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Regression based analysis and visualization of for identifying Flexural Behaviour of M60 Beams under repeated Compressive Load based on observational data sets

V. S. Sethuraman[a]*, . K.Suguna[b]

[a] *Research Scholar,* [b]*Professor, Department of Civil & Structural Engineering, Annamalai University, Chennai*

Abstract

In this paper, we are focusing on exploring the impact of linear regression based statistical analysis of observed civil data sets that can be used to identify the eqation to improve the efficiency and effectiveness of future data collection and further refinement of activities in various civil engineering applications. The cutting edge technology in modern day construction emphasizes the quest for high strength concretes to ultra-high strength concretes. The high strength concretes are manufactured invariably by the selective addition of several mineral admixtures like silica fume, metakaoline, flyash, rice husk ash, ground granulated blast furnace slag, etc. The manifold applications of concrete desired to have a compressive strength ranging from 60 to 100 MPa has made a paradigm shift for the need of High Strength Concrete (M60) in the construction scenario. The present paper of this research work focuses on the flexural response of M60 beams under cyclic loading. We are taking the datasets of volume fraction and compressive strength of concrete as two independent variables to generate equation using linear regression. The data sets are gathered by means of perfoming real-time experiments. The experimental programme consisted of six M60 beams prepared by the addition of 8% silica fume at a constant water-cement ratio of 0.36 with different percentages of tension reinforcement and variation in spacing of shear reinforcement. All the beams are designed for under reinforced condition. The steel ratio is modified in terms of 1.0%, 1.25% and 1.5% and the shear reinforcement is spaced at 100 and 200 mm c/c combinations. The purpose of variation in tension steel ratio and shear reinforcement spacing is to find out the effect of confinement in strength, ductility and cracking. The test on beams is carried out under cyclic loading till failure to obtain the engineering performance and other associated properties. The test results indicated that there has been a wide range of enhancement in parameters like strength, deformation, ductility, and minimization of cracks and crack width. Also the experimental results are validated with the analytical model developed using regression analysis computed using Minitab software.

Keywords: High strength concrete, Silica fume, Confinement, Cyclic loading, Steel ratio, Under reinforcement; Linear Regression; Minitab;

1. Introduction

The use of high strength concrete (with f'c>50MPa) is very common in buildings and other structures designed recently. Economy, superior strength, stiffness and durability are the major reasons for its popularity. Structural Engineers are presently exploring the benefits of using this efficient material in various applications.

High Strength Concrete has compressive strength of upto 100 MPa as against conventional concrete which has compressive strength of less that 50 MPA. Concrete having compressive strength greater than 200 MPa is classified as Ultra high strength concrete. The ingredients of high strength concrete are the same as those used

* Corresponding author. Tel: +91 9444 241 144
E-mail address: vssphd1@gmail.com

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in conventional concrete with the addition of one or two admixtures, both chemical and mineral. A proper mix can be obtained using a proper particle packing method and it is essential to use a plasticizing chemical admixture to produce high strength concrete. Generally, water-reducing admixtures (WRA's) are used.

2. HSC – An Overview

2.1. Need for High Strength Concrete

i. To put the concrete into service at much earlier age, for example opening the pavement at 3-days
ii. To build high-rise buildings by reducing column sizes and increasing available space.
iii. To build the superstructures of long-span bridges and to enhance the durability of bridge decks.
iv. To satisfy the specific needs of special needs of special applications such as durability, modulus of Elasticity and flexural strength. Some of these applications include dams, grandstand roofs, marine foundations, parking garages and heavy duty industrial floors.

2.2. Classification of concrete

Concrete is classified based on IS 456:2000 and as per ACI code as furnished in Table 1 and 2

Sl. No	Name of Group of Concrete	Grade Designation
1	Ordinary Concrete	M10 to M20
2	Standard Concrete	M25 to M55
3	High Strength Concrete	M60 to M80
Note: M refers to mix and the number to specified compressive strength of 150 mm size cube at 28 days expressed in N/ mm^2		

Table 1: Classification based on IS 456:2000

Sl. No	Name of Group of Concrete	Concrete Strength (Cylinder Strength f'c)
1	Normal Strength Concrete (NSC)	21 MPa to 42 MPa
2	High Strength Concrete (HSC)	60 MPa to 90 MPa
3	Ultra High Strength Concrete (UHSC)	115 MPa to 160 MPa

Table 2: Grouping concrete as per ACI code

2.3. Aggregates

Aggregates overwhelmingly occupy the largest volume of any constituent in concrete and profoundly influence concrete performance in both the fresh and hardened states. Selection of appropriate aggregates is important for all structural concretes, regardless of strength.

Fine-aggregate:

The optimum gradation of fine aggregate for high-strength concrete is determined more by its effect on water demand than on particle packing.

Properties	Fine Aggregate
Absorption	2.8%
Specific gravity	2.60
Density	1726 kg/m3
Sulphate content	0.75%

Table 3: Properties of fine aggregate

Coarse-aggregate:

As the target strength increases, the properties of aggregates as they relate to water-demand become less relevant and the properties that relate to interfacial bond become more important. Even though the water