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Research Paper

EFFECT OF USING CORN STARCH AS CONCRETE ADMIXTURE

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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, coloring, 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. In this particular study used corn starch. The workability of concrete is tested using slump test. The starch is added for testing with different percentages of cement. The workability of concrete/ cement increases with the addition of starch admixtures. Density of concrete increases in the addition of 1% of corn starch further increase in the addition of starch admixtures reduces the density. Compressive strength of concrete increases in the addition of 1% of corn starch further increase in the addition of starch admixtures reduces the compressive strength. The starch admixtures such as corn starch can replace the use of chemical admixtures. It also reduces the additional cost of using chemical admixtures.

Keywords: Concrete admixture, Corn starch, Chemical admixtures

INTRODUCTION

Admixtures are incorporated into concrete in today's world in order to achieve variety of goals. This in effect improves the properties of fresh and hardened concrete. The effect of these admixtures on properties of concrete depends for example on a lot of factors such as functional groups, chemical configuration and molecular weight (Ouyang *et al.,* 2009). Continuous changes in the requirements for high strength and durable concrete structures interwoven with economic considerations necessitate intense search for materials and products. Chemical admixtures are used in the production of concrete in order to achieve various durability properties, instance of chemical admixture are water soluble synthetic and natural organic polymers. Polymers used as admixtures are said to enhance the

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joining of the mixing constituents as a result of intertwining polymer film which. Chemical admixtures are used as high range water reducer admixtures and have impacted on rheological and mechanical behavior of cement-based systems. This allows for a latent time that permits casting of concrete in excellent condition. These chemical admixtures are oil based, non-renewable products such as Poly Naphthalene Sulphonate (PNS), Poly Carboxylate (PC) and Polyacrylate (PA). They contain formaldehyde which when accidentally or intentionally released into the environment may result in undesirable environmental toxic effects. In recent times research efforts have been focused on recycled materials. Renewed efforts are also being concentrated on research into varieties of admixtures since for obvious reasons they enhance properties of fresh and hardened concrete. Major admixtures used for cementitious based systems are oil based and are non-renewable materials with potential for pollution such as formaldehyde (Zhang *et al.,* 2008). With the development of green concrete in recent times there is the need for development of bio-based admixtures that may perform as equally well as oil based polymers used as admixtures, hence the use of starch. Xing *et al.* (2006) and Crepy *et al.* (2011) noted that starch is one of the most abundant polymer resources in the world and have comparable performance of starch and starch derivatives in their dispersing ability with petrochemical polymers. Starches and its derivatives are known to exhibit viscosity modifying characteristics. A major advantage of starch is that it is a renewable material that has varieties of industrial applications because it is inexpensive and environmentally friendly. Starch derivative is an anionic material that has been used as film-forming agent for coating seeds, super absorbents, as adhesive in the paper industry and drug carrier. The use of starch and starch derivatives as viscosity modifying admixture in cementitious systems have been reported in recent times. However, the behavior of the polymers in cementations systems may vary depending on a lot of parameters.

Akindahunsi, *et al.* (2015), "Strength and durability properties of concrete with starch admixture", analyses concrete cubes containing different percentages of the cassava and maize by weight of cement (0, 0.5, 1.0,1.5and 2.0%).Crushed granites 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 for use where a longer period of time is required for casting the 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 (2011), "Comparative effects of cassava starch and simple sugar in cement mortar and concrete 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 was cured 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.

Okafor (2008) the potentials of cassava flour as a setretarding admixture in concrete",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 h 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.

Olekwu *et al.* (2014), "the use of cassava starch in earth burnt bricks", 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 additive for 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 (2014), "Minimising hot weather effects on fresh and hardened concrete by use of cassava powder as admixture" 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 demanding more water to maintain a given slump and set more quickly. Cassava powder is a low cost admixture to increase the workability and retard the setting time of concrete. Laboratory results showed that the use of cassava powder as a retarder has the potential 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.

Akindahunsi and Uzoegbo (2012), Use of starch modified concrete as a repair material, Corn is a rich source of carbohydrate, starch extracts and a source staple food for majority of sub-Saharan African population. Starch and its derivatives have been widely described as rheology-modifying admixtures; in an ongoing research the effect of using corn starch modified concrete isreported. Its effects on concrete properties such as compressive strength, sorptivity and permeability were determined on samples with 0, 2.5 and 5% addition of starch by weight of cement .

Akindehinde Ayotunde Akindahunsi, Wolfram Schmidt, Herbert C Uzoegbo and SunnyE.Iyuke

(2013), The Influence of Starches on some Properties of Starches and its derivatives are known to exhibit viscosity modifying concrete characteristics. In an on-compressive strength, heat of hydration and creep are examined. Various percentages (0.0, 0.5, 1.0, 1.5 and 2%) of starches by weight of cement were added to concrete mixes prepared in the laboratory.

The aim of this study is to investigate the characteristics of concrete and sustainable analysis by using the starch as admixture in concrete. The system design of concrete and civil engineering structures that involve materials selection, structural shape, construction work and maintenance should be carried out in a manner that is environmentally friendly because this will contribute to environmental sustainability. Thus its important to use organic admixtures to modify various properties in concrete because they are available in abundance; their preparation is not so sophisticated. They are renewable materials, therefore contributing to sustainable green construction. The use of organic admixtures including starch and its derivatives to modify different properties of cement and concrete.

EXPERIMENTAL INVESTIGATION

Materials Used

Coarse aggregate used for the work have 12.5 mm maximum size and used fine aggregate, Ordinary Portland cement manufactured in Iraqhas been used throughout this investigation, and the ratios used 1:2:3 for cement, fine and course aggregates respectively with water/ cement ratio of 0.47; potable water was used in the mixing of concrete. The use of corn starch as the proportions of cement.

Concrete Preparation

The mixing of materials sand, cement, stone and water. The dosage of corn starch (Figures 1.0) added to the batches of mixes prepared were (0, 1.0, 3.0, and 5.0)% by weight of cement respectively. The 0% concrete mix represented the Normal while a set (1.0, 3.0 and 5.0%) each was prepared for cornstarch. The dry materials were mixed with four turns during this process mixing was done for a minute after which water was added for a minute and the fresh concrete was properly mixed for another minute. (100 x 100 x 100) mm

Table 1: Physical Properties of Cement

Physical Properties	Test Results	Standard Specifications IQS 5/1984
Specific surface area (Blaine method), m^2/kg	495	≥230
Setting time (Vicate apparatus),		
Initial setting, h:min		
Final setting, h:min	2:55	≥00:45
	4:35	≤10:00
Compressive strength, MPa		
3 days	33.5	≥15
7days	38.6	≥23
Soundness (Autoclave) method, %	0.3	≤0.8

Table 2: Chemical Composition of Cement		
Oxides composition	**Content %**	**StandardSpecifications IQS 5/1984**
CaO	63.06	-
SiO_2	22.	-
Al_2O_3	6.25	-
Fe_2O_3	3.13	-
MgO	2.95	<5
SO_3	3.03	<2.8
LOI	3.33	<4
Insoluble residue	1.21	<1.5
Lime Saturation Factor L.S.F	0.88	0.66-1.02
Mineralogical Composition (Bogue's equations)		
C_3S	47.04	-
C_2S	28.11	-
C_3A	10.98	-
C_4AF	6.98	-

Table 3: Gradation of Fine Aggregate		
Sieve size (mm)	**Passing %**	**Standard passing % of zone (2)**
4.75	93	90-100
2.7	83.4	75-100
1.18	69	55-90
0.6	47.31	35-59
0.3	15.405	8-30
0.15	0.707	0-10

Table 4: Gradation of Coarse Aggregate		
Sieve size (mm)	**Passing %**	**Limit of Iraq specificationNo.45-1984**
12.5	100	100
9.5	88	100-85
4.75	10	25-0
2.36	2.5	5-0

moulds were filled with fresh concrete and vibrated on a mechanical vibrating table for twenty seconds.The concrete cubes were left twenty four hours after which they were demoulded and placed inside curing tanks with constant temperature of 23 ± 2 C. They were moist cured for 7, 28, days, at the end of each curing.

Figure 1: Corn Starch

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 (Figure 2).

Figure 2: Slump Test

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 (Figure 3).

Figure 3: Compressive Strength Test

Test on Density

To find the density, we use the following law:

Density = Weight/Volume

Weight = The Weight of Cubic of concrete (Figure 4)

Volume = Mold size of concrete

(100 mm * 100 mm * 100 mm)

Figure 4: Preparation of Samples

(a) Concrete Mixer

Figure 4 (Cont.)

(b) Concrete Cubes

RESULTS

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

Table 5: Workability of Concrete with Starch Admixtures

Different percentages of starch admixtures	Slump (mm)
Normal concrete	5
1%corn starch	15
3%corn starch	18
5%corn starch	20

Table 6: Density of Concrete with Starch Admixtures at 7 Day

Different percentages of starch admixtures	Density (kg/m^3)
Normal concrete	2325
1%corn starch	2380
3%corn starch	2374
5%corn starch	2356

Through the table notes at increasing the proportion of starch leads to improving the workability.

Table 7: Density of Concrete with Starch Admixtures at 28 Day

Different percentages of starch admixtures	Density (kg/m^3)
Normal concrete	2344
1%corn starch	2440
3%corn starch	2420
5%corn starch	2410

Table 8: Compressive Strength of Concrete with Starch Admixtures at 7 Day

Different percentages of starch admixtures	Compressive Strength (N/mm^3)
Normal concrete	15.4
1%corn starch	21.1
3%corn starch	20
5%corn starch	19.86

Table 9: Compressive Strength of Concrete with Starch Admixtures 28 Day

Different percentages of starch admixtures	Compressive Strength (N/mm^3)
Normal concrete	22
1%corn starch	26
3%corn starch	25.72
5%corn starch	24.25

The Density of concrete added with different combination of starch admixtures at 7 day are tabulated below.

Through the figure notes when starch ratio of 1%, the density increases from the normal density concrete and when the ratio 3%, 5% leads to a decrease of the density ratio of 1%, but higher than normal density of the mixture and the reason for this decline is the nature of the material starch gelatin.

Figure 5: Density of Concrete with Starch Admixtures at 7 Day

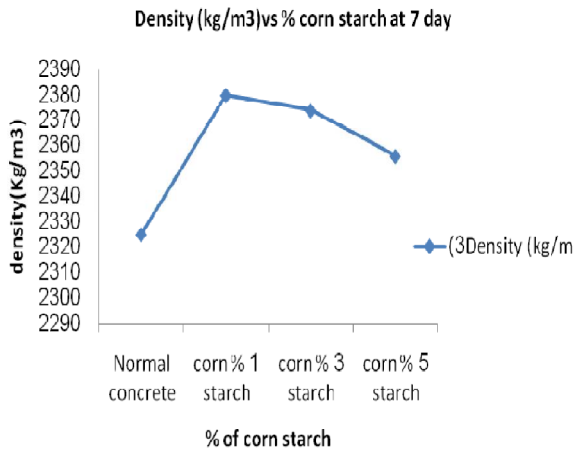

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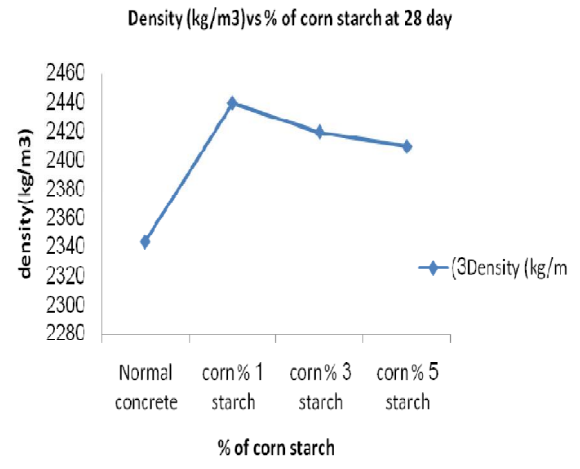
Figure 6: Density of Concrete with Starch Admixtures at 28 Day



The 7 day compressive strength of concrete added with different combination of starch admixtures are tabulated as follows.

Through the figure notes when starch ratio of 1%, the compressive strenght increases from the normal concrete and when the ratio 3%, 5% leads to a decrease of the compressive strenght ratio of 1%, but higher than normal concrete of the mixture and the reason for this decline is the nature of the material starch gelatin.

Figure 7: Compressive Strength of Concrete with Starch Admixtures at 7 Day

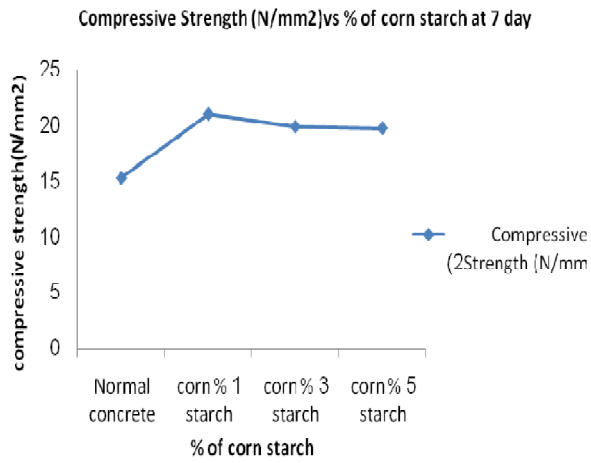
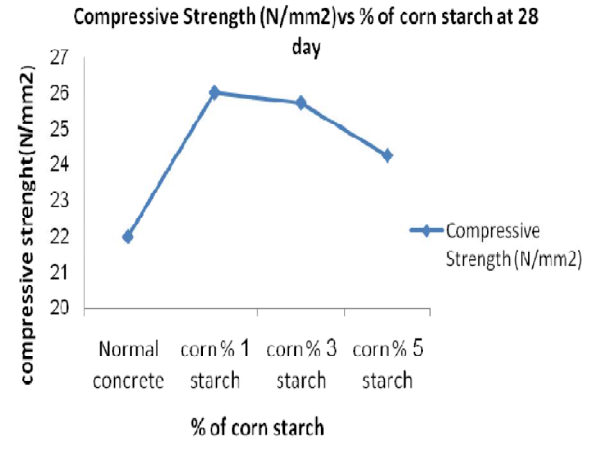


Figure 8: Compressive Strength of Concrete with Starch Admixtures 28 Day



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Through the figure notes when starch ratio of 1%, the compressive strength increases from the normal concrete and when the ratio 3%, 5% leads to a decrease of the compressive strength ratio of 1%, but higher than normal concrete of the mixture and the reason for this decline is the nature of the material starch gelatin.

CONCLUSION

From the study carried out, it is found that

1. The workability of concrete is increased by the addition of starch admixtures namely corn.
2. The density of concrete increases in the addition of 1% of corn starch further increase in the addition of starch admixtures reduces the density.
3. The compressive strength of concrete increases in the addition of 1% of corn and further addition of corn starch reduce the compressive strength.
4. Since corn is locally available and are cheaper than chemical admixtures, we can replace chemical admixtures by these starch admixtures.

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