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# Comparative Study of Seismic Behaviour of G+15 Storey Building Using Lightweight Concrete And Normal Weight Concrete

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**ABSTRACT:** Concrete to be considered as a lightweight concrete, with density less than  $2000 \text{ kg/m}^3$ . The primary use of structural lightweight concrete (SLWC) is to reduce dead load of concrete structure which allow structural designer to reduce the size of structural member which results in reduction of earthquake forces of structure. The purpose of this study is to develop and compare the results of structural lightweight concrete by admixing with perlite. The concrete is targeted to have a density of less than  $2000 \text{ kg/m}^3$ . In this paper, a G+15 storeyed building is analysed by using Response Spectrum method with the use of Structural Lightweight Concrete and Normal Weight Concrete. Bending moments, shear forces, storey drift and Displacement, Time period are consider and comparison of results of both NWC and SLWC is been done. The final results and conclusion will be based on the behaviour of building to the seismic forces and the comparative parameters like base shear, lateral storey drift, displacement, cross section area of steel and reducing in size of structural member etc. of both the cases.

**KEYWORDS:** Structural Lightweight Concrete, Density of Concrete, Expanded Perlite aggregate, Response Spectrum Method, Base Shear, Lateral storey drift, Displacement.

## I. INTRODUCTION

Structural Lightweight concrete (SLWC) has been used successfully for structural purposes for many Years; because of their improved properties such as the workability, strength, less dead load. Structural Lightweight concrete has low density and is adaptable for construction of buildings in low-seismic zones. Different types Of lightweight aggregate (LWA) suitable for construction purposes can be found, varying in their composition, density, surface texture, porosity and water absorption capacity. The most frequently used LWAs are pumice, tuff, scoria, cinders, expanded clay, expanded glass, perlite, expanded vermiculite and sintered ash. Expanded Perlite can be used as a manufacturing lightweight concrete. Structural seismic responses are based on mass of the structure or dead weight of the structure; the selection of materials to maintain the low dead weight can be adopted. The mechanical properties of lightweight aggregate concrete are given by ACI 318 Building code; the modulus of elasticity for normal weight concrete is more when compared to the structural lightweight aggregate concrete. Elastic modulus for SLWC is a function of density and characteristic compressive strength of concrete. Most of the experimental studies concluded that poisons ratio of SLWAC and normal concrete are nearly equal. The coefficient of thermal expansion for normal concrete and lightweight aggregate concrete is  $7 \times 10^{-6} / ^\circ\text{C}$  and  $13 \times 10^{-6} / ^\circ\text{C}$  respectively was identified in various experimental studies. The equation of elastic modulus for lightweight concrete given by the ACI code is shown below:

$$E = 0.043 \times \omega^{1.5} \times \sqrt{F_c}$$

Where;  $\omega$  = density of concrete ( $\text{kg/m}^3$ )  
 $f_c$  = compressive strength of concrete (Mpa)

## II. LITERATURE REVIEW

The present work is aimed at comparative study of behaviour of Multi-Storeyed Buildings with structural lightweight concrete and normal weight concrete. Various studies have been carried out till date for design of concrete mix and structural lightweight concrete buildings below as follows:

**Mohammed Ibrahim et.al (2020)** This study focuses on the development of durable structural lightweight concrete (LWC) by incorporating expanded perlite aggregate (EPA) in the range of 0 to 20% by weight. In order to ensure its durability when exposed to chloride environment, concrete was produced with low water-to-cement ratio and ordinary Portland cement (OPC) was replaced with 50% and 7% ground granulated blast furnace slag (GGBFS) and silica fume (SF), respectively. The mechanical properties and durability of concrete were assessed by determining the unit weight, compressive strength, flexural strength, drying shrinkage, chloride permeability and migration, as well as resistance of concrete to corrosion of reinforcing steel. Very importantly, thermal insulation properties were determined using a hot guarded plate. In addition, a finite element model (FEM) was prepared to study the behavior of EPA -modified concrete under seismic loading. The results showed that the unit weight of concrete was reduced by 20% to 30% when compared with the normal weight concrete (NWC). The compressive strength of the developed LWC was sufficient to be used as structural concrete, particularly of those mixtures containing 10% and 15% perlite aggregate. The durability of LWC was comparable to NWC in terms of chloride diffusion and resistance of concrete to corrosion of reinforcing steel. The tangible outcomes also include the superior thermal insulation properties of LWC compared to NWC. The greater incorporation of EPA in the concrete resulted in better behavior under seismic loading.

**Annie Sweetlin. J.P et.al (2020)** Structural Low Density Aggregate Concrete has an ability to reduce the self-weight of the structure as well as reduces the risk of earthquake damages to a structure because earthquake forces are proportional to mass of the structure. For structural application of lightweight concrete, the density is more important than the strength. A low density for the same strength level reduces the self-weight, foundation size and construction costs. In this study, structural lightweight aggregate concrete was designed with natural Perlite aggregate that will provide an advantage of reducing dead weight of structure also compared the strength of normal concrete with perlite concrete by fully replacing coarse aggregate with perlite by varying the water cement ratio in perlite concrete. The investigations were carried out using several tests which include compressive test, split tensile test. By analyzing the test results the perlite concrete can be effectively used in non-load bearing walls and in-fill walls and the dead load of the structure can be effectively reduced.

**Bhuvaneshwari. K et.al (2017)** In this paper author has studied use of perlite in concrete as a lightweight concrete. Structural lightweight aggregate concrete was designed with natural perlite aggregate, for reducing dead weight of structure. In this paper author has also compared the strength of normal concrete with perlite concrete by replacing perlite with sand. Replacement was done in percentages, 5, 10, 15, 20 and 25% of sand is been replaced by perlite. In normal concrete mix. The result was been carried out by conducting several tests that is compressive test, split tensile test and flexural test. Author concludes with the result that compressive strength was high by replacing 10% of perlite with sand and percentage increase was 1.85% at 28 days. Split tensile strength was high at 10% perlite and percentage increase was 10.46% at 28 days. Flexural strength was high at 10% perlite and the percentage increase was 10.20% at 28 days. The compressive, split tensile and flexural strength were reduced if the replacement percentage of perlite increased.

**Swamy Nadh Vandanapuet.al (2018)** In this research paper the seismic response of six storied reinforced concrete frame with the use of lightweight concrete was design. The structure is modelled with standard software and analysis is carried out with lightweight concrete and normal weight concrete. The result of this experiment came as storey drift and storey displacement was 10% more in LWC than NWC. The LWC structure subjected to seismic analysis result in less bending moment and shear forces which reduce the cross section of members and also reduce the steel in moment and shear resisting section.

## III. METHODOLOGY

The following steps are undertaken within the present study are as follows: 1. In present research 2 different model G+15 structure building using perlite lightweight concrete and normal weight concrete is done. 2. Modelling of the structure is done using ETABS. 3. Seismic analysis as per IS 1893-2016. 4. Design and analysis of structure using IS

456-2000, IS 875. 5. Result for the perlite as a lightweight concrete targeted to have a density of less than 2000 kg/m<sup>3</sup> and result for normal weight concrete taken from IS 10262-2019. 6. Design and analytical work is been carried out by method using response spectrum analysis. 7. Interpretation of result and conclusion will be based on comparison of behaviour of structure and changes in size parameters, bending moment, storey displacement and drift, base storey and time period of both the building.

#### IV. STRUCTURAL MODELLING

In this study, structure will be model for the following cases: 1. G+15 storeyed building with structural lightweight concrete and normal weight concrete. 2. Analysis and conclusion of same structure by using response spectrum method. 3. Analysis and conclusion by using response spectrum method. 3. The frame structure will be modelled using ETABS software with storey height of 3m, the member size are varied as per the design requirements. 4. The model is analysis with 2 different material properties one is structural lightweight concrete and other is normal weight concrete. 5. Model is design as according to IS 456-2000. 6. The material properties required for the structure is density, elastic modulus, Poisson's ratio, compressive strength, coefficient of thermal expansion and shear modulus can be calculated as recommended by ACI 318 Building code. 7. Density of structural lightweight concrete of perlite mix design can be taken as less than 2000 kg/m<sup>3</sup> and density of normal weight concrete is taken as 2500 Kg/m<sup>3</sup>.

#### V. PRELIMINARY DATA

Following are the data assumed for carrying out this study, 1. Length in X direction=20m. 2. Length in Y direction=20m. 3. Typical storey height=3m. 4. Ground storey height=3.5m. 5. No. of storey =G+15. 6. Height of bldg. =48.5m. Load consideration are as follows: 1. Dead load: as per calculation of changes in density, compressive strength, Poisson's, modulus of elasticity. 2. Live load: 3 kN/m<sup>2</sup>. 3. Wind load: as per IS 875 part 3. 4. Seismic zones: III.

#### VI. CONCLUSION

As by reviewing literature it can conclude that various experiment has been done to reduce the density of concrete by using expanded perlite aggregate and naturally occurring perlite in replacement of coarse aggregate, fine aggregate or cement as a lightweight.

When used as the primary aggregate in concrete, expanded perlite provide several key advantages to the construction and precast manufacturing application. Though lightweight concrete is not usually suited for structural or load bearing uses, in other application it provide improvement in load stress, noise reduction, thermal transfer resistance, and fire rating. Perlite concrete can be use as structural lightweight concrete by maintaining its density up to 2000 kg/m<sup>3</sup> and its compressive strength 30- 35 Mpa.

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