International Journal of Scientific Engineering and Research (IJSER)
www.ijser.in
ISSN (Online): 2347-3878, Impact Factor (2014): 3.05

Effect of Starch Admixtures on Fresh and Hardened Properties of Concrete

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Abstract: ***Admixtures are used to alter the properties of concrete. Admixtures are substances introduced into a batch of concrete, during or immediately before its mixing. There are numerous benefits available through the use of admixtures such as: improved quality, colouring, greater concrete strength, increased flow for the same water-cement ratio, enhanced frost and sulphate resistance, improved fire resistance, cracking control, acceleration or retardation in setting time, lower density and improved workability. The specific effects of an admixture generally vary with the type of cement, mix proportion and dosage. Starch can be used in concrete as admixture. Starch changes the setting time of concrete. In this particular study, starches used aretapioca and maize.The setting time of concrete is tested using vicat apparatus. The workability of concrete is tested using slump test. The starch is added for testing with different percentages of cement. Thesetting timeand workability of concrete/cement increases with the addition of starch admixtures.Compressive strength, split tensile strength and flexural strength of concrete increases gradually up to an addition of 1.5% of maize and 2% of tapioca. Further increase in the addition of starch admixtures reduces the compressive strength, split tensile strength and flexural strength.The starch admixtures such as maize and tapioca can replace the use of chemical admixtures. It also reduces the additional cost of using chemical admixtuers.***

Keywords: Admixtures; Setting time; Workability; Starches; Concrete

1. Introduction

Concrete is considered as a very strong and versatile mouldable construction material. Its composition is cement, fineaggregate and coarse aggregate mixed with water. The cement and water coats the fine and coarse aggregate in the form of a paste or gel. The cement, which is chemically reacted with water hardens and binds the whole mix together. The initial hardening reaction occurs within a few hours. To achieve full hardness and strength, the concrete takes some weeks. Concrete continues to harden and gain strength over many years. Substances added to concrete mixes to modify one or more properties of the concrete to make them suitable for some specific purposes are known as admixtures. Normally, admixtures are used to modify a single property. But some of the admixtures are able to modify more than one properties of the concrete or grout mix. An admixture for a special purpose can also be introduced in a mix.

Admixtures are classified into several categories according to the purposes of their use. Some common categories are accelerating admixtures,water reducing admixtures, retarding admixtures, air entraining admixtures etc. Admixtures can be classified by function as follows: air-entraining admixtures, accelerating admixtures, hydration-control, corrosion inhibitors, shrinkage reducers, retarding admixtures, water-reducing admixtures, colouringadmixtures, plasticizers, alkali-silica reactivity inhibitors, and miscellaneous admixturessuch as workability andbonding admixtures, foaming,grouting, dampproofing and permeability reducing admixtures, gas-forming, anti-washout and pumping admixtures. Chemical, mineral and starch admixtures are also used in concrete.

Admixtures are those ingredients added in concrete mixture immediately to alter the properties of concrete in addition to cement, water and aggregates.Starch is used for different purposes such as a thickener / stabilizer and gelling agent. It is used in the construction industry as gypsum board binder, asbestos, clay and limestone binder, fire-resistant wallboard, plywood / chipboard adhesive, cement block binder and paint filler.Starch can also be used as admixtures in concrete.Starches such as tapioca and maize increase the setting time and workability of concrete. The maize and tapioca are abundantly available. The cost of starch admixturesis lower than that of chemical and mineral admixtures.

The tapioca and maize are agricultural products. The use of them as a replacement for chemical admixtures in concrete is an eco- friendly concept. Use of tapioca and maize reduce the additional cost of using chemical admixtures.Starch admixtures such as tapioca and maize increase the setting time of concrete/cement.

1.1 Literature Review

1.2 A. A. Akindahunsi, et al. (2015)[1]analysed concrete cubes containing different percentages of the cassava and maize by weight of cement (0, 0.5, 1.0, 1.5 and 2.0 %). Crushed granite is used as coarse and fine aggregates. The maximum coarse aggregate size used is 22 mm. Starches used in this investigation generally delay the setting time of cement. It was an advantage foruse where a longer period of time is required for castingthe concrete. Cassava starch will lead to less slump and higher viscosity in concretes when compared to maize starch. The durability properties of the concrete were improved by the addition of cassava and maize starches.**Abalaka, A. E. (2011)**[2]studied the comparative effects of cassava starch and simple laboratory quality sugar on concrete. Simple white sugar was used at concentrations of 0 to 1% by weight of cement and wascured at 3, 7, 14 and 28 days using ordinary Portland cement. Cassava starch was used at the concentrations of 0 to 1% by weight of cement in concrete. Maximum compressive

strength recorded for cassava starch at 28 days occurred at 0.05% concentration with a slightly reduced initial setting time. The maximum compressive strength increase for sugar at 28 days occurred at 0.06% concentration with an increase in initial setting time. Within the range of cassava starch concentration presented in this work, it could serve as a good substitute for sugar as an admixture in concrete.**F. O. Okafor (2008)**[3] investigated the potentials of cassava flour as a set-retarding admixture in concrete. The properties tested include workability and setting time of the fresh concrete and compressive strength of the hardened concrete. Cassava flour delayed the setting time of cement up to 6 hours at dosage level not exceeding 3% by weight of cement.The observed increase in the relative compressive strength is of the order of 11% at 3% dosage level of the admixture. Enhanced workability, compaction and higher density are achieved by the use of cassava flour as admixture in concrete.On the basis of this investigation, it would appear that cassava flour perform satisfactorily as a set-retarding admixture in concrete.**Giridhar V., et al. (2013)**[4] focused on the effect of Sugar and Jaggery on strength properties of concrete. Experiments were carried out for evaluating the strength properties of concrete using Sugar and Jaggery as admixtures. The main function for usage of Sugar and Jaggery is to extend the initial setting time of concrete. Three different percentages of admixtures were chosen in the experimentation as 0, 0.05 and 0.1% by weight of cement. Workability and compressive strength were increased when the dosage of admixtures were increased. Segregation and bleeding was very less due to the usage of these admixtures.**J.J. Brooks, et al. (2000)**[5] studied the effect of fly ash, silica fume, metakaolin, and ground granulated blast furnace slag on the setting times of high-strength concrete had been investigated using the penetration resistance method. Whenpart of the cement is replaced by mineral admixtures, the setting times of the high-strength concrete is retarded. While the shrinkage-reducing admixture was found to have negligible effect on the setting times of normal strength concrete, a significant retarding effect is shown by it when used in combination with superplasticiser in high-strength concrete. The inclusion of granulated blast furnace slag at replacement levels of 40% and greater resulted in significant retardation in setting times. When replacement levels of the mineral admixtures were increased, it was found that there was a greater retardation in setting times. **Olekwu B. E., et al. (2014)**[6] focused on the use of cassava starch as an additive in burnt earth bricks. Cassava is available in most part of the country. Hence the possibility of using cassava starch as an additivefor producing burnt earth bricks is of great importance to enhance their physical property, such as compressive strength, water absorption and abrasion resistance. Cassava starch content of 0%, 4%, 6%, 10% and 12% were used in the mix. The result from the research showed that water absorption of burnt earth bricks was reduced considerably with the addition of cassava starch in the mix. At an optimum amount of 6% of cassava starch content, satisfactory performance of the earth burnt bricks was achieved and is thus recommended for incorporation as an additive in producing earth burnt bricks.**George R. O. (2014)**[7] presented possible implementation of hot weather concreting practices using cassava powder admixtures that eliminate or minimize fresh and hardened concrete problems. From literature, it is found that hot weather increases the temperature of fresh concrete demandingmore water to maintain a given slump and set more quickly. Cassava powder is a low cost admixture to increase the workability andretard the setting time of concrete. Laboratory results showed that the use of cassava powder as a retarder has thepotential of retarding setting time, increasing workability and increasing both the long and early term strength of the concrete. Its use is a simple and economically preferred solution to its environmental problem.

2. Experimental Investigation

2.1 Materials used

Cement used is Dalmia cement OPC with53 grade confirming to specifications as per IS: 12269-1987[8].Specific gravity of cement is found out as 3.15as per IS 4031 Part: 11 -1988[9]. Standard consistency is found out as 31 % as perIS 4031 Part: 4 -1988[10] and initial setting time is found out as 40 minutes as per IS 4031 Part: 5 -1988[11]. The fine aggregate used is M sand with specific gravity 2.65. The coarse aggregate used is crushed granite stone of maximum size 20 mm with specific gravity 2.70. Tapiocaand maize starches used are first dried and then crushed into powder form. The maximum size of starches used are 10 micro meter.

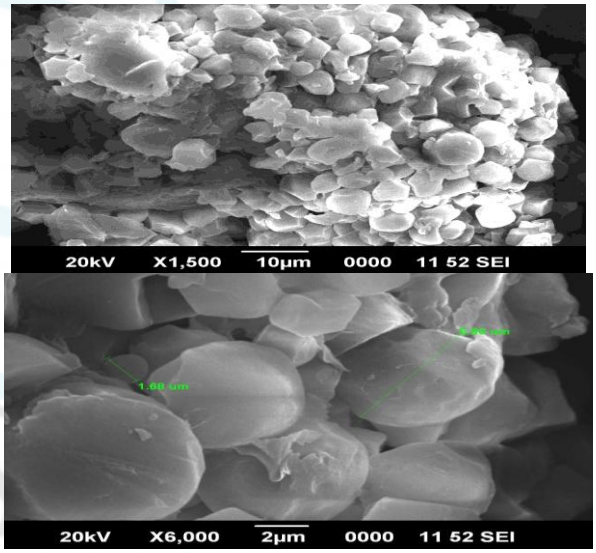

Figure 1: SEM imagesof tapioca powder

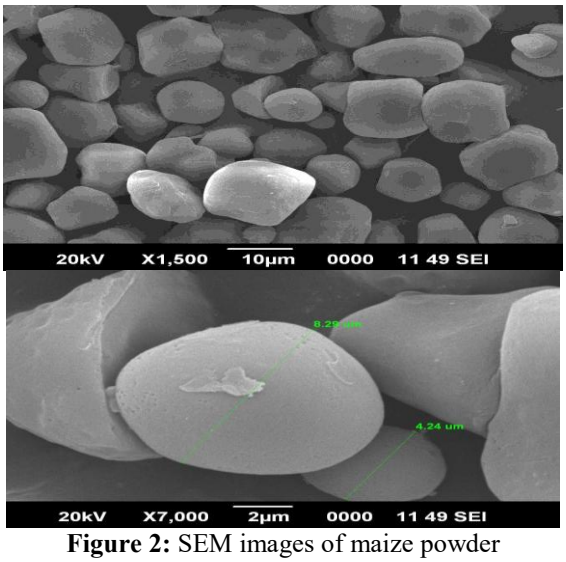

Figure 2: SEM images of maize powder

2.2. Test for Setting Time

The cement paste with different percentage addition of starch admixtures is prepared and the initial setting time is found out using Vicat apparatus. The addition of maize is fixed as 1.5% of cement and the addition of tapioca is varying (0.5%, 1.0%, 1.5%, 2%and 2.5%). These are added to the cement in combination of two starches.

2.3. Test on Workability of Concrete

The concrete with different percentage addition of starch admixtures is prepared and the workability of concrete is found out using slump test.

2.4. Test on Compressive Strength of Concrete

The compressive strength of concrete with different percentage addition of starch admixtures is found out using compression testing machine.

2.5. Test on Split Tensile Strength of Concrete

The split tensile strength of concrete with different percentage addition of starch admixtures is also found out.

2.6. Test on flexural Strength of Concrete

The flexural strength of concrete with different percentage addition of starch admixtures is found out using universal testing machine.

3. Results

The initial setting time of cement added with different combination of starch admixtures are tabulated follows.

Table 1: Initial setting time of cement with starch admixtures

Different percentages of starch admixtures	*Initial setting time (minutes)*
0.5 % tapioca and 1.5%maize	130
1.0 % tapioca and 1.5%maize	136
1.5 % tapioca and 1.5%maize	145
2.0 % tapioca and 1.5%maize	156
2.5 % tapioca and 1.5%maize	160

The workability of concrete added with different combination of starch admixtures are tabulated below.

Table 2: Workability of concrete with starch admixtures

Different percentages of starch admixtures	*Slump(mm)*
Control Concrete	100
0.5 % tapioca and 1.5%maize	102
1.0 % tapioca and 1.5%maize	106
1.5 % tapioca and 1.5%maize	111
2.0 % tapioca and 1.5%maize	116
2.5 % tapioca and 1.5%maize	121

The 28 day compressive strength of concrete added with different combination of starch admixtures are tabulated as follows.

Table 3: Compressive strength of concrete with starch admixtures

Different percentages of starch admixtures	*Compressive Strength (N/mm^2)*
Control Concrete	36.635
0.5 % tapioca and 1.5%maize	37.681
1.0 % tapioca and 1.5%maize	38.565
1.5 % tapioca and 1.5%maize	39.781
2.0 % tapioca and 1.5%maize	40.515
2.5 % tapioca and 1.5%maize	38.832

The split tensile strength of concrete added with different combination of starch admixtures are tabulated as below.

Table 4: Split tensile strength of concrete with starch admixtures

Different percentages of starch admixtures	*Split Tensile Strength (N/mm^2)*
Control Concrete	3.158
0.5 % tapioca and 1.5%maize	3.281
1.0 % tapioca and 1.5%maize	3.496
1.5 % tapioca and 1.5%maize	3.658
2.0 % tapioca and 1.5%maize	3.862
2.5 % tapioca and 1.5%maize	3.524

The Flexural strength of concrete added with different combination of starch admixtures are tabulated as follows.

Table 5: Flexural Strength of concrete with starch admixtures

Different percentages of starch admixtures	*Flexural Strength (N/mm^2)*
Control Concrete	5.08
0.5 % tapioca and 1.5%maize	5.29
1.0 % tapioca and 1.5%maize	5.47
1.5 % tapioca and 1.5%maize	5.68
2.0 % tapioca and 1.5%maize	5.83
2.5 % tapioca and 1.5%maize	5.70

4. Conclusion

From the study carried out, it is found that the setting time and workability of concrete are increased by the addition of starch admixtures namely tapioca and maize. So whenever a delay in placing of concrete is necessary, we can use these admixtures. The compressive strength, split tensile strength and flexural strength of concrete increase up to an addition of maize 1.5 % and tapioca 2% and further addition of maize and starch reduce the compressive strength, split tensile and flexural strength.Since tapioca and maize are locally available and are cheaper than chemical admixtures, we can replace chemical admixtures by these starch admixtures.

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