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Analysis of A Green Building Considering Lateral Loads

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ABSTRACT

Construction industry is growing rapidly and new technologies have evolved very fast to cater to different difficulties in the construction industry. Among all materials used in the construction industry, concrete is the main material for construction. Billions of tons of naturally occurring materials are mined for the production of concrete which will leave a substantial mark on the environment. Nowadays recycling waste and industrial products gaining popularity to make concrete environment-friendly material and the concrete can be called Green Concrete.

The green building concept, in broader terms, involves a building, which is designed, built, operated, maintained or reused with objectives to protect occupant health, improve employee productivity, use wisely natural resources and reduce environmental impact. In other words the green building process incorporates environmental considerations into every stage of the building construction.

This research will give us a brief idea about as well as advantages and disadvantages of green concrete. This paper proposed the guidelines for the design of fly ash-based green concrete and presented a comparative analysis of a high-rise green structure and a conventional structure where the modelling and analysis was performed using the analytical application STAAD Pro. The research further highlights how sustainable building materials can contribute to lessen the impact of environmental degradation, and generate healthy buildings which can be sustainable to the occupant as well as our environment.

Keywords: Green building; Sustainable development; Modern building techniques; Cost efficiency; Environment-friendly, Structural Analysis and.

Introduction:

Unfortunately concrete is not an environmental friendly material, either to make, or to use, or even to dispose of. To gain the raw materials to make this material, much energy and water must be used, and quarrying for sand and other aggregates causes environmental destruction and pollution .claimed to be a huge source of carbon emissions into the atmosphere. Some claim that concrete is responsible for up to 5% of the world's total amount of carbon emissions, which contribute to greenhouse gases. The reason for the huge popularity of concrete is the result of a number of well-known advantages, such as low cost, general availability, and wide applicability. But this popularity of concrete also carries with it a great environmental cost. Cement-based materials are the most abundant manufactured materials in the world. Today's exciting trend is the Green building is in our country. The potential environmental benefit to society of being able to build with green concrete is huge. Green Concrete as the name suggests is eco friendly and saves the environment by using waste products generated by industries in various forms like rice husk ash, micro silica, etc to make resource-saving concrete structures . Use of green concrete helps in saving energy with emissions, waste water. Green concrete is very often also cheap to produce as it uses waste products directly as a partial substitute for cement, thus saving energy consumption in production of per unit of cement. Over and above all green concrete has greater strength and durability than the normal concrete. It is realistic to assume that the technology can be developed, which can reduce the CO2 emission related to concrete production.

Green Concrete

Concrete which is made from concrete wastes that are eco-friendly are called as **"Green concrete"**. Green Concrete is a term given to a concrete that has had extra steps taken in the mix design and placement to insure a sustainable structure and a long life cycle with a low maintenance surface. e.g. Energy saving, CO2 emissions, wastewater. Today the word green is not just limited to colour, it represents the environment, which is surrounding us. "Green concrete" is a revolutionary topic in the history of concrete industry. This was first invented in Denmark in the year 1998 by Dr. WG. Concrete wastes like slag, power plant wastes, recycled concrete, mining and quarrying wastes, waste glass, incinerator residue, red mud, burnt clay, sawdust, combustor ash and foundry sand. The goal of the **Centre for Green Concrete** is to reduce the environmental impact of concrete. To enable this, new technology is developed.

LITERATURE RERVIEW:

Ammar Qassem Ahdal et.al (2022) in a research paper, it was hypothesized that the mechanical performance of green concrete prepared by substituting cement with Natural Zeolite (NZ) and waste Polyethylene Terephthalate (PET) fibres will yield stronger, cost-effective, and environmentally green concrete for the construction industry. The microstructure, morphology, and surface properties of the locally extracted NZ were characterized using X-ray Diffraction, SEM and BET, respectively. The influence of quantity, shape, orientations, and surface of NZ and PET fibers along with varying curing times, i.e., 28, 90, and 180 days were considered for experimentation.

Emad S. Bakhoum and Yasser M. Mater (2022) research paper aimed to develop an approach using a multicriteria decision-making algorithm based on Analytical Hierarchy Process (AHP), to select the most suitable industrial waste to achieve the desired green concrete properties. The research starts by determining the alternatives including 18 industrial wastes, and the criteria including 14 properties of concrete. An algorithm was developed using a python script to analyze the influence of incorporating each of the industrial waste alternatives on both the mechanical and sustainable properties of concrete. Subsequently, the efficiency of the proposed algorithm is validated using three case studies that present different circumstances of concrete specifications.

OBJECTIVES:

- To configure a workable and economic structural system. This involves the selection of the appropriate structural types and laying out the location and arrangements of the Structural elements such as columns and beams.
- Conduct seismic analysis of a conventional structure considering seismic load
- Conduct seismic analysis of a green building considering seismic load.

METHODOLOGY:

Step 1: Research paper from different authors was summarized in this section who have focused towards analysing multi storey high rise structures considering seismic loads with different zones and soil condition

Step 2: In order to initiate the modelling of the case study, firstly their's need to initialize the model on the basis of defining display units on metric SI on region India as STAAD PRO supports the building codes of different nations. The steel code was considered as per IS 800:2007 and concrete design code as per IS 456:2000.

Step 3: STAAD PRO provides the option of modelling the structure with an easy option of Quick Template where the grids can be defined in X, Y and Z direction. Here in this case, 5 bays in considered in both X and Y direction with a constant spacing of 4m making the model symmetrical in nature. G+8 storey green structure is considered with typical storey height of 3.2 m and Bottom storey height of 3.2 m.

Step 4: Next step is to define the material properties of concrete and steel. Here in this case study, green concrete and rebar HYSD 415 is considered and its predefined properties are available in the STAAD PRO application.

Step 5: Defining section properties for Beam, Column. Beam size of 400x300mm, Column size of 450x450mm and Slab size of 125 mm is considered in the study.

Step 6: Assigning Fixed Support at bottom of the structure in X, Y and Z direction in both the considered cases.

Step 7: Defining Load cases for dead load, live load and seismic analysis for X and Y Direction.

Step 8 Defining Seismic Loading as per IS 1893: 2016 Part I.

Step 9: Conducting the model check for both the cases in STAAD PRO

Step 10: Analysing the structure for dead load, stress analysis and displacement.

Table 1 Geometrical Specifications of the Structure

Geometrical Specification	
Particulars of Item	Properties
Number of Storey	G+8
Typical Storey height	3.2m
Bottom Storey Height	3.2m
Floor Diaphragm	Rigid
Number of Grid Lines in X-direction	6

Number of Grid Lines in Y-direction	6
Beam Size	400x300mm
Beam Shape	Rectangular
Column Size	400x400mm
Column Shape	Rectangular
Slab Depth	125mm
Slab Type	Thin Shell

ANALYSIS RESULT:

The two cases were evaluated for G+8 structure considering green building and rcc building The structure was modelled and analyzed using analytical application STAAD PRO 2016. The case study was compared on parameters of Base shear, storey displacement, storey stiffness, storey drift and storey shear.

Base Shear in kN

Table 2 Base Shear in kN

Base Shear in kN	
RCC Building	1389.092
Green Building	3040.287

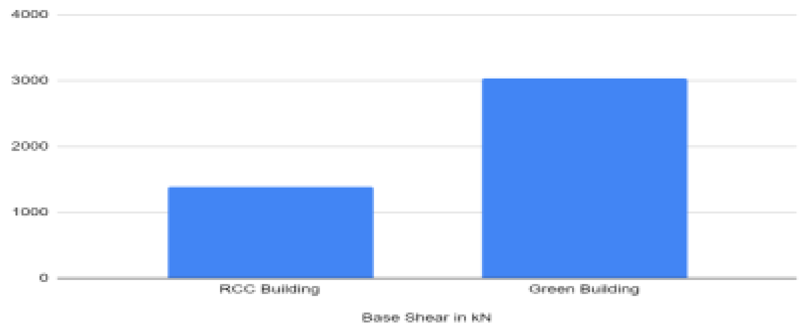

Fig 1 Base Shear in kN

Inference- Base shear is an estimate of the maximum expected lateral force on the base of the structure due to seismic activity. It is calculated using the seismic zone, soil material, and building code lateral force equations. From the above table we can say that the base shear is more for green building in comparison to RCC structure. The figure above states that base shear of RCC structure is 9% less in comparison to green building since its mass and stiffness are less.

Time Period in sec

Table 3 Time Period in sec

Natural Period in sec	
RCC Building	3.217
Green Building	2.708

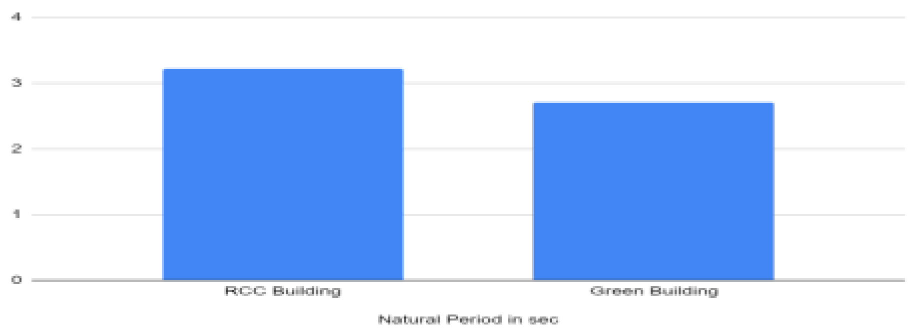

Fig 2 Time Period in sec

Inference: Natural Period Tn of a building is the time taken by it to undergo one complete cycle of oscillation. It is an inherent property of a building controlled by its mass m and stiffness k. These three quantities are related by its units are seconds (s). Tn = 2 π √ (m/k). The period was found maximum for RCC structure and least for Green Building.

Conclusion

Base Shear

It is an estimate of the maximum expected lateral force on the base of the structure due to seismic activity. It is calculated using the seismic zone, soil material, and building code lateral force equations. Results stated that the base shear is more for green building in comparison to RCC structure. The base shear of RCC structure is 9% less in comparison to green building since its mass and stiffness are less.

Time Period

Natural Period Tn of a building is the time taken by it to undergo one complete cycle of oscillation. It is an inherent property of a building controlled by its mass m and stiffness k. These three quantities are related by its units are seconds (s). Tn = 2 π √ (m/k). The period was found maximum for RCC structure and least for Green Building.

Storey Displacement

Story displacement is the deflection of a single story relative to the base or ground level of the structure. Intuitively, we can expect higher total displacement values as we move up the structure. So, a graph showing the story displacement vs. the height of the structure looks exactly like the deflected shape. The percentage decrease of storey displacement for green building was 2.21% compared to RCC structure along x-direction and y-direction. The maximum storey shear was visible for bare frame structure proving to be 12% higher which used to increase with height of each storey.

Storey Drift

Storey drift is the lateral displacement of a floor relative to the floor below, and the storey drift ratio is the storey drift divided by the storey height. The percentage decrease of storey drift for green building is 36.11% compared to RCC structure along the x-direction.

Shear Force

Storey Shear is the lateral force acting on a storey due to the forces such as seismic and wind force. Buildings having lesser stiffness attract lesser storey shear and vice versa. The percentage decrease of storey shear for Green building was 7.50% compared to RCC Building along x-direction.

Storey Displacement

Storey Moment was on the higher side by 4.1 % in RCC structure and increased to 8% with the increase in height when compared to green building

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