iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 Issue: II Month of publication: February 2024

DOI: https://doi.org/10.22214/ijraset.2024.58426

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue II Feb 2024- Available at www.ijraset.com

Self Compaction Concrete

Deepmala Petwal[1], Gajendra Singh[2]
Department of civil engineering, Himgiri Zee University

Abstract: In this paper, we present the main objective of this study is to gain an absolute knowledge on self-compacting concrete (SCC) and to sort out the research gap in field of self-compacting concrete containing admixtures. This research study is carried out in the three phases and the details are Phase – I to develop the mix design of M50 grade using Nan-Su method. To optimize the developed mix proportions by using statistical (DOE) design; ranging content of the key variables of self-compacting concrete cement. To study the fresh concrete properties (rheological) and mechanical properties (compressive strength) of self-compacting concrete by varying different parameters such as fine aggregate, coarse aggregate, super plasticizer (SP) and water/binder ratio.
Keywords: Self compacting concrete, Nan-Su method, Super plasticizer

I. INTRODUCTION

Concrete is second most widely used material.. This shows the eminent role of concrete in current era. The basic components of normal concrete are cement, fine aggregate, coarse aggregate, admixtures and water; mixed in different proportions using vibrator. The rapid development of construction industry urges the researchers to invent the special concretes with the optimized status and less hazardous to environment. There are several researches going on, in improving the efficiency of concrete, making concrete more durable, eco-friendly, high strength and cost effective. Self-Compacting Concrete (SCC) has become the new trending technique over Normally Vibrated Concrete (NVC). The presentation of SCC speaks to a noteworthy innovative propel, which prompts a superior nature of cement that created a quicker and more efficient concrete development process. The SCC is used in UK as well as few parts Europe. This created a vast European exploration venture that examined the practicability of utilizing Self-compacting concrete in both structural designing and building structures, which contained a high quantity of binder and superplasticizer content in order to guarantee satisfactory filling capacity and passing capacities and to avoid isolation matrices materials. This traditional mix design method requires more number of trial mixes for obtaining a mix proportions for required target strength compared to proposed method; this leads to lose in time, energy and cost; it also leads to production of more industrial wastes. Later, In 2002 EFNARC (European Federation National Association Responsible for Concrete) published guidelines of fresh concrete that has to satisfy minimum requirements for SCC but does not specify a perfect design to obtain the mix proportion for fixed characteristic target strength.

TABLE I
Difference between EFNARC and Nan-su method

EFNARC – Guidelines	Proposed mix design with Nan-Su method
Target strength is not defined	Design is based on target strength
Properties of material does not plays any role in calculation of mix proportion/fixing the grade of concrete	Properties of material such as: a. packing density factor, b. bulk density, c. Specific gravity plays a vital role.
Mix proportion is concluded by approximate trial and error method	Mix proportion is derived by proper steps.
There is no defined principle for material considerations	The principle of design is, to fill the paste of binders into the voids of aggregates that is piled loosely, that is why the loose bulk density of the aggregates has been taken into account.
Uneconomical; leads to wastage of materials in defining the mix proportion. Results in environmental hazards.	Reduces the number of trial mixes, helps to attaining the perfect optimized mix proportions.

II. COMPONENTS OF CONCRETE

A. Fibre in concrete

Concrete is very good in compression and weak in tensile properties. Using fibres in concrete is not new, it has been in practice from the ancient period around 19th century. The concept of composite material was started from the year of 1950's. The detailed research is going on in enhancing the tensile properties of concrete, by adding different kinds of fibres in different ratio. Addition of fibres helps in arresting the initial internal micro cracks which is considered as a major reason for failure of concrete, improves the shrinkage and improves the impact resistance (Till, 2008). Addition of fibres in self-compacting concrete makes the concrete most effective and efficient concrete comparing to Normally Vibrated Concrete (NVC) of almost similar properties. Steel fibres help to enhance different mechanical properties, imperviousness to fire, lessen the plastic and drying shrinkage of SCC in addition to improve the sustainability of the SCC. Eventually, incorporation of Macro-Steel fibres (length more than 30mm) affects the workability of fresh concrete, making the matrix stiffer. Despite of higher proportions of fibres gave better flexural quality, workability of Steel Fibre Reinforced Concrete (SFRC) was observed to be antagonistically influenced with aspect ratios and proportions.

B. Fly Ash

The raise in demand of raw materials in the field of construction has made the materials scarce and the crucial need to secure nature against pollution. These factors has stressed the essentialness of improving new structure materials centered on industrial waste spawned from coal burnt thermal power plants producing insurmountable disposal problems due to their prospective to pollute the environment. Fly-ash is a pozzolanic material which is a secondary product obtained after the ignition of coal in thermal power plants. When mineral admixture used in concrete, especially fly ash it improves the strength and durability properties of concrete. Fly ash can be utilized either as a mineral admixture or as a halfway substitution of cementitious material. It can also be utilized as partial substituent of fine aggregates. In some cases fly ash as a complete substituent of binder content and as supplementary expansion to accomplish distinctive properties of cement. Such concrete are called as geopolymer concrete or green concrete.
Plain concrete having only cement as the binder content utilized in mass concrete construction like dams, high raised buildings, etc. would lead to high heat of hydration subsequently prompting issues like high drying shrinkage. The utilization of materials like fly ash or slag helps in decreasing the temperature rise during the hydration process in Portland cement (Mehta and Monteiro, 1997). Tests have demonstrated that cement glues containing 10%-30% fly ash cause critical pore refinement in the 28 days to 90 days.

C. Micro Silica

Micro Silica Fume is a fine, grey color, dust like siliceous particle with pozzolanic property, created when high-quality quartz is diminished in 'an electric arc furnace heater' by the time of generation of silicon or ferrosilicon combination. Silica fume is produced when quartz are added 25% during the manufacturing process. The shape of micro silica fume is spherical in shape of diameter 50 nm-100 nm. 85% of the total composition of the MSF is mostly comprised of silica content (SiO2). The actual compositions of micro silica fume depending up on the recuperation approach, smelter, etc. Since the size of the material is inversely proportional to the surface area, this Nano size prompts to maximum surface area, upto 30000 m2/kg. Initially the silica fume was directly exposed to environment; the minute Nano particle created several hazards to the eco-system.

D. Steel Fibre

The Egyptians was the one who utilized using fibres in matrix as a composite material. They used straws, hairs from creatures to support their mud blocks in the construction (Wong, 2004). There are 'n' numbers of various sorts of steel fibres with various business names. Fundamentally, the steel fibres are differentiated according to their manufacturing procedure. Such as, melt and mill extract, cold drawn cut wire, slit sheet and likewise be grouped based on 'shape and cross section'. Round shaped steel fibres are created by cutting or chopping the continuous wire into discrete fibres, most commonly fibres have the diameter ranging from 0.25 mm to 0.75 mm. Steel fibres having flat shape cross sections have the thickness starting from 0.15mm to 0.40mm and having the width ranging from 0.25 to 0.90 mm are produced by shearing sheets or by straightening continuous fibres the different types of steel fibers are shown in Fig. 1.1.

Fig. 1.1 Steel Fibers with Different Aspect Ratio

However, the improvements of Fibre Reinforced Concrete (FRC) composites have given a specialized premise to outreach the inadequacies of concrete. The commonly used fibre is the steel fibres which are further subdivided into hook end steel fibre, crimped or corrugated steel fibre and straight steel fibre. These steel fibres are available in market with different cross sections and lengths. There are several pros and cons of using steel fibres in the concrete matrix. Eventually, incorporation of macro-steel fibres, (length more than 30 mm) affects the rheological properties of fresh concrete by making the matrix stiffer. Hence, by exploiting the good rheological properties of SCC at fresh state that fills the formwork without vibration, the steel fibres can be added to the mix to produce “Micro-Steel Fibre Reinforced Self-Compacting Concrete (MSFRSCC) with a more uniform fibre dispersion in a highly workable mixture”. The calculated mix design was derived as per proposed Nan Su method. In order to verify and optimize the derived material content, totally 33 trial mixes had been categorized with the help of DOE, shown in Table 4.11. The slump flow and compression tests were carried out for all 33 trial runs that containing five variable factors such as binder content, HRWR, B/W, fine aggregate and coarse aggregate. The results of the responses are shown in Table 4.12.

TABLE II
Outcome Of The Responses

Mix ID	(mm)	(28 Days) (MPa)	(kg/m3)
TM1	573	43.1	2279.15
TM2	679	52.9	2334.75
TM3	596	44.6	2282.54
TM4	706	54.2	2338.42
TM5	592	40.7	2308.25
TM6	704	50.0	2366.25
TM7	622	41.7	2311.64
TM8	753	52.3	2369.92
TM9	611	54.2	2319.15
TM10	657	56.2	2374.75
TM11	572	46.1	2322.54
TM12	688	59.6	2378.42
TM13	580	46.8	2348.25
TM14	690	58.9	2406.25
TM15	608	44.5	2351.64
TM16	720	60.8	2409.92
TM17	510	45.5	2319.15
TM18	624	54.8	2374.75
TM19	554	46.7	2322.54
TM20	653	56.1	2378.42
TM21	560	42.3	2348.25
TM22	644	52.2	2406.25
TM23	574	43.0	2351.64
TM24	671	54.2	2409.92
TM25	480	45.0	2359.15
TM26	595	55.1	2414.75
TM27	540	44.1	2362.54
TM28	617	55.9	2418.42
TM29	512	43.5	2388.25
TM30	520	53.0	2446.25
TM31	542	44.5	2391.64
TM32	640	54.4	2449.92
TM33	640	51.0	2363.86

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue II Feb 2024- Available at www.ijraset.com

III. FACTORS INFLUENCING THE SLUMP FLOW (PARETO CHART)

Slump flow test was performed for all 33 trial mixes. The test outcome of the performed slump flow is represented in Fig. 4.7. Pareto chart helps to focus on the most significant variables, when there are many problem causing agents while analyzing about the particular response. The significant roleplayed by each variable in enhancing the slump flow is shown in Fig. 4.8. Form Table 4.12 it is clearly seen that all mixes satisfying the minimum slump flow of 500mm. Therefore, picking up the optimum coarse aggregate content is very important to get the optimum flow with maximum strength.

Fig. 4.7 Slump Flow of trial mix number - TM25

Fig. 4.8 Slump Flow of trial mix number - TM16

IV. CONCLUSIONS

Based on the detailed experiments, including ABAQUS modeling study and regression analysis, the following points are summarized: Mix proportions were arrived for M50 grade of SCC using Nan-Su proposed method of mix design.

From Design of Experiments (DOE) methods, totally 33 mixes were designed using 2k factorial method to optimize the mix proportions of SCC. All five variables (cement, fine aggregate, coarse aggregate, superplasticizer and water/binder ratio) had showed a significant role in influencing the responses (Slump flow and compressive strength).

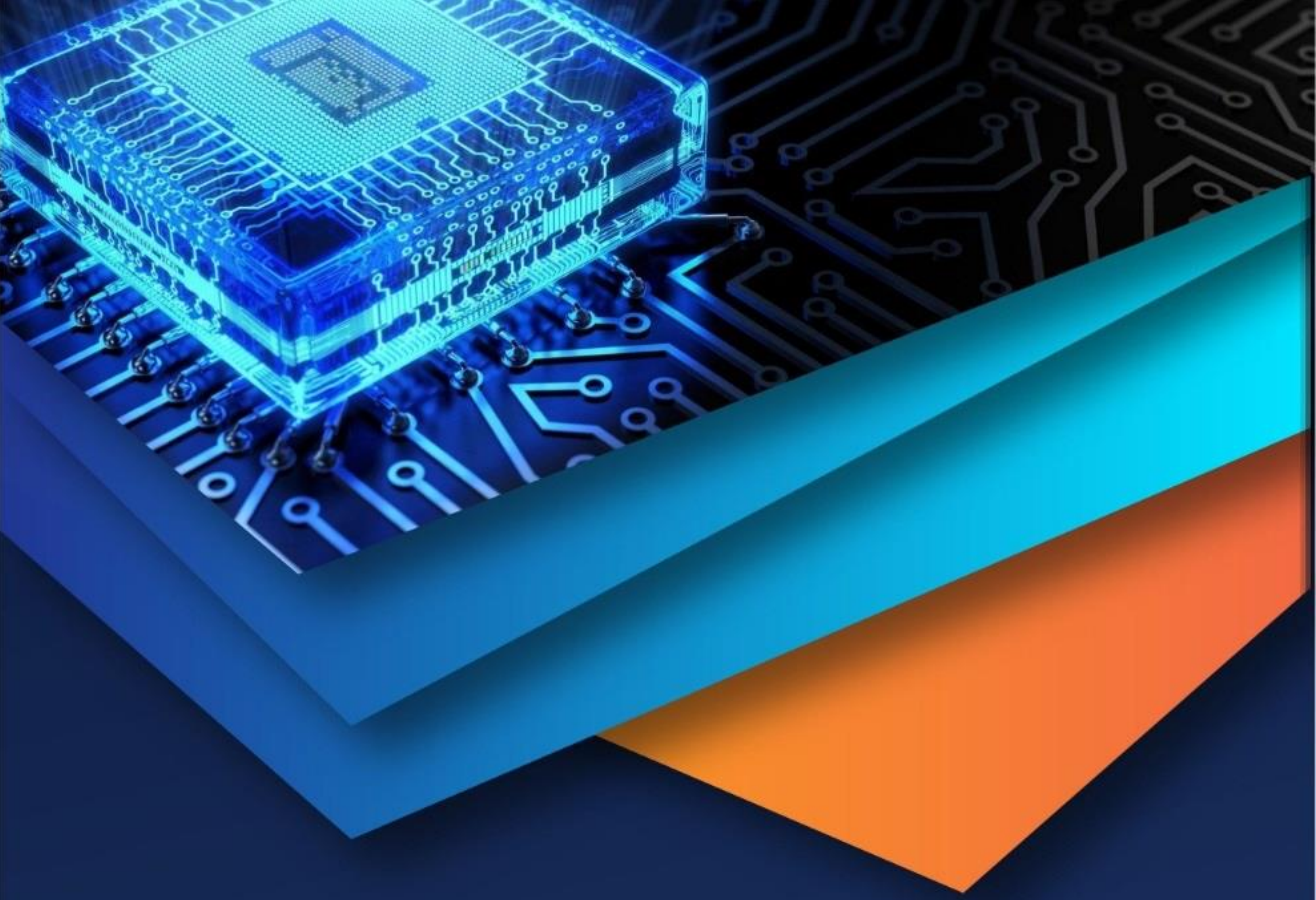
From the above experiments the mix proportions were optimized. Regression equations were developed for compressive strength and slump flow with respective to variables.

V. ACKNOWLEDGMENT

I/we have immense pleasure in expressing my heartfelt thanks to my guide Mr Gajendra Gusain Assistant Professor, Department of Civil Engineering, Himgiri Zee University for his valuable guidance, timely suggestions and constant encouragement during the project.

REFERENCES

[1] Ambuja technical literature series 98, June 2004.
[2] Bartos J. M., "Measurement of Key Properties of Fresh Self-compacting Concrete", CEN/PNR Workshop, Paris (2000).
[3] D'Ambrosia M, Lange D, Brinks A (2005) "Restrained shrinkage and creep of selfconsolidating concrete". In: Shah S (ed.) SCC 2005: 4th international RILEM symposium on self-comp pacting concrete, Chicago, November 2005.
[4] EN206-1: 2000 - Concrete Part 1 – "Specification, performance, production and conformity"
[5] Eurocode 2 – European Standard prEN 1992-1: "Design of concrete struc-tures. Part 1: General rules. 2 draft, (January 2001).
[6] Fujiwara H, "Fundamental Study on the SelfCompacting Property of High- Fluidity Concrete", Proceeding of the Japan Concrete Institute, Vol. 14, No.1, pp. 27-32, June 1992, pp. 27-32.
[7] Gainster R. and Gibbs J., (2001) "Self compacting concrete part 1. The material and its property". JouranlConcrete, July/August 2001.
[8] Hayakawa M, et. al. "Development & application of super workable concrete", RILEM International Workshop on Special Concretes: Workability and Mixing, Paisley, 1993.
[9] Kodama Y; "Current condition of selfcompacting concrete", Cement Shimbun, No. 2304, Dec 1997.
[10] https://www.sciencedirect.com/topics/materials-science/self-compacting-concrete#:~:text=Self%2Dcompacting%20concrete%20is%20a,in%20Japan%20in%20the%201980s.
[11] https://theconstructor.org/concrete/self-compacting-concrete-properties-tests/7683/
[12] https://en.wikipedia.org/wiki/Self-consolidating_concrete



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY