Int. J. Integr. Stud. 2026; 2(7): 41-46

ISSN: 3049-3277

International Journal of Integrative Studies (IJIS)

Journal homepage: www.ijis.co.in

RESEARCH ARTICLE

A Comprehensive Framework For Mix Proportioning of IS Method for HSC

[1*] **Darshana Sorte,** [2] **Dr. Priyanka Pandey**

[1]Research scholar, Associate Professor & HOD Department of Civil Engineering, Sangam University, Bhilwara Rajashthan, India
[2]Associate Professor & HOD Department of Civil Engineering, Sangam University, Bhilwara Rajashthan, India

ABSTRACT
In construction industry most widely use material is concrete in the world. It is made of cement, fine aggregate, coarse aggregate, and water. But high-strength concrete is the concrete having high compressive strength, high density, and very low permeability. High-strength concrete is made by replacing cement with mineral admixtures like silica fume, fly ash, etc. To prepare high-strength concrete several changes have to be made like water content, replacement of cement by admixture, and addition of superplasticizer.

Keywords: *Superplasticizer, Fly ash, Silica fume, High Strength, admixture.*

INTRODUCTION
Concrete in construction is now essential. But conventional concrete will not be effective in high chemical conditions. Therefore, some properties of concrete have to improve and made super concrete. High-strength concrete is concrete where compressive strength is increased by using high-quality material and the design of mix. To produce High strength crushed rock aggregate should be used. The size of this aggregate should be 10 mm to 12.5 mm and this aggregate should not be too angular and elongated. The reason behind using small-size aggregates is that the bond strength between small aggregates is greater than the larger aggregate.

One more parameter has to be checked while preparing high-strength concrete and that is water cement ratio. Because this parameter is sensitive and inversely proportional to the compressive strength of concrete.

[1]Research scholar, Associate Professor & HOD Department of Civil Engineering, Sangam University, Bhilwara Rajashthan, India

Email-id:

Corresponding Author: Darshana Sorte
Research scholar, Associate Professor & HOD Department of Civil Engineering, Sangam University, Bhilwara Rajashthan, India
DOI: https://doi.org/10.63856/ijis/v2i7/06

How to cite this article: Sorte, D., (2026). A Comprehensive Framework for Mix Proportioning of is Method for Hsc. *International Journal of Integrative Studies*, 2(7), 41-46.

Source of support: Nil

Conflict of interest: None.
Received: 25//062026 **Revised:** 30/06/2026 **Accepted:** 15/07/2026
Published: 28/07/2026

Simultaneously water-cement ratio is directly proportional to the workability. That means if the water-cement ratio increases it will increase workability but decrease strength and if the water-cement ratio is decrease it will decrease workability but increase strength. So, the low water-cement ratio should be considered during mix design. Due to the low water-cement ratio and the use of other cementitious materials, it will be mandatory to use a superplasticizer.

Polycarboxylate ether-based superplasticizer helps in water reduction in concrete by 30%. But the dosage of superplasticizer should be calculated by making multiple trials.

2. Literature Review

2.1. A R Hariharan, A S Santhi, and G Mohan Ganesh have performed multiple combinations such as C, C+FA, C+SF, and C+FA+SF. And they observed that concrete with a combination of fly ash and silica fume gives high compressive strength than others. And also suggest the preferable amount of silica fume as 6%. Silica fume is responsible for early strength in concrete whereas fly ash contributes to long-term effects on the compressive strength of concrete.

2.2 Lakhbir Singh and Arjun Kumar studied the partial replacement of cement with silica fume to increase the compressive strength of concrete. The test was performed by adding 5%, 10%, and 15 % silica fume during the preparation of concrete and they observed that 5-10% content of silica fume is effective to increase its compressive strength.

2.3 Chaitanya Raj, Divyanshi Tyagi, and Gaurav Budhani studied that, the different sizes of aggregate will decrease the number of voids in the concrete mix and ultimately increase the density of concrete. They use 40% aggregate of sizes range 4.75mm to 10mm and 60% aggregate of sizes range 10mm to 20mm. And coarser sand zone 2 is suggested to fill the remaining voids. They also observed that the accelerated curing method gives early high compressive strength in concrete.

2.4 Prashant M. Dhamanage and Mysore V. Nagendra observed that a low water-cement ratio increases the compressive strength of concrete but affects the workability of concrete. To maintain the workability without affecting the water-cement ratio polycarboxylate ether-based superplasticizer has been used. They also observed that workability was also affected by the fly ash and silica fume. Due to this 10-20% replacement of cementitious materials is suggested.

2.5 J. J. Brooks and others two observed that, the general effect of SF, MK, FA and GGBS is to retard the setting times of high-strength concrete. The influence of increasing the levels of SF, FA and GGBS is to provide greater retardation in the setting times of high-strength concrete. The effect of GGBS at replacement levels of 40% and higher causes excessive retardation in setting times as the initial and final setting times were greater than 11 and 17 h, respectively. For high-strength concrete containing MK, there was a progressive increase in the retarding effect up to 10% replacement levels. However, at a higher replacement level of 15%, the retarding effect appears to reduce.

2.6 M. Mazloom and others two observed that, The percentages of silica fume that replaced cement in this research were: 0%, 6%, 10% and 15%. Apart from measuring the workability of fresh concrete, the mechanical properties evaluated were: development of compressive strength; secant modulus of elasticity; strain due to creep, shrinkage, swelling and moisture movement. The results of this research indicate that as the proportion of silica fume increased, the workability of concrete decreased but its short-term mechanical properties such as 28-day compressive strength and secant modulus improved. The compressive strength of concrete mixtures containing silica fume did not increase after the age of 90 days. Silica fume did not affect the total shrinkage; however, as the proportion of silica fume increased, the autogenous shrinkage of high-strength concrete increased and its drying shrinkage decreased. The total creep and basic creep were similar, and decreased as the level of silica fume replacement increased.

3. Materials

To increase the compressive strength of concrete high-quality material should be used.

High-strength concrete was made of cement, sand, fly ash, silica fume, aggregate, water, and superplasticizer.

i. Cement: Ordinary Portland cement (OPC), 53 grades conforming to IS: 12269-1987.

ii. Sand: Locally available sand confined to zone II of IS: 383-1970.

iii. Fly ash: It is a byproduct resulting from the burning of anthracite and bituminous coals. So use of fly ash leads to cost and energy savings. It has pozzolanic properties; hence it is used as a replacement of cement. It increases the late compressive strength of the concrete.

iv. Silica fume: Silica fume is a very fine, amorphous, and reactive mineral admixture. It reacts readily with the calcium hydroxide, which is produced during Portland cement hydration. When cement reacts with water byproduct calcium hydroxide is formed, this reaction is called hydration. This byproduct further reacts with silica which gives calcium silicate hydrate which is responsible to increase bond strength in concrete.

v. Aggregate: In this research work, we used a crushed stone aggregate of 10-20mm size by 60% and 4.75-10mm size by 40%.

vi. Superplasticizer: Sika ViscoCrete 3006 ES was used as a high range water reducing admixture (HRWRA) by replacement of water by 30% or above.

vii. Water: Portable water was used for preparing high strength concrete.

4. Methodology

- Collection of Materials like Ordinary Portland Cement, Coarse aggregate, Fine aggregate, Fly ash, silica fume, and Admixture.
- Laboratory test on basic ingredients of concrete like Cement, Coarse aggregate, and Fine aggregate.
- Finalize Mix design for concrete.
- Partial replacement of cement with Fly ash, Silica fume in various percentages.
- Check the workability of concrete.
- Casting of cube specimen.
- Determine the Compressive strength of concrete.

5. TRIAL MIX

5.1 Trial mix Proportion

Table 1. TRIAL MIX

Trial Mix No.	Water To Binder Ratio	Cementitious content: Fine Aggregate: Coarse Aggregate	Admixture (% of cementitious material)
1	0.31	1:1.21:2.17	1%
2	0.31	1:1.21:2.17	1%
3	0.33	1:1.22:2.18	1.5%
4	0.33	1:1.22:2.18	1.5%

5.2 Mineral admixture content

Table 2. Mineral admixture Content

Trial No.	Fly Ash	Silica Fume
1	10%	5%
2	15%	5%
3	15%	10%
4	20%	10%

6. RESULTS

6.1 Trial 1 (Compressive Test Result)

The 7-Days And 28-Days Compressive Test Result of Trial-1 are given in the following table 3.

Table 3. Trial 1 (Compressive Test Result)

Age In Days		**7**	**28**
No Of Cubes		**3**	**3**
Compressive Strength in MPa	**Cube 1**	**45.39**	**72.03**
	Cube 2	**47.11**	**74.88**
	Cube 3	**42.03**	**72.95**
Average Compressive Strength in MPa		**44.84**	**73.29**

6.2 Trial 2 (Compressive Test Result)

The 7-Days And 28-Days Compressive Test Result of Trial-2 are given in the following table 3.

Table 4. Trial 2 (Compressive Test Result)

Age In Days	**7**	**28**
No Of Cubes	**3**	**3**

Compressive Strength In MPa	**Cube 1**	**46.30**	**74.09**
	Cube 2	**39.41**	**76.08**
	Cube 3	**43.04**	**79.25**
Average Compressive Strength in MPa		**42.92**	**76.47**

6.3 Trial 3 (Compressive Test Result)

The 7-Days And 28-Days Compressive Test Result of Trial-1 are Given in the following table.

Table 5. Trial 3 (Compressive Test Result)

Age In Days		**7**	**28**
No Of Cubes		**3**	**3**
Compressive Strength in MPa	**Cube 1**	**53.32**	**77.54**
	Cube 2	**42.04**	**71.65**
	Cube 3	**51.67**	**76.08**
Average Compressive Strength in MPa		**49.01**	**75.09**

This Trial 3 is failed, Because the difference between 3 cubes of 7 days is exceed 10MPa.

6.4 Trial 4 (Compressive Test Result)

The 7-Days And 28-Days Compressive Test Result of Trial-4 are given in the following table.

Table 6. Trial 4 (Compressive Test Result)

Age In Days		**7**	**28**
No Of Cubes		**3**	**3**
Compressive Strength in MPa	**Cube 1**	**49.21**	**74.20**
	Cube 2	**52.03**	**81.55**
	Cube 3	**51.08**	**79.43**
Average Compressive Strength in MPa		**50.77**	**78.39**

6.6 Variations between trial 1 to trial 4 are as follows:

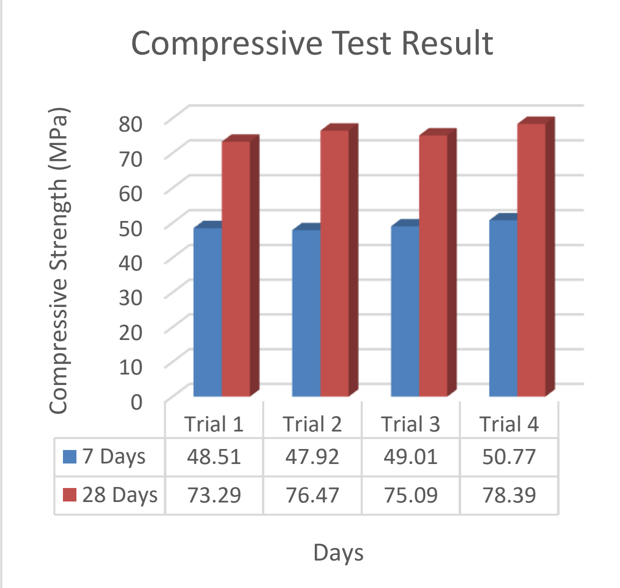

Fig. 1. Variations Between Trial 1, 2, 3 and 4 with respect to Compressive Strength.

7. Conclusions

1) From this research, the optimum percentage of replacement of cement with mineral admixtures is 15%-30%.
2) Water-cement ratio for preparing high-strength concrete should be less than 0.34.
3) Due to the low water-cement ratio, the use of superplasticizers becomes mandatory to increase workability.
4) The difference between 3 cubes of compressive strength should not be exceed 10MPa.
5) Addition of Fly ash increases workability whereas silica fume decreases workability.
6) Use of fly ash and silica fume make this concrete green concrete.
7) Proper dosage of superplasticizer should be used.

7. References

1. Study on Strength Development of High Strength Concrete Containing Fly Ash and Silica fume" A R Hariharan, A S Santhi, G Mohan Ganesh. International Journal of Engineering and Technology (IJEST), ISSN :0975-5462, Vol. 3 No. 4 April 2011
2. STUDY OF PARTIAL REPLACEMENT OF CEMENT BY SILICA FUME" Lakhbir Singh, Arjun Kumar, Anil Singh International Journal of Advanced Research (2016), Volume 4, Issue 7, 104-120, ISSN 2320-5407
3. Analysis on Mix Design of High Strength Concrete (M90)" Chaitanya Raj, Divyanshi Tyagi, Gaurav Budhani International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, p-ISSN: 2395-0072, Volume: 05 Issue: 06, June-2018
4. HIGH STRENGTH CONCRETE: A REVIEW" Prashant m. Dhamanage, Mysore V. Nagendra International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, p-ISSN: 2395-0072, Volume: 07 Issue: 08, Aug 2020
5. Effect of admixtures on the setting times of high-strength concrete" J.J. Brooks, M.A. Megat Johari, M. Mazloom Cement & Concrete Composites 22 (2000) 293-301.
6. [6] "Effect of silica fume on mechanical properties of high-strength concrete" M. Mazloom, A.A. Ramezanianpour, J.J. Brooks Cement & Concrete Composites 26 (2004) 347–357
7. IS 456: 2000 code of practice for Plain and Reinforced Concrete (Fourth Revision).
8. IS 10262: 2019 Guidelines for Concrete Mix Proportioning (Second Revision).
9. L. Zhang, Z. Zhang, and W. Zhao, "Compatibility between polycarboxylate superplasticizers and supplementary cementitious materials," *Construction and Building Materials*, vol. 259, 2020.
10. American Concrete Institute (ACI), *ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete*, ACI Committee 211, Farmington Hills, MI, USA, 1991.
11. R. N. Swamy and B. Vijaya Rangan, "Durability of concrete," *ACI SP-100*, Detroit, MI, USA, 1987.
12. J. Newman and B. S. Choo, *Advanced Concrete Technology: Mix Design and Construction*. Oxford, UK: Elsevier, 2003.
13. American Concrete Institute (ACI), *ACI 211.4R: Guide for Selecting Proportions for High-Strength Concrete Using Portland Cement and Other Cementitious Materials*, ACI Committee 211, Farmington Hills, MI, USA, 2008.
14. E. Fuller and S. E. Thompson, "The laws of proportioning concrete," *Transactions of the American Society of Civil Engineers*, vol. 59, no. 2, pp. 67–143, 1907.

15. C. L. Andersen and H. H. Andersen, "Particle packing and concrete mix design," *Powder Technology*, vol. 130, no. 1–3, pp. 266–269, 2003.
16. European Federation of Concrete (fib), *fib Model Code for Concrete Structures 2010*. Ernst & Sohn, Berlin, 2013.
17. J. Stark and B. Wicht, *Cements and Their Reactions*. London, UK: CRC Press, 2000.
18. F. Golafshani, H. Rahai, and M. Safi, "Predicting the compressive strength of high-performance concrete using artificial neural networks," *Computers & Concrete*, vol. 7, no. 3, pp. 279–293, 2010.
19. T. C. Powers, "Structure and physical properties of hardened Portland cement paste," *Journal of the American Ceramic Society*, vol. 41, no. 1, pp. 1–6, 1958.
20. S. Mindess, "The significance of materials science to concrete technology," *Materials Science Forum*, vol. 79–82, pp. 1–32, 1991.
21. S. H. Aïtcin and R. Pleau, *High-Performance Concrete and Applications*. London, UK: CRC Press, 1998.
22. P. K. Mehta, "Reducing the environmental impact of concrete," *Concrete International*, vol. 23, no. 10, pp. 61–66, 2001.