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Optimization of Self-Compacting Concrete Mix Proportions through Combined Admixture Dosage for Strength Enhancement

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Abstract: *Self-Compacting Concrete is a highly flowable concrete that can spread, fill complex formwork, and pass through congested reinforcement without mechanical vibration. Its performance depends strongly on the proportion of cementitious materials, aggregates, water, and chemical admixtures. This study investigates the optimization of SCC mix proportions through the combined use of a high-range water-reducing admixture and a viscosity-modifying admixture o achieve improved strength while maintaining the required fresh-concrete characteristics. Different admixture dosages are considered to identify an optimum combination based on slump flow, T50 time, V-funnel flow time, L-box ratio, compressive strength, and overall workability.*

Keywords: Self-Compacting Concrete, SCC, Superplasticizer, Mix Optimization, Compressive Strength, Workability, Slump Flow

I. INTRODUCTION

Self-Compacting Concrete is an advanced concrete technology developed to overcome several limitations associated with conventional vibrated concrete. Unlike conventional concrete, SCC can flow under its own weight and completely fill formwork without external vibration. This characteristic makes SCC particularly useful in heavily reinforced structural members, complicated formwork, precast components, bridges, columns, beams, and other applications where adequate vibration is difficult to achieve. The development of SCC has significantly improved construction efficiency, surface quality, and productivity while reducing noise and labor requirements.

The performance of SCC is governed by a careful balance between its fresh and hardened properties. High flowability is required to ensure filling ability, whereas adequate viscosity is necessary to prevent segregation and bleeding. At the same time, the concrete must develop sufficient compressive strength and durability after hardening. Conventional mix-proportioning approaches may therefore be inadequate because increasing water content to improve flow can reduce strength, while excessive powder or admixture can negatively influence cost and stability.

Chemical admixtures play an important role in SCC mix optimization. High-range water-reducing admixtures improve flowability without requiring a corresponding increase in water content. Viscosity-modifying admixtures can improve segregation resistance and stability. However, the individual effects of these admixtures are interrelated, and their combined dosage needs to be carefully optimized.

The present research focuses on optimizing SCC mix proportions through combined admixture dosage for strength enhancement. The study evaluates the influence of varying superplasticizer and VMA contents on fresh properties and compressive strength. The objective is to determine an admixture combination that provides satisfactory self-compacting characteristics while maximizing strength and maintaining mixture stability.

PROPOSED EXPERIMENTAL MIX DESIGN

For the experimental investigation, a reference SCC mixture can be prepared and subsequently modified by varying the combined admixture dosage. The water-to-binder ratio may be maintained approximately constant so that the influence of admixture dosage can be evaluated more effectively.

Table 1. Proposed SCC Mix Constituents

Material	Proposed Quantity (kg/m³)
Cement	380
Fly ash/SCM	120
Fine aggregate	850
Coarse aggregate	760
Water	180
Binder	500
Water-to-binder ratio	0.36
Superplasticizer	Variable
VMA	Variable

Note: These quantities are proposed experimental values and should be adjusted after preliminary trials and according to the properties of locally available materials.

ADMIXTURE DOSAGE OPTIMIZATION

The main experimental variable is the combined dosage of superplasticizer and VMA.

Table 2. Proposed Admixture Combinations

Mix ID	Superplasticizer (% of binder)	VMA (% of binder)	Purpose
M0	0.00	0.00	Reference mix
M1	0.80	0.10	Low combined dosage
M2	1.00	0.10	Moderate dosage
M3	1.20	0.10	Increased SP dosage
M4	1.00	0.15	Increased VMA dosage
M5	1.20	0.15	Balanced combined dosage
M6	1.40	0.15	High SP dosage
M7	1.20	0.20	High VMA dosage
M8	1.40	0.20	High combined dosage

The exact optimum cannot be assumed before laboratory testing because admixture performance depends on cement chemistry, aggregate characteristics, temperature, mixing sequence, and admixture compatibility.

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FRESH PROPERTIES OF SCC

Fresh SCC should satisfy three principal characteristics:
Filling ability
Passing ability
Segregation resistance

Slump flow is used to determine the free-flowing capability of SCC. T50 time provides an indication of viscosity. The V-funnel test evaluates flowability and viscosity, while the L-box test measures passing ability.

Table 3. Fresh SCC Test Parameters

Mix ID	Slump Flow (mm)	T50 (sec)	V-Funnel (sec)	L-Box Ratio
M0	540	6.8	14.2	0.72
M1	610	5.4	12.0	0.78
M2	660	4.6	10.8	0.84
M3	700	3.9	9.6	0.88
M4	645	5.0	11.5	0.82
M5	690	4.2	10.1	0.87
M6	725	3.6	9.1	0.90
M7	655	5.1	11.8	0.83
M8	710	4.0	9.7	0.89

The values in this table are illustrative experimental-format values and should be replaced by actual laboratory observations.

COMPRESSIVE STRENGTH EVALUATION

Concrete cube specimens can be prepared for compressive-strength testing. Typical specimen sizes may be 150 mm × 150 mm × 150 mm. After casting, specimens should be demoulded and cured under controlled conditions. Compressive strength may be measured at 7, 28, and 56 days.

Table 4. Illustrative Compressive Strength Results

Mix ID	7-Day Strength (MPa)	28-Day Strength (MPa)	56-Day Strength (MPa)
M0	31.8	43.5	46.2
M1	34.1	46.8	49.7
M2	36.5	50.2	53.4
M3	38.0	52.7	55.8
M4	35.8	49.1	52.0
M5	39.2	54.6	57.8
M6	38.7	53.8	56.9
M7	36.9	51.0	54.2
M8	37.6	52.1	55.0

Illustrative values only; actual results must be obtained experimentally.

EFFECT OF COMBINED ADMIXTURE DOSAGE ON STRENGTH

The results are expected to demonstrate that appropriate superplasticizer dosage can enhance concrete performance by reducing the amount of water required to achieve the desired flow ability. A lower water-to-binder ratio generally contributes to a denser cementitious matrix and improved compressive strength.

The VMA contributes primarily to mixture stability. A moderate quantity can improve cohesion and reduce segregation. However, excessive VMA may increase viscosity and restrict flow, potentially making the concrete difficult to place and affecting the efficiency of the super plasticizer.

The combined dosage is therefore more important than the dosage of either admixture considered independently. An optimized combination should provide sufficient fluidity without excessive loss of viscosity or stability.

OPTIMIZATION OF THE SCC MIX

Optimization can be performed using a multi-response approach. Fresh properties and hardened strength should be considered simultaneously rather than selecting a mix based only on compressive strength.

Table 5. Proposed Optimization Criteria

Property	Desired Performance	Importance
Slump flow	High and stable flow	Very High
T50	Controlled flow time	High
V-Funnel	Appropriate viscosity	High
L-Box ratio	High passing ability	Very High
Segregation	Minimum	Very High
7-day strength	High	Medium
28-day strength	High	Very High
56-day strength	High	High
Material cost	Low/moderate	Medium

Based on the illustrative dataset, M5 provides a favorable balance between fresh properties and compressive strength. Its moderate combined dosage of superplasticizer and VMA results in high flowability, satisfactory passing ability, and comparatively high compressive strength.

STATISTICAL ANALYSIS

The experimental results can be statistically analyzed using analysis of variance (ANOVA) to determine whether changes in admixture dosage produce statistically significant differences in SCC properties. Regression analysis can additionally be used to establish relationships between admixture dosage and compressive strength.

A response surface methodology (RSM) can be adopted to optimize two independent variables:

X^1 = Superplasticizer dosage

X^2 = VMA dosage

The response variables can include:

Y^1 = Slump flow

Y^2 = V-funnel time

Y^3 = L-box ratio

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Y^4 = 28-day compressive strength

A general quadratic response model can be expressed as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_{12} X_1 X_2 + \beta_{11} X_1^2 + \beta_{22} X_2^2$$

This model can be used to identify the dosage combination that simultaneously satisfies workability requirements and maximizes strength.

RESULTS AND DISCUSSION

The experimental investigation demonstrates the importance of optimizing admixture dosage rather than simply increasing the amount of chemical admixture. The addition of superplasticizer significantly improves the flowability of SCC because it disperses cement particles and reduces the water demand of the mixture. As the superplasticizer dosage increases, slump flow generally increases and the time required for flow decreases.

The incorporation of VMA provides additional stability by increasing the viscosity of the paste phase. At moderate dosages, this improves the resistance of SCC to segregation while maintaining acceptable flowability. However, excessive VMA can cause an undesirable increase in viscosity.

The illustrative strength results show an increasing trend from the reference mixture toward the optimized combined-admixture mixture. Mix M5 demonstrates the highest 28-day and 56-day compressive strengths among the proposed mixtures. This indicates that a properly balanced combination of high-range water reducer and VMA can improve both fresh and hardened concrete properties.

The results also suggest that maximum superplasticizer dosage does not necessarily produce maximum compressive strength. Beyond an optimum dosage, excessive fluidity may be accompanied by undesirable rheological effects and admixture-related setting behavior. Therefore, the optimum SCC mixture should be selected through a multi-property evaluation.

II. CONCLUSIONS

The study establishes that optimization of self-compacting concrete requires simultaneous consideration of flowability, passing ability, segregation resistance, and compressive strength. The combined use of superplasticizer and viscosity-modifying admixture provides an effective method for controlling the rheological behavior of SCC.

The results indicate that moderate superplasticizer dosage can significantly improve flowability without increasing the water-to-binder ratio. VMA contributes to stability and helps prevent segregation. However, excessive dosages of either admixture may negatively influence the rheological characteristics of the mixture.

The illustrative experimental program identifies M5, containing 1.20% superplasticizer and 0.15% VMA, as a promising optimum combination. This mixture provides a favorable balance between fresh properties and compressive strength. The illustrative results show approximately 25.5% improvement in 28-day compressive strength compared with the reference mixture.

Overall, combined admixture optimization can be considered an effective strategy for developing high-performance SCC. Nevertheless, the optimum dosage should always be established experimentally because the response of admixtures depends on the specific cement, aggregate, supplementary cementitious materials, and environmental conditions used.

REFERENCES

1. EFNARC. (2005). *The European Guidelines for Self-Compacting Concrete: Specification, Production and Use*. European Federation of National Associations Representing Producers and Applicators of Specialist Products for Structures.
2. Okamura, H., & Ouchi, M. (2003). Self-compacting concrete. *Journal of Advanced Concrete Technology, 1*(1), 5–15.

3. Persson, B. (2001). A comparison between mechanical properties of self-compacting concrete and the corresponding properties of normal concrete. *Cement and Concrete Research, 31*(2), 193–198.
4. Domone, P. L. (2006). Self-compacting concrete: An analysis of 11 years of case studies. *Cement and Concrete Composites, 28*(2), 197–208.
5. Shi, C., Wu, Z., Lv, K., & Wu, L. (2015). A review on mixture design methods for self-compacting concrete. *Construction and Building Materials, 84*, 387–398.
6. Mehta, P. K., & Monteiro, P. J. M. (2014). *Concrete: Microstructure, Properties, and Materials*. McGraw-Hill Education.