Research Paper

EXPERIMENTAL STUDY ON THE DEVELOPMENT OF SELF COMPACTING MORTAR FOR CASTING FERROCEMENT ELEMENTS

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ABSTRACT

The development of the self compacting mortar (SCM), using two types of water reducer agent and two types of super plasticizer has been conducted to cast the ferrocement elements. The optimum dosages of the admixtures were studied using marsh cone test. The flow characteristics of the mortar were examined by performing mini slump test. The compressive strength at 3rd ,7th, 14th and 28th day shows an appreciable improvement in the strength. Optimum mortar has been decided for casting the ferrocement section based on the paste and solid state behavior of the self compacting mortar.

KEYWORDS Self compacting mortar, marsh cone, mini slump test, optimum dosage.

INTRODUCTION

Ferrocement is thin wall cement - composite material consisting of cement mortar and continuous layers of small thin wires or expanded metals as reinforced over the length of the member. (1) The versatile material, Ferrocement has high resistance to roughness, ductility, durability, strength, crack resistance that is greater than the normal reinforced or other concrete construction, this is due to the uniform distribution and high specific surface area of the reinforcement.(2,3) The selection of constituent materials like cement, aggregate and placing of mortars should be carefully executed. The yield strength of the wire mesh is studied by conducting the direct tensile test on the wire mesh along the longitudinal and lateral directions. The mortar performance depends on the chemical composition of cement, the nature of the aggregate, water-cement ratio and admixtures used. Since the Ferrocement is a thin member and the cover to the reinforcement is very small, the durability can be improved only by providing a rich mortar. The use of chemical and mineral admixtures in the mortar helps to reduce the water cement ratio, there by a low permeable mortar can be achieved. [4] The recommendations of various concrete codes around the world specify the use of limited water for getting mortars of structural grade. The combined use of mineral admixtures and super plasticizers resulted in synergistic effects and gives a range of modifications enabling durable mortars to be used in a variety of conditions [5,6,7].

Development of high workable OPC mortar by partial replacement of cement by slag (to a maximum of 50%) and adding the superplasticizer about 0.5% of total binder by weight but the increase in strength is marginal with further increase in superplasticizer beyond 0.2%.(8) To ensure adequate workability to the mortar, researchers have adopted the method of pouring by enhancing high water cement to the mortar. (9,10) resulting the increase in

Porosity of the mortar mix thereby increasing the water absorption and decrease in compressive strength. The super plasticizers are used to maintain workability and to reduce water cement ratio and thereby reducing the porosity of mortar. The experimental results from the author states that the minimum flow required by casting thin ferrocement elements (6, 8, 10 and 12mm thick, 400mm high and 200mm wide) by the method of pouring [11] by applying flow table test as per the specifications of ASTM C 230-90. This study is aimed towards the optimum dosage of admixtures, self compacting mortar (SCM) & compressive strength at 3,7,14 and 28 days.

METHODOLOGY

Cement: Cement is the most important ingredient used. One of the important criteria for the selection of cement is its ability to produce improved microstructure. Hence selection of proper grade and quality of cement is important for obtaining rich mix. Portland Pozzalona Cement (PPC) as per the IS: 8112-1989 is used in this study. The grade of PPC can be taken as 33 grade as per the recommendation of IS 456: 2000.

Fine aggregate: For the present investigation, locally available river sand was conforming to IS: 383 – 1970, Passing through 4.75mm and retained on 300 micron, to achieve minimum void ratio. The fineness modulus of the fine aggregate is 2.51 and specific gravity of fine aggregate is 2.56.

Admixture

Admixtures are the chemical, which is used to alter or improve one or more properties of cement mortar or concrete. In this Present scenario, Engineers go for the prefabricated structural elements due to the constraints in the time of construction, site space availability & insufficient workmanship etc., this leads to the development of the prefabricated structures and self compacting mortar and concretes. Compare to the manual concreting self compacting concrete or mortar give more uniformity in the mix and less porosity, high density concretes. A new class of water reducing admixtures has emerged during last two decades, known as “super plasticizer”. There are the high range water reducers.

In the ferrocement construction, many prefabricated elements are used in the low cost housing and in as participating formwork for the framed structures. To cast the ferrocement elements mortar mix of 1:2 to 1:3 is used with water cement ratio ranging from 0.35 to 0.55 depends on the type of element ot be cast. As it is stated, ferrocement is a very thin member from 20mm to 35mm thickness and it has continuous wires as reinforcement. The cover generally given for ferrocement will be 2mm -5mm only. If the mortar has high porosity the ferrocement elements are liable to get corrosion and the life of the element gets reduced.

Table 1. Properties of Admixtures

Admixture type/ specifications	CONPLAST SP430	SIKAMANT FF(T)	CONPLAST P211	CONPLAST SP337
Type	Super plasticizing admixture	Super plasticizing admixture	Lingo sulphonates	Organic polymers
Specific gravity	1.220 to 1.225 at 300C	Around 1.25	1.18 - 1.20 @250C	1.18 to 1.20 at 270C
Air entrainment	Approx. 1% additional air is entrained	-	Typically less than 2.0%.	Approximately 1% additional air is entrained
Compatibility	Can be used with all types of cements except high alumina cement.	compatible with all types of cement excluding slag cement	compatible with all types of cement	compatible with all types of cement

Water

For this investigation ordinary portable tap water, this is conforming to the requirement of BIS: 456 – 2000 is found to Using the two types of water reducer and the super plasticizer self compacting mortar has been developed. Optimum dosage of the SCM mortar is arrived using the marsh cone test. Time taken for the mortar to flow is noted by increasing the percentage dosage of the admixture. Optimum dosage is calculated from time Vs percentage dosage of admixture curve for all type of admixtures. Flow character of the fresh mortar is studied for the w/c ratio of 0.4, 0.45 & 0.5 using the mini slump test.

EXPERIMENTAL RESULTS AND DISCUSSION

Optimum dosage of SCM

The optimum dosage of superplasticizers to be added in the weight of cement is found by Marsh cone test. The term Marsh Funnel is sometimes used as Marsh Cone, particularly within the concrete industry. The Marsh funnel is fitted with a tube of 10 mm internal diameter and of length 60 mm, which is often referred to as a Marsh cone. Thus a Marsh cone is a flow cone with an aspect ratio of 2:1 and a working volume of at least a litre.

A Marsh funnel is a Marsh cone with a particular orifice and a working volume of 1.5 litres. Some manufacturers supply devices which they call Marsh cones, with removable tubes with size ranges from 5 to 15 mm. These can be used for quality control by selecting a tube which gives a convenient time, say 30 to 60 seconds. The results for the various admixtures were shown in Fig 1.

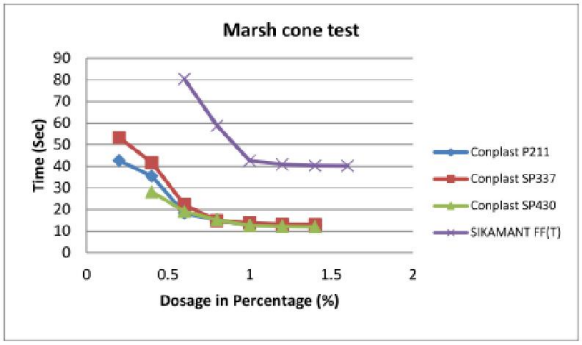

Fig 1. Optimum Dosage of Super plasticizer using Marsh cone test

Flow character of SCM

The slump flow test for SCM is described by EFNARC 2002. In this test, the truncated cone mould is placed on a smooth plate, filled with mortar, and lifted upwards. The subsequent diameter of the mortar is measured in two perpendicular dimensions and the average is reported as the final diameter. Segregation and bleeding were visually checked during the slump flow test and was not observed. The results were shown in Fig 2.

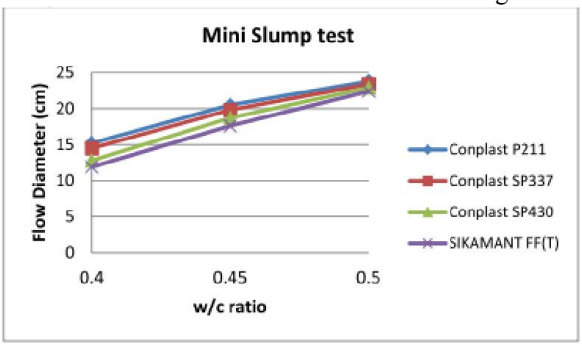

Fig 2. Flow Characteristics of SCM using Marsh cone test

Compressive Strength of SCM

The ranges of mix proportion recommended for common ferrocement application are between 1:2, 1:2.5 and 1:3 (cement: sand) by weight, but not greater than 1:3 and water cement ratio by weight, 0.35 to 0.5. The higher the sand content higher is the required water contents to maintain same workability. Fineness modulus of the sand, water cement ratio and sand-cement ratio should be determined from trial batches. In the present study the proportion of cement –sand mortar used for the ferrocement channels is 1:2 (cement: sand), the water-cement ratio for mortar taken as 0.50 and a superplasticizers is used as admixture to enable Self Compacting Mortar (SCM). This is used to evaluate compressive strength and flow properties of Self Compacting Mortar (SCM).

The compressive strength is a measure of the concrete's ability to resist loads which tend to crush it Fig 3. The cubes of sizes 70.6 mm x 70.6 mm x 70.6 mm were casted and tested as per IS 516-1959 for 7 days and 28 days results are given in Table 2 and Fig 4.

Fig 3. Compressive Strength Test on Mortar Cube

Table 2. Compressive Strength Test Results for Mortar Cube

Type of Admixture	Average Compressive strength in N/mm^2			
	@ 3 days	@ 7 days	@ 14 days	@ 28 days
Conplast P211	3.65	5.57	8.64	15.22
Conplast SP337	10.55	13.54	18.33	28.30
Conplast SP430	10.14	12.04	14.49	21.67
SIKAMANT FF(T)	10.42	14.06	17.79	25.3

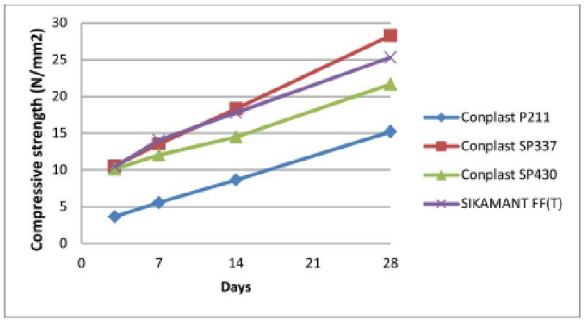

Fig 4. Compressive Strength of Mortar Cube

CONCLUSION

- Optimum dosage for Conplast SP430 and SIKAMANT FF (T) is found as 1.2% using Marsh cone and water content for SCM using Mini Slump is found as 0.5.
- Compressive Strength of SCM using SIKAMANT FF (T) is increased by 2.76% in 3days, 16.78% in 7 days, 22.77% in 14 days and 17.62% in 28 days when compared to Conplast SP430.
- Optimum dosage for Conplast SP337 and P211 is found as 1.2% using Marsh cone and water content for SCM using Mini Slump is found as 0.5.
- Compressive Strength of SCM using Conplast SP337 is increased by 65% in 3days, 58.8% in 7 days, 52.6% in 14 days and 46.02% in 28 days when compared to Conplast P211.
- Water Absorption of SCM using Conplast SP337 is less than Conplast P211.

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