Study on Stress-Strain Behavior of Standard and High-Strength Concrete - A Review

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Abstract-*This Documentation presents study on behavior of standard and high strength concrete with stress-strain analysis. Generally, many types of research have been conducted on high strength concrete with different trial mixes to determine the stress and strain behavior of standard and high-strength concrete. To understand and predict the performance of high-strength concrete, the parameters such as modulus of elasticity poisons ratio, ultimate strength had been obtained and compared with the standard concrete. Concrete is majorly used in compression that is why its compressive stress-strain analysis is a great concern. Day to day the use of high-strength concrete is rapidly increasing and there are different types of admixtures, plasticizers, water reducers used for the design of high strength concrete. The high strength concrete is obtained by doing different trial methods by reducing the water-cement ratio and adding superplasticizers along with admixtures. Concrete takes 28 days to reach its 90% strength and it would theoretically take infinity time to achieve 100% strength, so investigation beyond 28 days is beneficial. High strength concrete is used in the construction of high-rise structures and its mainly used in components such as columns in lower floors to resist high loads, shear walls and foundations.*

Keywords: Standard concrete; high strength concrete; ultimate stress; shear walls; superplasticizers.

Introduction

Concrete is a mixture of four basic components cement, fine aggregate, coarse aggregate, and water. These materials can be replaced by other different similar property materials which add additional strength to concrete. Starting from the Romans and Greeks from the 200 B.C to the present day there are lots of changes in concrete designs and proportions of materials. As the use of concrete is increasing, different types of researches are going on to develop high strength concrete. As per IS-456 High strength, concrete has been described as the concrete having a characteristic compressive strength of more than 60mpa.

The High strength concrete is obtained by reducing water-cement ration and parallelly using different admixtures, plasticizers, superplasticizers. As there is no exact mix design for high strength concrete as standard concrete, we have to perform different trail methods by varying water-cement ratio, percentage of superplasticizers to obtain the desired results. To attain high strength concrete, the properties of the materials should be extremely good compared to standard concrete materials. Introduction of mineral admixtures such as silica fume, fly ash, GGBS and chemical admixtures such as plasticizers, water reducers may be used to enhance the properties of high strength concrete. Water reducers are those which reduce the percentage of water required and increase the workability.

The most important properties of high strength concrete have been described below:

- Modulus of elasticity is high.
- Resistance against abrasion.
- Long life and high durability.
- Low permeability.
- Resistance to chemical attack.
- Scaling damage and resistance to frost action.
- Impact resistance and toughness.
- Carbonation.
- Ease of placement.

The strength of concrete is affected by several factors, some of these are mentioned below.

- Mixing Proportioning and Selection of materials.
- The method of curing.
- The size of the specimen.
- Temperature of the treating specimens.

These parameters have a direct impact on the stress-strain behavior of the concrete.

Concrete gains 50% strength by 3-7 days curing and 90% strength by 28 days curing, the investigation on 90days curing may give the additional strength for standard and high strength concrete.

The stress-strain analysis gives the complete behavior of the concrete materials. The ultimate stress-strain of hardened concrete may be computed under axial load. Young's modulus and modulus of elasticity can be computed through stress-strain analysis and helps to predict the value of strain corresponding stress and curve variations between their strengths for standard and high strength concrete. The ascending and descending order of curve variations of both standard and high-grade concrete gives more accurate values and ease of understandings.

The need for stress-strain analysis

The stress-strain analysis allows designers and engineers to analyze the behavior of concrete in building constructions, the some of the benefits of stress-strain analysis are listed below.

- The stress-strain analysis computes the mechanical behavior of the material.
- Modulus of elasticity can be computed which is an important parameter in the evaluation of deformations.
- It shows the strain corresponding to the stress.
- Poisons ratio can be obtained, which is required constant for determining stress and their deflection properties of materials.
- Ultimate stress can be found which is useful to find the maximum stress that a material can exert.

Requirements of high strength concrete

As there is no exact mix ratio for high strength concrete-like standard concrete, one should perform different trial methods to obtain the designed characteristic compressive strength.

To make each trail method of concrete mix gain high strength, the below points to be undertaken

- The water-cement ratio should be very less i.e. 0.25 or even less than that.
- Slump should be more than normal concrete.
- High Water reducers should be used.
- Good compaction to escape voids present.
- High cement content.
- Good property aggregates to be used.

Applications of high strength concrete

Due to the maximum compressive strength of high strength concrete, it has many advantages compared to standard concrete and are applied in various cases such as in

- High rise structures.
- Columns-specially in lower floors to resist high loads.
- Shear walls.
- High way bridges.
- Space-saving areas.

2. Literature review

A literature review has been conducted based on the study of previous research papers published in various journals, corresponding to the stress-strain behavior of Standard and High strength concrete.

Tiefeng Chen et.al performed to determine the flexural strength, compressive strength, fracture toughness of ultra-high-performance concrete with silica fume and fly ash of various dosages. Different autoclave curing condition with different pressure and duration times (i.e.0.5mpa,1mpa,1.5mpa and time 6h,8h,10,12h) were considered in the study. It has been proved by increases in fly ash content up to a certain percentage increases compressive strength and different dosages of fly ash give different values of compressive strength. The autoclaving curing increases the compressive strength and flexural strength about 37.5% and 30.3% for ultra-high-performance concrete.

Chaitanya raj presented information of variation in the strength of M100 grade by using the different percentage of superplasticizer and checked compressive strength for curing 28 days. The IS 456:2000 code has been followed for the properties of materials in this research. The master-selenium superplasticizer has been obtained the strength of 111.8 N /mm^2. The superplasticizer used with in the percentage of 0.8% to 1% of total binder weight which gave the slump of 120mm. The required weight of total fine aggregates and coarse aggregates has been obtained by different trail methods for high strength concrete.

Sishminder pal Singh performed research work on concrete behavior using the superplasticizer and loss of slump, workability, and compressive strength. The comparison between the super plasticized concrete and the normal concrete without superplasticizer gives the need of superplasticizer. Different superplasticizers are used and concluded that selenium 140 has obtained more compressive strength than the other superplasticizers in concrete mix for 7 days and 14, 28 days the values of compressive strength are very much different from that of other superplasticizers.

Suvarna Latha performed the analysis of the stress-strain behavior of the hardened concrete. Different admixtures such as ground granulated blast furnace slag, high volume fly ash with different percentages (0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%) are used. Different grades of concrete specimens with different binder materials were tested. The shear values are computed and tabulated to analysis the stress-strain behavior of all the concrete specimens which are designed respectively with their concrete mix proportion. Different curves are drawn with their respective values and given the conclusion that replacing of GBS with natural sand gives a better bond between the cement particles which directly increase the compressive strength of concrete.

3. Conclusion

The following conclusion can be drawn from the present study.

1. The high strength concrete can resist high loads and high deformations compared to standard concrete.
2. By decreasing the water-cement ratio and adding water reducers, the strength of concrete can be increased.
3. The stress-strain behavior of the concrete gives a detailed analysis of the designed concrete mix.
4. Investigation on curing beyond 28 days may give additional strength to concrete, which is useful to variate standard and high strength concrete more efficiently.
5. The stress-strain analysis between the standard and high strength concrete gives curve variations which will make easier to understand the strength variations.
6. Modulus of elasticity poisons ratio, ultimate stress can be computed by stress-strain analysis of high strength concrete which are main factors in structure designing.

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