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Evaluation the Effects of Natural polymers (Powder of Gum Arabic) as Admixture in Concrete Mixes

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***Abstract**: An experimental program was conducted to investigate the effect of natural polymers (Powder Gum Arabic) and evaluate the efficiency on fresh and hardened concrete for trying to produce a concrete with high strength. an experimental study was carried out to test for compressive strength of concrete for three types of concrete mixes each mixture were casted in the form of cubes were studied for 28 days, one of those mentioned mixes is a (control mix). Finally the results are compared with the normal conventional concrete (control mix). The main aim of this investigation is first to prepare the strength of concrete of compressive strength 30N/mm2 with locally available ingredient and then to study the effect of different proportion of fiber waste and fiber glass in the mix and to find the optimum range of the effective proportion. The various proportions considered are 0.4%, 0.6%, 0.8%, and 1.0 of weight of cement. the research was shown that the effect of Gum Arabic on the fresh concrete that the workability increases as the proportion of Gum Arabic additives increases, and for the hardened concrete the specific compressive strength increases up to 0.6% of the Gum Arabic content of cement weight, and also show's beyond these mention proportioned that the compressive strength decreases.*

Keywords: Concrete, Gum Arabic, Workability, Compressive strength.

1. INTRODUCTION

Concrete is one of the most popular construction materials in the world. Chemical admixtures are ingredients added to concrete to enhance its properties. However, most chemical admixtures on the market today are expensive, thereby making them out of reach for small consumers of concrete. In Africa, use of chemical admixtures is rare despite the harsh weather conditions. In the current study, Gum from Acacia karroo (GAK) was used as a water-reducing admixture in concrete [1] Gum Arabic, also known as Gum Acacia, Chaar Gund, Char Goond or Meska, is a natural gum made from the sapincluding two types of acacia trees; Acacia Senegal and Acacia Senegal. Gum Arabic and harvested on a commercial scale from wild trees in the Sahel from Senegal to Somalia and Sudan, although it was there in earlier times in some areas of the Arabian Peninsula in the west of Asia [2].

Gum Arabic is among the additives and admixtures being used in concrete to modify the properties of concrete. Gum Arabic is the most abundant plant produced naturally as exudates from the bark of acacia tree [3]. It is a natural product of the Acacia Senegal tree occurring as exudates from the trunks and branches. Gum Arabic is a product of Acacia Senegalis. Other acacia species such as Acacia niotical and Acacia Arabica also produce similar gum of inferior quality [4]. The gum exudates are produced after mechanical damage to the bark of the tree or after a bacterial or fungal attack. The process of gum formation popularly known as gummosis is believed as a protective mechanism by these plants to check further attacks [5]

Rose et al (2016) [2] showed that in hot weather climates, there is a tendency to add water to concrete to make it more workable. The addition of GAK to concrete can reduce this tendency. There was a remarkable improvement of concrete workability when GAK was used at above a 0.5% dosage. At a 2% dosage, the slump of concrete increased by 200%. However, the drawback observed was the quick slump loss due to the adhesive nature of GAK. This type of concrete is applicable in pre-cast technology.

N.S. Abdeljale et al (2012) [6] present The significant effect of the Gum Arabic liquid occurred at a ratio of 0.4% of the additive, The compressive strength of concrete decreased with the increase of Gum Arabic liquid and the compressive strength and slump tests increase with the increase in the ratios of Gum Arabic modified liquid.

2. EXPERIMENTAL STUDY

In order to achieve the stated objectives , this study was carried out in few stage .on the initial stage ,all the material and equipment's needed must be gathered or check for availability. Then the concrete mixes according to the predefined proportions. Concrete samples were tested through concrete tests such as cube test. Finally the results obtained were analyzed to draw out conclusion.

High performance concrete was designed by using BSI curing method. Trail control mixes for 28 days with using Gum Arabic Additive in concrete with different dosages 0.4%, 0.6%, 0.8%, and 1.0 respectively from cement weight. The results of laboratory experiments were analyzed and discussed to investigate the Gum Arabic additive on workability of fresh concrete and compressive strength of hardened.

3. MATERIALS

3.1 Material Used:

Cement: The cement used was Ordinary Portland cement (45Grade) conforming to IS: 12269–1987 the test result in table

Type of testing	Results of testing	Ref.BS12:1996
Standard of cement paste	32%	W/C not less than 26% And not more than 33%
Initial setting time	105 min	Not less than 60 min
Final setting time	2 hour 35 min (155 min)x	Not more than 10 hours
Fineness of cement	1%	Not more than 10%
Soundness of cement	2mm	Not more than 10mm
Compressive strength (28) days (standard)	45 N/mm^2	≥42.5N/mm^2 ≤62.5 N/mm^2

Fine Aggregate: The sand used for experimental program was locally procured. The fine aggregates were tested as per British Standard Specification BSI: 882-1997. The specific gravity of sand was found out to be 2.75.

Coarse Aggregate: The natural broken stone (coarse aggregate) used for the study was of 20mm size maximum. It is conforming BSI: 882-1997. It was retrieved from a local quarry .The shape and quality of aggregate was uniform throughout the project work and the specific gravity was found to be 2.61. Table 1 shows the results of tests of impurities, specific gravity and water absorption of coarse and fine aggregates

Table 2: Properties of aggregates

Experiment name	Fine aggregate	Coarse aggregate
Impurities	% 2.5	-
Specific gravity	2.75	2.61
Water Absorption	0.755%	0.47%

Water: The used water from Khartoum city water distribution system

Gum Arabic: picked from western Sudan and extracted from Hashab trees (figure1).

Fig.1*. Gum Arabic from Hashab Trees*

3.2 Mix Design Method

BSI curing method of mix design was used for mix design for concrete cubes test .concrete specimens with various percentages of Gum Arabic were prepared .the details of various mix proportions for different ratios of Gum Arabic at 28 days.

The aggregate dry density used was 1600kg/m^3 ,and the maximum aggregate size use in all mixes was 20mm .using standard cubes moulds (150*150*150)mm,3cubes representing each ratio, were casted and tested at age 28 days.

3.3 Components of mix materials:

Concrete Mixes Design: The concrete mix to resist compression design (30 N / mm^2) The quantities of materials for all the mixtures as illustrated table3: Mix design: (density of 2375 kg / m^3).

Table 3: The amounts of the mixture of design

Mix Materials	Weight(kg/m^3)
Cement content	426
Fine aggregate content	738
Coarse aggregate content	1490
Water content	2Leters

Ratios and weight of Gum Arabic of cement content. Showed in table 4

Table 4: The ratios and weights of Gum Arabic

Ratios	Weight *g*
0.4	0.017
0.6	0.025
0.8	0.034
1.0	0.042

Cube Area = 150×150 = 22.5 ×103 mm^2

Cube Volume = 150×150×150 =3.375 ×106 mm^3.

The result of these experiments have been shown in tables 5 to 10

4 RESULTS OF EXPERIMENTS

Results of Hardened Concrete

The results of hardened concrete tests conducted by adding different ratios of Gum Arabic,, result for 0.4%, 0.6%, 0.8%, and 1.0 of Gum Arabic are shown in tables 5 to10 and depicted graphically in Figures 1to 6.

Table 5: Results of Compressive Strength Tests of the Control Mix Using (0.0 % of Gum Arabic)

Cube No	Age	Area of cube mm^2	Failure Load (kN)	Strength (N/mm^2)	Average strength (N/mm^2)
1	28day	22500	1028	46	43.4
2			960	43	
3			943	42	

Table 6: Results of Compressive Strength Tests of the Control Mix Using (0.4 % of Gum Arabic)

Cube No	Age	Area of cube mm^2	Failure Load (kN)	Strength (N/mm^2)	Average strength (N/mm^2)
1	28*day*	22500	830	37	35
2			702	31.5	
3			830	37	

Table 7: Results of Compressive Strength Tests of the Control Mix Using (0.6 % of Gum Arabic)

Cube No	Age	Area of cube mm^2	Failure Load (kN)	Strength (N/mm^2)	Average strength (N/mm^2)
1	28*day*	22500	1114	50	48
2			1037	46.5	
3			1046	47	

Table 8: Results of Compressive Strength Tests of the Control Mix Using (0.8 % of Gum Arabic)

Cube No	Age	Area of cube mm^2	Failure Load (kN)	Strength (N/mm^2)	Average strength (N/mm^2)
1	28day	22500	223	10	12.5
2			128	6	
3			439	22	

Table 9: Results of Compressive Strength Tests of the Control Mix Using (1.0 % of Gum Arabic)

Cube No	Age	Area of cube mm^2	Failure Load (kN)	Strength (N/mm^2)	Average strength (N/mm^2)
1	28*day*	22500	960	43	41
2			943	42	
3			866	38.5	

Table 10: Average for Results of Compressive Strength and slump Tests using (% of Gum Arabic)

Ratios of Gum Arabic	Compressive Strength (N/mm^2)	Slump (mm)
00	43.4	10.5
0.4	35	11
0.6	48	13
0.8	41	17
1.0	12.5	-

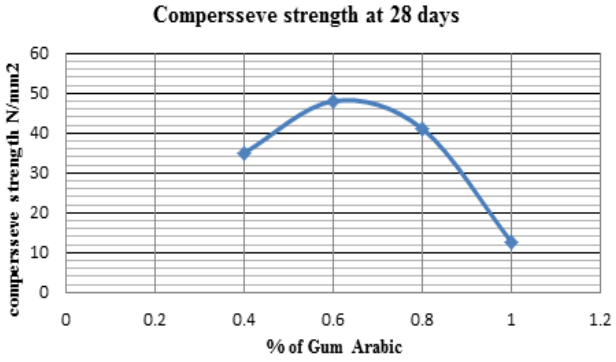

Fig.2. *Relation between % of Gum Arabic and compressive strength of concrete at ages 28 days*

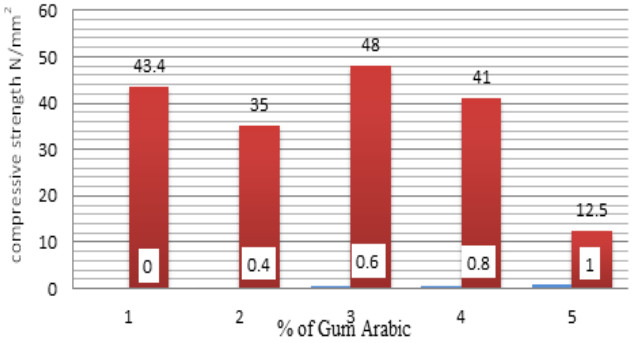

Fig.3. *Relation between % of Gum Arabic and compressive strength of concrete at ages 28 days*

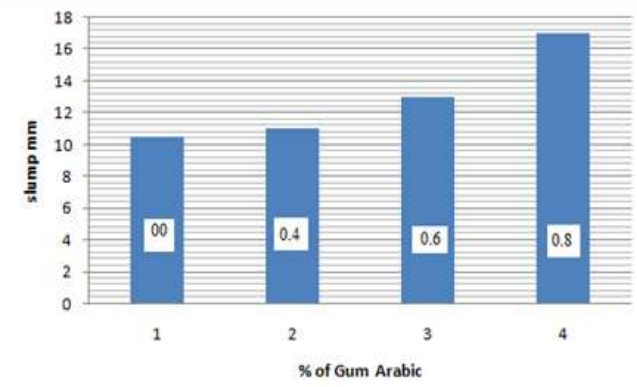

Fig.4. *Relation between % of Gum Arabic and compressive strength of concrete at ages 28 days*

5 DISCUSSION OF THE RESULTS

The results obtained from the different tests are summarized and discussed as following:

1. Tables 10 and Figures 2,3 &4 show the results of compressive strength and slump, from which it was found that there was significant change in the properties of fresh and hardened concrete when adding all ratios of Gum Arabic liquid, during all ages, the compressive strength values decrease and slump values increase, in all mixes at all ages,
2. Average Compressive strength of concrete increased with increasing amounts of Gum Arabic to the ratio of 0.6% which gave 48 mPa at 28 days and also show's beyond these mention proportioned that the compressive strength decreases. After it clear there is an effect on the compressive strength of concrete as shown in table 9 and Fig. 2&3
3. Slump increased with increasing the amount of Gum Arabic
4. slump became fall at 1.0% of Gum Arabic

5. CONCLUSION AND RECOMMENDATION:

The effect of Gum Arabic use in concrete was tested, and different properties were studied both in the fresh and the hardened state. From the results obtained, the following conclusions were made:

- The highest decrease in compressive strength observed was 48 mPa % at a 0.6% Gum Arabic dosage.
- The usage of Gum Arabic increased the workability of concrete mixes
- The effective ratio of Gum Arabic 0.6% of weight of cement

From this study it can be recommended that the modified of Gum Arabic ratios 0.6% & 0.8% must be adopted in normal concrete mixes since they obtained the highest values of compressive strength of the hardened concrete and in hot weather climates, there is a tendency to add water to concrete to make it more workable. The addition of Gum Arabic to concrete can reduce this tendency

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