structures provide improved stiffness and reduced lateral deformation compared to conventional steel column structures.

The study concludes that composite structural systems exhibit better seismic performance and enhanced structural stability for multi-storey buildings located in earthquake-prone regions. The findings of this work can be useful for structural engineers and researchers in the selection and design of efficient earthquake-resistant building systems.

Keywords: Seismic behaviour, Composite columns, Steel columns, Multi-storey building, ETABS, Response spectrum analysis, Earthquake-resistant structures.

I. GENERAL INTRODUCTION

Earthquakes create severe effects on constructions made of civil engineering, such as buildings. During seismic activity, buildings are subjected to horizontal vibrations and lateral forces that may lead to structural damage if proper design measures are not adopted. Therefore, earthquake-resistant design has become an essential requirement in modern construction practice.

Urban regions' rapid expansion has increased the building of multi-storey and tall structures. As the elevation of structures rises, the effect of Additionally, seismic forces becomes significant. Conventional structural systems may experience excessive deformation and instability under earthquake loading. Hence, engineers are focusing on advanced structural systems that provide better strength, stiffness, and stability.

II. NEED FOR THE STUDY

The demand for safe and economical earthquake-resistant buildings is continuously increasing. The major reasons for carrying out this study are:

1) Increasing construction of tall buildings
2) Need for improved seismic safety
3) Requirement for efficient structural systems
4) Reduction of structural displacement
5) Improvement in stiffness and stability
6) Better resistance to earthquake forces

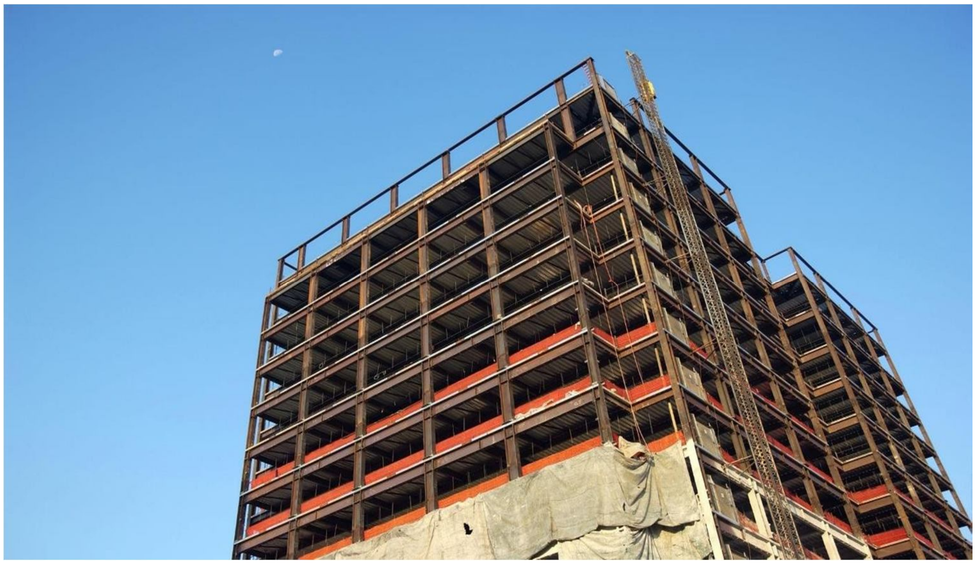
Comparative evaluation of steel and composite structural systems helps in selecting suitable structural solutions for seismic regions.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

A. Review on Steel Structures

Steel structures are commonly used in high-rise buildings because of their excellent tensile strength and ductility characteristics. Steel frames can absorb large amounts of energy during earthquakes.

Researchers observed that steel structures perform well under seismic loading due to their flexibility and energy dissipation capacity. However, excessive lateral displacement and storey drift may occur in tall steel buildings.



B. Previous Research Studies

1) Study 1

Researchers conducted seismic evaluation of a multi-story composite structures that use ETABS programmes. The research concluded which composite structures exhibited lower storey displacement compared to steel structures.

2) Study 2

A comparative analysis between RCC, steel, and composite buildings indicated that composite systems provide better stiffness and reduced time period.

3) Study 3

Experimental investigations on composite columns showed improved load carrying capacity and ductility characteristics under cyclic loading.

C. Material Characteristics

Concrete

Concrete of grade M30 is considered for modelling and analysis.

Concrete's characteristics

Ownership	Worth
Score	M30
Density	25 kN/m³
Ratio of Poisson	0.2
Elastic Modulus	27386 MPa

Elastic Modulus Relation $E_c=5000\sqrt{f_{ck}}$

Where:

- E_c = Elastic modulus of concrete
- f_{ck} = Characteristic compressive strength

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

D. *Structural Steel*

Steel material of Fe500 grade is used.

Steel Properties

Property	Value
Grade	Fe500
Density	78.5 kN/m³
Elastic Modulus	200000 MPa
Poisson Ratio	0.3

Steel provides excellent ductility and tensile resistance during seismic lo

III. STRUCTURAL COMPONENTS

Structural components are the important elements of a building that resist loads and transfer them safely to the foundation. In multi-storey buildings, structural elements like beams, columns, slabs, Basic foundations are crucial to resisting gravity loads also seismic forces.

In this project, two structural systems are considered:

- Steel column structure
- Composite column structure

A. *Composite Columns*

Columns made of composite are structural members created by mixing steel and cement so that both materials act together to resist loads.

B. *Composite construction improve Comparison Between Steel and Composite Columns*

Parameter	Steel Columns	Composite Columns
Structural Weight	Lower	Moderate
Stiffness	Lower	Higher
Ductility	Higher	High
Fire Resistance	Low	Better
Lateral Displacement	Higher	Lower
Load Carrying Capacity	Moderate	Higher
Construction Speed	Faster	Moderate
Seismic Resistance	Good	Better

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

C. Summary

Columns made of composite combine The benefits of concrete and steel to improve structural efficiency and seismic performance. Compared to steel columns, composite columns provide:
s stiffness, strength, and overall structural performance.

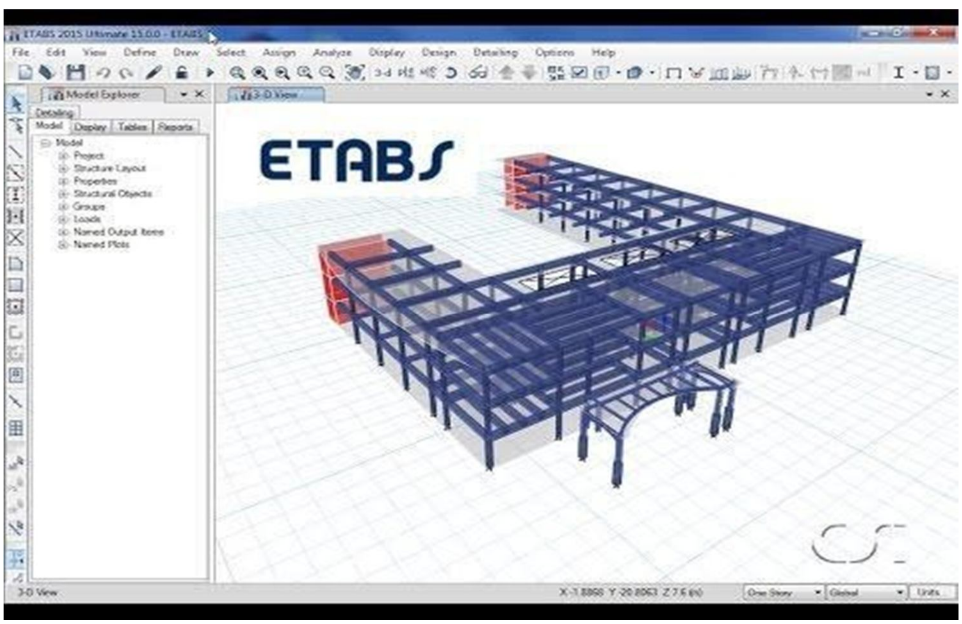
D. Methodology Material Characteristics

Concrete

Concrete of grade M30 is considered for modelling and analysis.

Concrete's characteristics

Ownership	Worth
Score	M30
Density	25 kN/m³
Ratio of Poisson	0.2
Elastic Modulus	27386 MPa



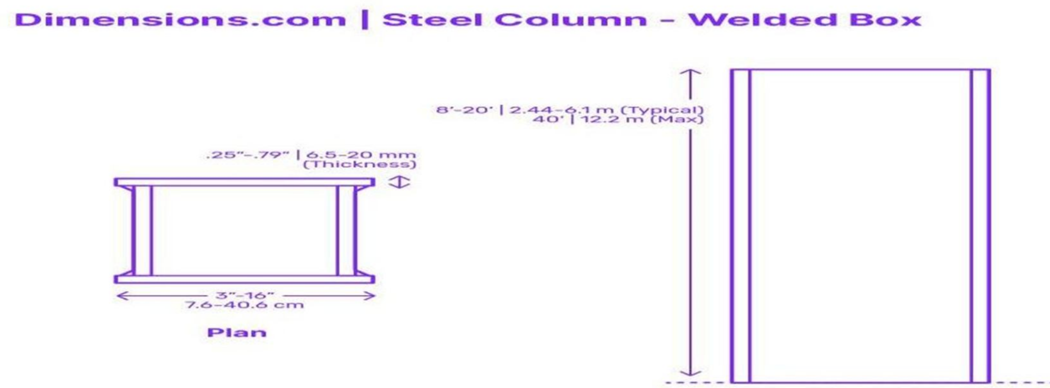
Elastic Modulus Relation $E_c=5000\sqrt{f_{ck}}$
Where:

- Ec = Elastic modulus of concrete
- fck = Characteristic compressive strength

Types of Steel Columns

1) I-Section Columns
2) Box Section Columns
3) Circular Hollow Sections
4) Tubular Steel Columns

Steel columns exhibit flexibility under seismic loading, which may increase lateral displacement in tall buildings.



Structural Steel
Steel material of Fe500 grade is used.

Steel Properties

Property	Value
Grade	Fe500
Density	78.5 kN/m³
Elastic Modulus	200000 MPa
Poisson Ratio	0.3

Steel provides excellent ductility and tensile resistance during seismic loading.
The section on methodology explains this complete procedure followed for the examination and comparison of several stories buildings having Stain columns & combined columns. In this study, structural Models are created using The seismic performance of ETABS software is assessed. under earthquake loading conditions.
The analysis process includes preparation of models of structures, assignment of the loads, earthquake analysis, and contrast of structural responses. Indian Standard code provisions are considered throughout the investigation.
The primary goal of this methodology is the identify The structural system that provides improved performance during seismic activity.

IV. FLOW CHART OF ETABS

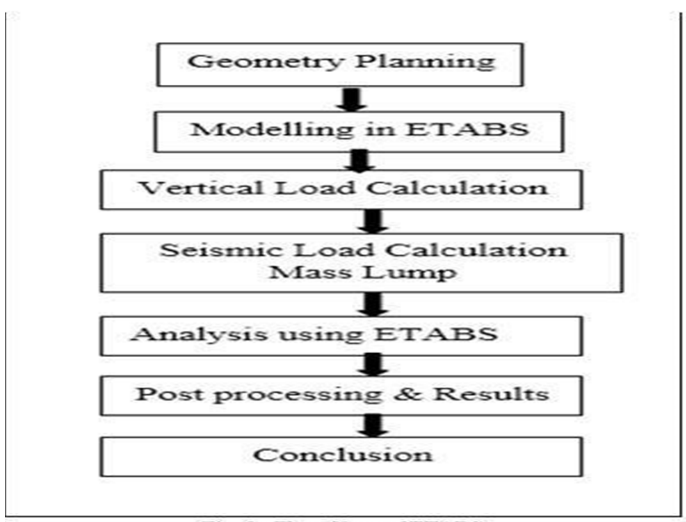


Fig. 3.: Flow Chart of ETABS

Seismic Coefficient Horizontally $A_h=\frac{ZI(S_a/g)}{2R}$

Where:

- Ah = Coefficient of horizontal seismic activity
- Z stands for seismic zone factor.
- I stands for importance factor.
- The spectral acceleration coefficient is equal to Sa/g.
- • R stands for response reduction factor.

Structural analysis is an essential stage in the layout of safe and stable structures situated in earthquake- Régions sujettes à. In this investigation, ETABS software is utilized to étudier le séisme response d'une structure à plusieurs étages provided using steel columns also composite columns.

ETABS is commonly used for modeling by structural engineers, analysis, also design at tall buildings because it offers efficient tools for dynamic analysis and interpretation of structural behavior.

Two separate structural models are developed for the study:

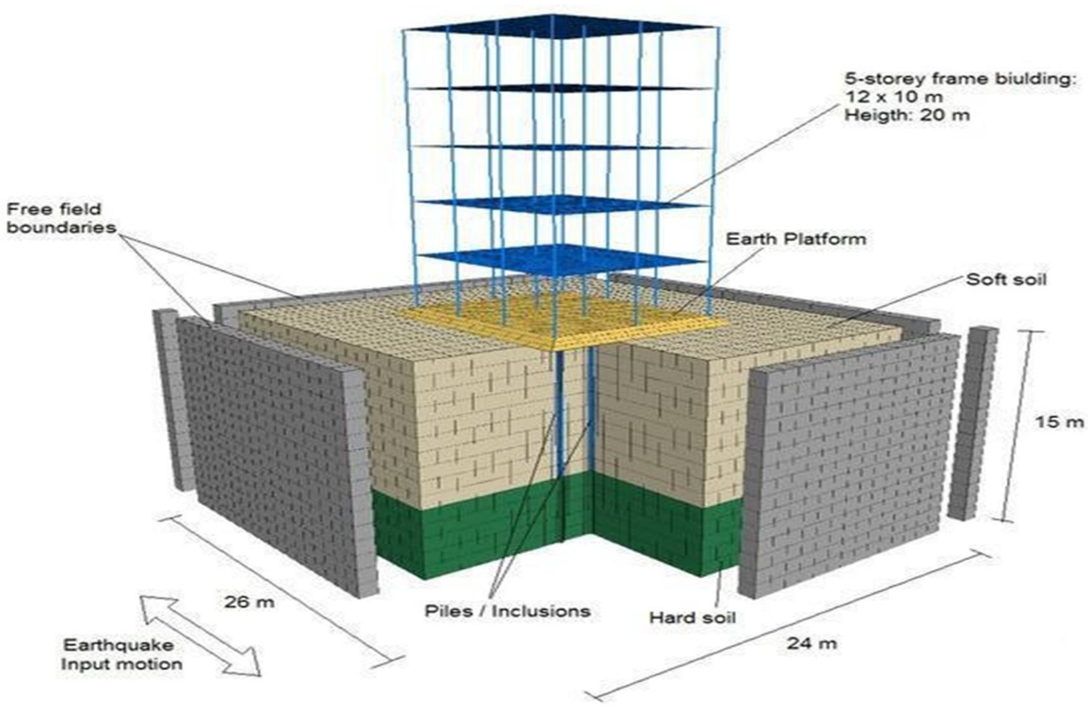
1. Multi-storey building with steel columns
2. Multi-storey building with composite columns

Both structural systems are analyzed under identical loading and seismic conditions to obtain reliable comparison results.

E. Details of the Structural Model

A typical high-rise structure configuration at selected for this analysis. Symmetrical geometry is adopted to reduce torsional irregularities during earthquake excitation.

Building Information



Parameter	Description
Building Type	Residential Multi-Storey Structure
Number of Floors	Ground + 15 Floors
Height of Each Floor	3 m
Total Structural Height	48 m
Bay Distance	5 m
Structural Arrangement	5 × 5 Bays
Seismic Zone	Zone V
Soil Condition	Medium Soil
Concrete Grade	M30
Steel Grade	Fe500

IV. LOAD CALCULATIONS

Load calculation is a significant stage at structural Design and analysis. Buildings are exposed to different kinds of loads during their life of service, and These weights must being considered properly to guarantee the stability and safety of the structure.

In this present research, the multi-storey building is analyzed under earthquake loads and gravity loads. The loads are calculated based on the Indian Standard Code provisions and assigned at ETABS software for seismic analysis.

The major loads taken into account in this project have:

- Dead load
- The live load
- The strain from earthquakes

These loads significantly influence the seismic behavior of steel and composite structures.

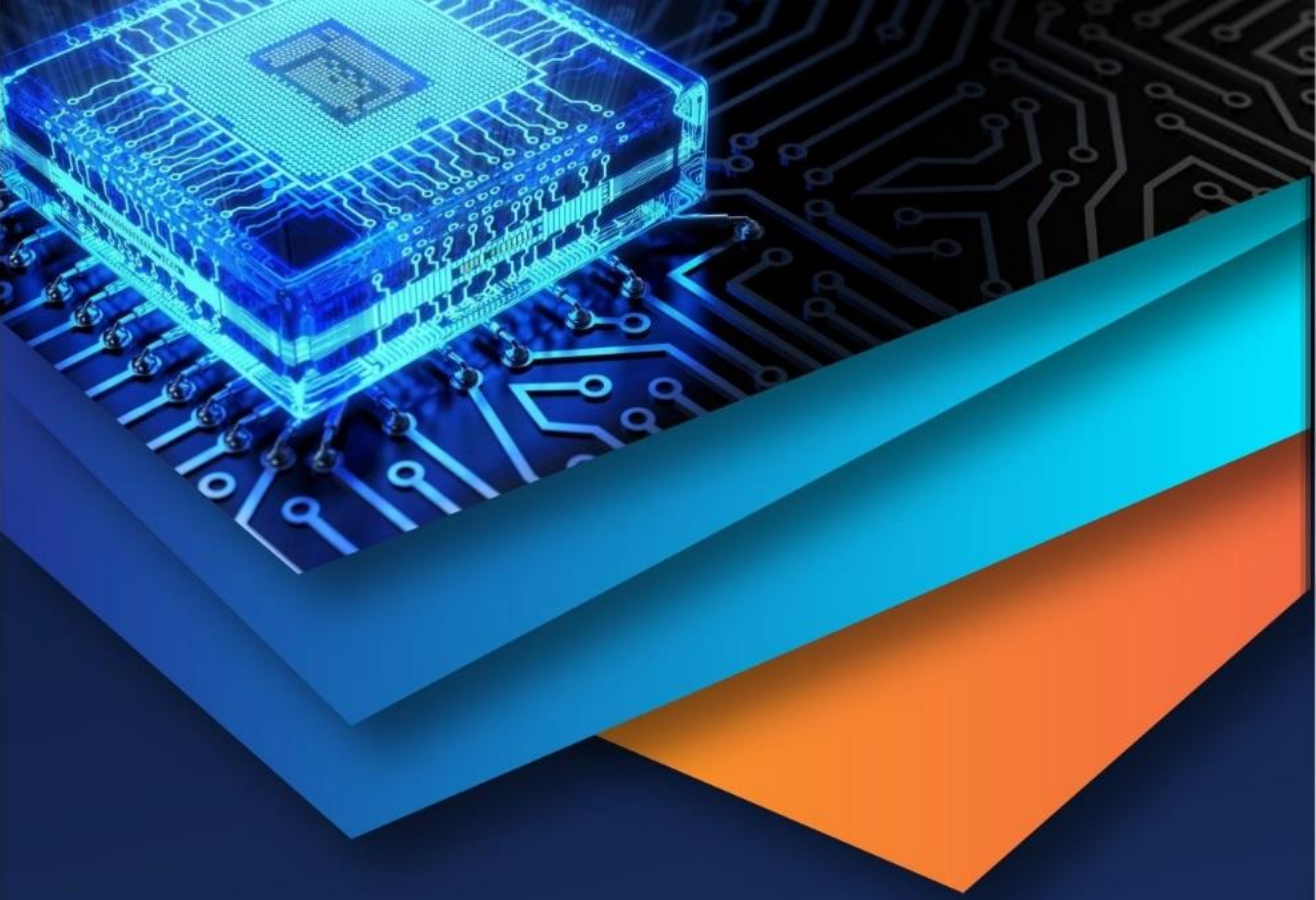
A. No Load

Permanent loads acting are referred to be dead loads. continuously on the framework throughout its life. These loads remain constant and incorporate each structural and non-structural component's self-weight..

The deceased load mainly consists of:

REFERENCES

[1] IS 1893 (Part 1): 2016, Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi.
[2] IS 456: 2000, Plain and Reinforced Concrete – Code of Practice, Bureau of Indian Standards, New Delhi.
[3] IS 800: 2007, General Construction in Steel – Code of Practice, Bureau of Indian Standards, New Delhi.
[4] IS 875 (Part 1 & Part 2): 1987, Code of Practice for Design Loads, Bureau of Indian Standards, New Delhi.
[5] ETABS Reference Manual, Computers and Structures Inc.
[6] Duggal, S.K., Earthquake Resistant Design of Structures, Oxford University Press.
[7] Chopra, A.K., Dynamics of Structures: Theory and Applications to Earthquake Engineering, Pearson Education.
[8] Wang, Y.C., Steel and Composite Structures, CRC Press.
[9] Salmon, C.G. and Johnson, J.E., Steel Structures: Design and Behaviour, Pearson Publications.
[10] Varghese, P.C., Advanced Reinforced Concrete Design, PHI Learning Pvt. Ltd.
[11] Research articles from



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY