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Comparative study on the design of RCC and steel G+ 15 story Residential Building

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Abstract

This study presents a comparative study of wind loads to decide the design loads of a G+15 building. The significance of this examination is to estimate the design loads for a structure which is subjected to wind loads in a particular region. It is well known fact that the wind loads may be estimated in particular zone with a specified zone factor. Then the wind load of that zone can also be estimated based on the basic wind speed and other factors of that particular region. However, the wind velocity is stochastic and time dependent. In the present study a multi-storied building is analyzed for wind loads using IS 875 code. In this Analysis, G+15 storied building is considered and applied various loads like wind load, static load and results are studied and compared between with wind load or without wind load.

Keywords: Zone factor, wind loads, design loads, high rise buildings.

I. Introduction

The structural design of a building should ensure that the building can withstand loads safely, operate without excessive deformation or movement that could lead to fatigue of structural elements, cracks or failure of fixtures, fittings or partitions, or failure. Inconvenience to occupants. It must consider the movements and forces due to temperature, creep, cracks, and imposed loads. It must also verify that the design is nearly buildable within acceptable manufacturing tolerances of the materials. It must allow the architecture to function and the building services to adapt to the building functionally (ventilation, lighting, etc). This project work is to analyze a Multi storeyed G+15 building for different load combinations using STAAD Pro software, STAAD foundation Advanced, RCDC software.

Based on the analysis, the design of the structure is done mainly following IS specifications. The requirements of a properly designed building structure are:

- Good Structural Configuration: The size, shape and structural system taking loads are such that they ensure a direct and smooth flow of inertia forces to the ground.
- Lateral Strength: The limit transverse force that it can resist is such that the damage induced in it does not result in collapse.
- Adequate Stiffness: Its transverse load resisting system is such that the earthquake induced deformations in it do not damage its filling under low-to moderate shaking.

II. BASIC OF G+15 BUILDING

The procedure for analysis and design of a given building will depend on the type of building, its complexity, the number of stories etc. First, the architectural drawings of the building are studied, structural system is finalized sizes of structural members are decided and brought to the knowledge of the concerned architect. The procedure for structural design will involve some steps which will depend on the type of building and also its complexity and the time available for structural design. Often, the work is required to start soon, so the steps in design are to be arranged in such a way the foundation drawings can be taken up in hand within a reasonable period of time. Further, before starting the structural design, the following information of data are required:

(i) A set of architectural drawings;

(ii) Soil Investigation report (SIR) of soil data;

(iii) Location of the place or type of building in order to decide loadings;

(iv) Data for lifts, water tank capacities on top, special roof features or loadings, etc. Choice of an appropriate structural system for a given building is vital for its economy and safety. There are two type of building systems:-

(a) Load Bearing Masonry Buildings.

(b) Framed Buildings.

(a) Load Bearing Masonry

Buildings Small buildings like houses with small spans of beams, slabs generally constructed as load bearing brick walls with reinforced concrete slab beams. This system is suitable for building up to four or fewer stories. (As shown in fig. below). In such buildings crushing strength of bricks shall be 100 kg/cm2 minimum for four stories.

(b) Framed Buildings

In these types of buildings, reinforced concrete frames are provided in both principal directions to resist vertical loads and the vertical loads are transmitted to vertical framing system i.e., columns and Foundations. This type of system is effective in resisting both vertical & horizontal loads. The brick walls are to be regarded as non-load bearing filler walls only. This system is suitable for the multi-storied building which is also effective in resisting horizontal loads due to the earthquake. In this system the floor slabs, generally 100-150 mm thick with spans ranging from 3.0 m to 7.0 m. In certain earthquake prone areas, even single or double storey buildings are made framed structures for safety reasons. Also, the single storey buildings of large storey heights (5.0m or more), like electric substation etc. are made the framed structure as brick walls of large heights are slender and load carrying capacity of such walls reduces due to slenderness.

III. Application of Finite Element Modelling In Beam

Finite element method is a numerical method to find out an approximate solution variable in a problem which is difficult to obtain analytically. The high-speed digital computer nowadays helps a lot in running and analyzing complex problems in continuum mechanics. A study on finite element method enable users to understand the synthesis of analysis, material behavior, and constructability, environmental, social and economic realities that influence solutions in the practice of engineering. Sandwich beam is finite element analysis

software that can analyze all types of complicated models using linear or nonlinear analysis. It is an associative feature-based Modeler. This means the model geometry is entered in terms of features which are then sub-divided into finite elements in order to perform the analysis. Increasing the number of elements usually increases the accuracy of the analysis but the time for the analysis to be done will also increase. In sandwich beam, every element of concrete and soil must be assigned with material constant to define structure properties in term of mass density, poison ratio and modulus of elasticity. Details step by step in sandwich beam are applied in this study to obtain the required natural frequency and mode shape and listed as follows:

- Creating a new model
- Defining the geometry and groups
- Defining the mesh-reinforcement bars and mesh-concrete
- Defining the geometric properties and material properties
- Assigning attributes to the bars and concrete
- Assigning supports and loading
- Set the eigenvalue control and running the analysis
- Viewing the results of reformed shape and creating a load versus displacement

IV. Research Motivation

Now a day's construction of multistoried building is basic need due to continuous increase in population. We are used conventional design techniques such as manual methods which is more time consuming and has more possibilities of errors which leads to requirement of computer aided software in order to achieve more faster results along with fair accuracy. The design is made using software are structural analysis design (STAAD Pro). The building subjected both the vertical load as well as horizontal loads. The vertical loads consist of dead load or gravity loads of structural component such as beam, column, slab footing etc. Staad-pro is structural software widely accepted due to its large scope of solving complex problems. This can solve typical Problem like seismic analysis using various load combination to confirm various code like IS 456:2000, 1893:2016, IS875:2015 etc. For multistoried buildings, the conventional load bearing structures tends to distribute the loads more uniformly and eliminate the excessive effects of localized loads but become uneconomical as they require larger sections to resist huge moments and loads. But in a framed structure, the building frame consists of a network of beams and columns which are built monolithically and rigidly with each other at their joints. Due to this rigidity at the joints, there will be reduction in moments and also the structure Therefore in non-load bearing framed structures, the moments and forces become less which in turn reduces the sections of the members.

V. Proposed Methodology

Predictive modeling offers several advantages over traditional forecasting techniques.

First, it is far quicker and easier to generate predictive modeling predictions. A predictive analytics platform can now handle much of the low-level manual work associated with

making these kinds of predictions. In many cases, these predictions can be generated frequently based on automated data collection and analysis to guide decisions with the most recent information.

Predictive models are also tailored to your business. Because the predictions these models generate are based on your company's proprietary data, they will be much more meaningful and actionable.

How Predictive Analytics and AI Work

Predictive analytics and AI create a dynamic system that forecasts future events with remarkable acuity. This system involves a series of steps that transform raw data into predictive insights. Here's a breakdown of how this integration works.

1. Data Collection and Preparation

Vast amounts of varied data are gathered. This data can be sales figures, customer interactions, sensor data, or anything else. The preparation phase is equally crucial, involving cleaning (to remove errors or inconsistencies) and preprocessing (to format and structure the data).

2. Model Building and Training

Once the data is ready, the next step is to build a predictive model. This is where AI, particularly machine learning, plays a pivotal role. During the training phase, the model is fed historical data so it can learn and identify patterns, trends, and relationships within the data. The choice of algorithm impacts the model's ability to learn from data, with options ranging from simple linear regression to more complex neural networks.

3. Validation and Testing

After training the model, it's crucial to test its accuracy and effectiveness. This is done by using a separate dataset, not seen by the model during training, to evaluate its performance. Validation assesses how well the model can generalize its learning to new, unseen data.

4. Deployment and Real-time Predictions

Once validated, the model is deployed into a production environment where it can start making real-time predictions. For instance, a predictive model in a retail setting might analyze real-time sales data to forecast future demand, enabling the business to adjust its inventory accordingly.

5. Continuous Learning and Improvement

AI-driven predictive models aren't static. They're designed to learn and adapt. As new data becomes available, the model can be retrained or fine-tuned, enhancing its predictive accuracy. This continuous learning is fundamental to AI, ensuring that the predictive analytics process remains relevant and accurate as conditions change.

Algorithm

A neural network (also called an ANN or an artificial neural network) is a sort of computer software, inspired by biological neurons.[1] Biological brains are capable of solving difficult problems, but each neuron is only responsible for solving a very small part of the problem. A neural network is made up of cells that work together to produce a desired result, although

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each individual cell is only responsible for solving a small part of the problem. This is one method for creating artificially intelligent programs.

Neural networks are an example of machine learning, where a program can change as it learns to solve a problem. A neural network can be trained and improved with each example, but the larger the neural network, the more examples it needs to perform well—often needing millions or billions of examples in the case of deep learning.

AI is being used to predict various aspects of the building lifecycle, including lifespan, potential issues, and energy consumption. AI can also predict human lifespan and personality traits by analyzing life events.

AI in Building Lifecycle:

Structural Health Monitoring:

AI algorithms analyze data from sensors to detect patterns and anomalies, predict potential structural issues, and provide insights for preventive maintenance, helping to avoid failures and extend the lifespan of structures.

VI. Result and Simulation

ANALYSIS STEPS

The model plan is drafted to prepare the model of (G+15) building in Staad Pro. which comprising the following steps:

Step - 1: Creation of nodal points.

Step - 2: Represent the beams and columns. Use command of add beam.

Step - 3: 3D view of structure. Use Transitional repeat command in Y direction to get the 3D view of structure. .

Step - 4: Assign the Supports and property with load.

Step - 5: 3D rendering view.

In this chapter, the results of various parameters such as Axial Force, Bending Moment, Displacement, member forces, Quantity of concrete etc. of framed structure were obtained by post processing unit and output file of Staad.

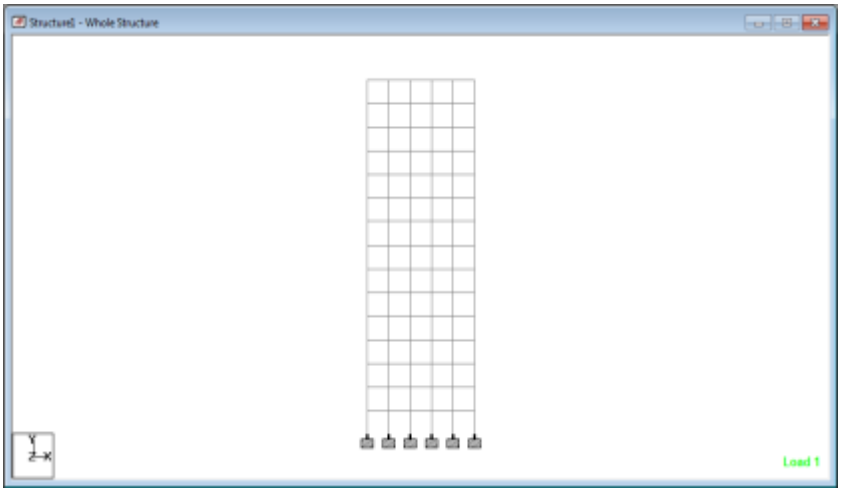

Fig.1 Design View.

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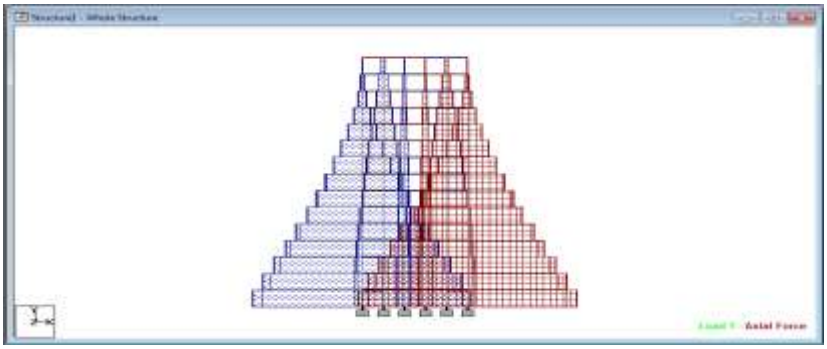

Fig.2 Axial Force.

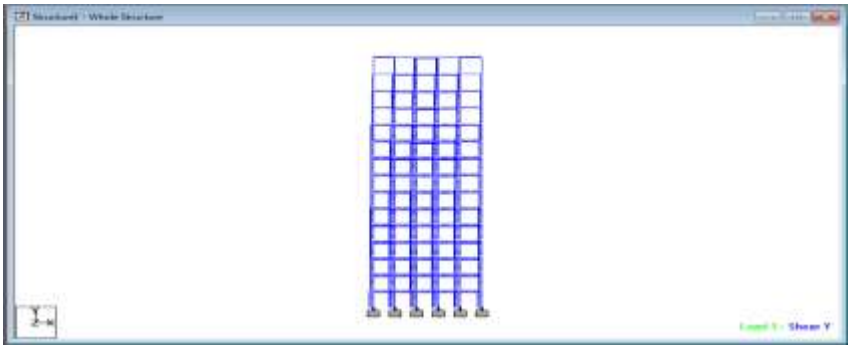

Fig.3 Shear YY.

Table 1. Bending Z direction.

Distance	Fy	Mz
0	-0.735	-2.321
0.25	-0.735	-2.137
0.5	-0.735	-1.953
0.75	-0.735	-1.769
1	-0.735	-1.585
1.25	-0.735	-1.402
1.5	-0.735	-1.218
1.75	-0.735	-1.034
2	-0.735	-0.85
2.25	-0.735	-0.666
2.5	-0.735	-0.483
2.75	-0.735	-0.299
3	-0.735	-0.115

Table 2. Deflection.

Distance	Deflection
0	55.303
0.25	55.302
0.5	55.302

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0.75	55.302
1	55.301
1.25	55.301
1.5	55.301
1.75	55.3
2	55.3
2.25	55.3
2.5	55.299
2.75	55.299
3	55.299

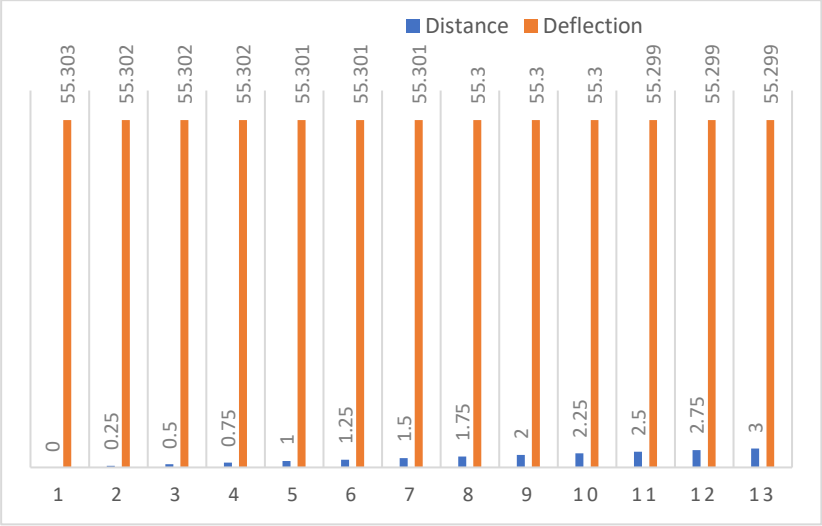

Fig.4. Deflection

ANN ANALYSIS

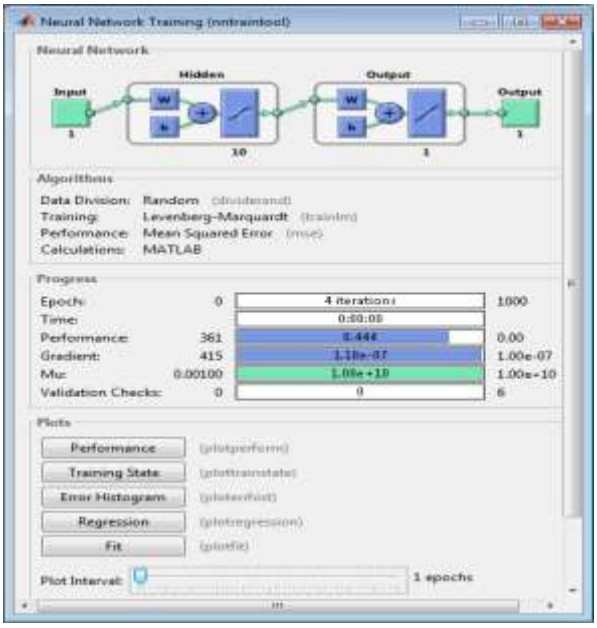

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Fig.5. ANN Prediction simulation.

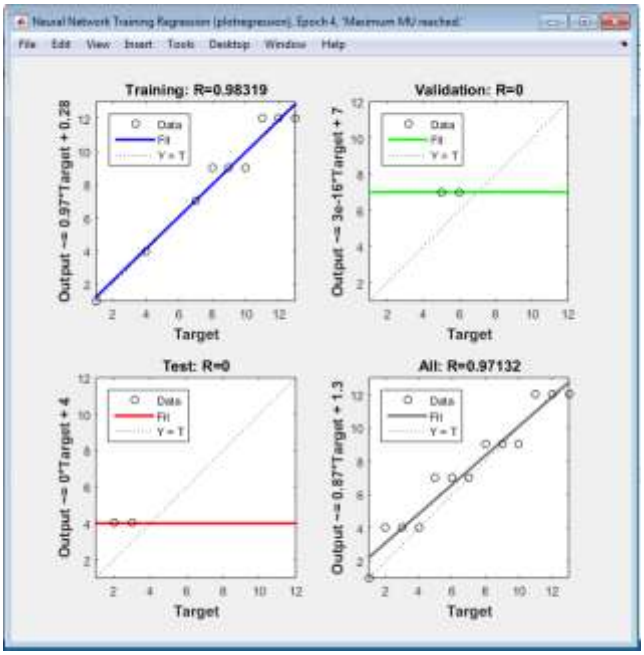

Fig.6 Displacement in 13 year Prediction rate 1.3mm.

Table 3. R-value

Subplot	Regression Equation	R-value
Training	Output = 0.97 × Target + 0.28	R = 0.98319
Validation	Output = -3.616 × Target + 14.7	R = 0
Test	Output = 0 × Target + 4	R = 0
All	Output = 0.97 × Target + 1.13	R = 0.97132

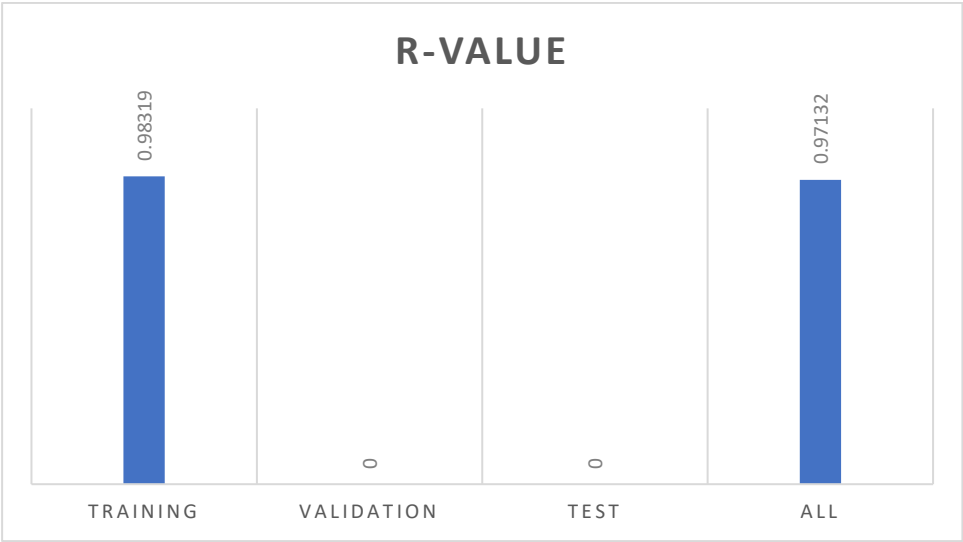

Fig.7 R value Variation.

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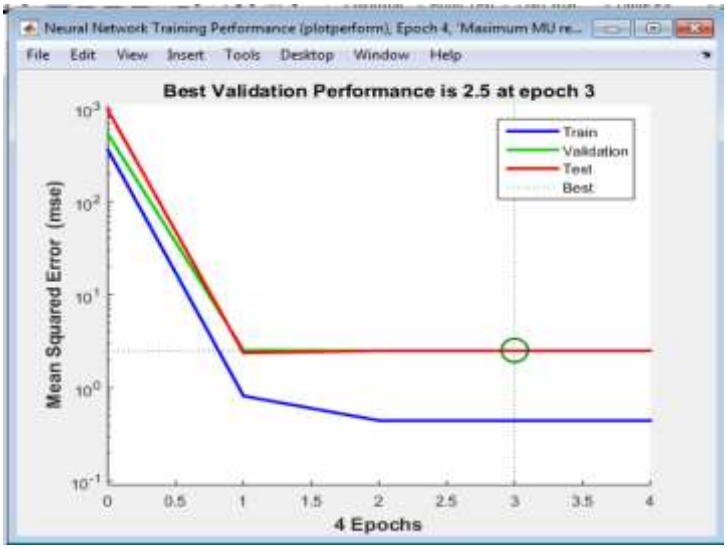

Fig.8 MSE curve.

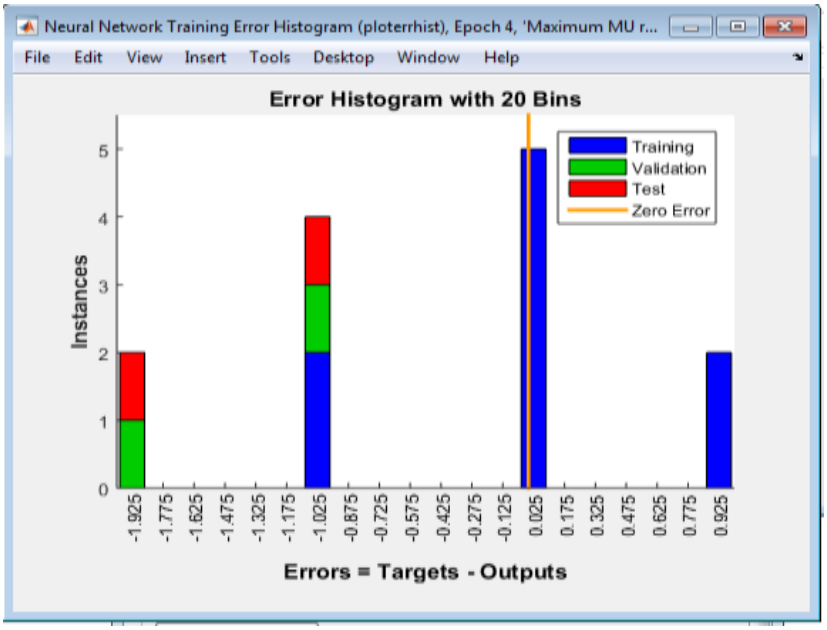

Fig.9 Error value and maximum accuracy at 99%.

VII. Conclusion and Future Scope

CONCLUSION

The analysis has been done with the help of STAAD Pro. The response of (G+15) story Reinforced Concrete building under seismic load as per IS has been studied and found safe against all possible loadings and deflection. Proposed method ANN is optimized displacement rate 1.3mm for maximum 13 year. STAAD-Pro gives result very fast as compared to manual derivation. Designing using Software like Staad Pro. Reduce lot of time in design work or job. All other specifications like section properties, material constants, support load, analysis and design requirements, printing, plotting facilities are available. We can conclude that the results from Staad Pro V8i are much accurate and the structure is safe

in analyzing and designing. The base shear, Lateral load, Joint displacement, member forces, horizontal and vertical reactions for all the joints of a building also has been calculated in STAAD Output View File.

Future Scope

The study of buildings in seismic zone condition can be extended for future study in a wide variety of conditions amongst which few are as follows:

I. The quantity of reinforcement required for the structure with seismic load can be checked to know the quantity of steel and cost of structure.

II. Light weight building materials can be incorporated in the structural elements where ever it is required to reduce the total weight of the structure and hence can reduce the cost of project.

III. As we know in very quickly change in global world there is an unfavourable construction in then affects society cannot be neglected in recent days.

The future scope of this study lies in integrating advanced Artificial Neural Network (ANN) models with optimization algorithms to improve accuracy in structural design. Further research can explore diverse load combinations, sustainability parameters, and seismic performance. Expanding case studies to varied geographic conditions will enhance reliability and practical applicability of ANN-based approaches.

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