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INVESTIGATING THE STRENGTH PROPERTIES OF HIGH STRENGTH CONCRETE MADE WITH GREWIA GUM EXTRACT (*DARGAZA*) AS ACCELERATOR

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ABSTRACT

Additives are used in the manufacture of high-strength concrete, and they play an important role in the concrete's consistency. An additive can come in the form of a mineral or a chemical. Chemical additives, on the other hand, are pricey, and their environmental friendliness cannot be certified because most producers keep their products composition a secret. Grewia Gum is a natural product which is abundant in the Northern part of Nigeria, and it is non-reactive and not harmful to the environment. The study therefore investigated the strength properties of high strength concrete using Grewia Gum extract as accelerator. The research identified the optimum mix proportion for high strength concrete using Grewia Gum as accelerator. The water/cement ratio of 0.50 and a design mix of 1:1.9:1.9 were used. Concrete were cast with Grewia Gum extract added to the concrete as admixture in varying percentages: 1%, 1.5%, and 2% by weight. The strength and density of concrete was determined. The flexural strength and tensile splitting strength of concrete for each percent of admixture was discovered to increase with increased days of hydration. The compressive strength of concrete cubes at 28 days for 0%, 1%, 1.5% and 2% were 43.1N/mm^2, 45.3N/mm^2, 22.8N/mm^2, and 21.0 N/mm^2 respectively. The strength of concrete beams at 28 days for 0%, 1%, 1.5% and 2% are 5.63N/mm^2, 7.63N/mm^2, 7.63N/mm^2, and 5.25N/mm^2 respectively. The strength of concrete cylinders at 28 days for 0%, 1%, 1.5% and 2% are 5.12N/mm^2, 5.94N/mm^2, 3.50N/mm^2, and 3.50N/mm^2 respectively. The investigation shows that 1% of Grewia Gum extract in concrete gave the optimum strength, higher than the control mix. The setting time was carried out using cement and Grewia Gum extract at 0%, 1%, 1.5% and 2%. The result shows that the higher the percentage the decrease in the initial and final setting time. The research also found out that the presence of Grewia Gum extract in high strength concrete can be used for structural members and is most suitable for construction where rapid setting time is required.

Keywords: high strength concrete, admixture, accelerator, grewia gum extract, strength properties

INTRODUCTION

Concrete is a commonly used building material all over the world, and its characteristics have evolved as technology has advanced (Kylasnath and Ranjan, 2017). According to Nima (2011), high compressive strength concrete is needed due to rapid population growth and increased demand for housing and infrastructure, as well as recent advances in civil engineering, such as high-rise and long-span buildings. Concrete has evolved into a necessary building material and is now used in larger quantities than any other (Nawy, 1996).

Normal-strength concrete cannot sustain loads that high-strength concrete can. High-strength concrete not only extends the variety of uses, but it also boosts the strength per unit cost, weight, and volume. These concrete blends have a higher modulus of elasticity, which improves stability and decreases deflections. (Aitcin, 1998). Concrete is a man-made material made up of concrete, cement, and water. Concrete use has increased at a faster pace in recent years as a result of infrastructure growth in both developing and developed countries. Because of the high demand and shortage of raw materials, the price of building materials is steadily rising. Structures should be able to accommodate the assets on which they were designed for the duration of their service life (Shetty, 2005).

Concrete is regarded as a highly durable and moldable building material. The fine and coarse aggregates are coated in a paste or gel made of cement and water. The cement hardens and ties the whole mix together after being chemically reacted with water. Within a few hours, the first hardening reaction happens. Over the course of several years, concrete hardens and increases strength. Admixtures are additives that are applied to concrete formulations to alter one or more properties of the concrete to make it suitable for a particular purpose. Admixtures will typically alter more than one property of a concrete or grout combination. In addition, an admixture for a particular reason may be applied to the blend. In infrastructure projects with concrete components that must withstand high compressive loads, high-strength concrete is needed. In the construction of high-rise buildings, high-strength concrete is commonly used. It has been used in components such as columns, shear walls, and foundations (especially on lower floors where loads are greatest). High-strength components are occasionally used in bridge construction (Aitcin, 1998).

A substance other than cement, water, and aggregate that is used as an ingredient in concrete that is applied to the batch directly before or after mixing is referred to as an admixture. It's used to change the properties of concrete to meet our needs. Admixtures are additives that are applied to concrete before or after it has been mixed. They are used to alleviate challenging building conditions or to impart specific properties to fresh or set concrete. Admixtures can increase the workability, longevity, and reliability of concrete, as well as solve issues including excessive heat and cold, early strength needs, and poor water-to-cement ratios (Darshan, Meet and Jayeshkumar, 2014). Despite their possible negative environmental impacts, the use of industrial additives as setting retarders and plasticizers has become common procedure in mortar mixtures in recent years. Man has used organic additives such as plant and animal extracts to enhance the setting properties of mortars for a long time (Aquila,Borg and Buhagiar, 2018).

The addition of bio-admixture to cement improves the rate of hydration and increases compressive strength. The accumulation of bio-admixture in aqueous solution affects the majority of the properties of cement mortar and concrete. Bio-admixtures are a low-cost, environmentally friendly viscosity-enhancing admixture that can be used to create long-lasting cement composites with enhanced mechanical and strength properties. When using admixtures to solve building issues associated with environmental pollution, eco-friendliness and safety are the most important factors to consider. This need necessitated research into the use of locally sourced plasticizers that are organic, environmentally friendly, and long-lasting. On very limited ventures, the expense of synthetic plasticizers and other chemical additives raises the cost of concrete manufacturing. Its rapid introduction in Africa and other developed countries has been slowed by this (Amarita, Indranuj, and Gogoi, 2017). Finally, the concrete industry's sustainability is primarily accomplished by lowering CO_2 emissions produced during the construction period. It is obtained by a variety of procedures, including the addition of synthetic admixtures to improve properties such as strength, stability, and longevity. The viability of a bio admixture is often determined by its cost effectiveness, ease of use, and availability (Indranuj, Amrita and Nabajyoti, 2016).

Grewia is a flowering plant that belongs to the genus Grewia. It was formerly classified as a member of the Tiliaceae or Sparrmanniaceae families. Most scholars now recognize the genus as a member of the Malvaceae family of mallows. The plant is described as a shrub or small tree that grows to a height of 10.5m and has densely stellate-pubescent young branches (Okorie, 2009). Grewia mollis can be found in tropical Africa, from Senegal and Gambia eastward to Somalia, and southward to Angola, Zambia, and Zimbabwe; it is also found in Yemen. Grewia mollis wood is commonly used for house building, bed frames, walking sticks, tool handles, clubs, bows and arrows, shields, spear shafts, and whips, among other things. It's also used to make charcoal and used as firewood. Grewia mollis has mucilaginous bark and leaves that are widely used in soups; dried and ground leaves are combined with bean meal to produce cakes. The bark is kneaded with water in the Democratic Republic of Congo to make a viscous paste that is used in sauces (Brink, 2007). Grewia polysaccharide gum is made from the inner stembark of the Grewia mollis, Juss edible fruit (Tiliceae). The grewia polysaccharide gum tree grows abundantly (both wild and cultivated) in Nigeria's middle belt, where the gum is eaten as a delicacy by the locals (Conway, 2011).

In order to solve man's immediate problems, large high-rise structures and civil structures such as bridges, dams, and roads are needed in Nigeria and beyond. The issues raised above, such as power, emissions, and the cost of chemical additives, have encouraged researchers to seek out suitable methods of producing cement with natural admixtures in order to fix them. The aim of this analysis is to look into the properties of high-strength concrete using grewia gum extract as an accelerator.

MATERIALS AND METHODS

Sieve analysis was performed on the aggregates (fine and coarse) used, to test for their properties and classifications. A mix ratio of 1:1.9:1.9 was used based on proper calculations. A constant water/cement ratio of 0.50 was used to achieve good workability of the matrix as a result of addition of the admixture- grewia gum. Before mixing the required quantities of sand, stones, grewia gum and water for the batches were weighed, cement and sand were thoroughly mixed before the coarse aggregates were added and finally the grewia gum admixture. The mixing of materials was done using a hand shovel after which the required quantity of water was added. The combined constituents were then mixed thoroughly on a platform continuously until a workable, smooth and consistent mixture was obtained.

Wooden moulds were oiled in order to facilitate the easy demoulding of hardened concrete. The moulds were then filled with the mixed concrete, compacted and vibrated on a vibrating table for 1 minute. The samples were marked for easy identification and left for 24 hours to harden. After demoulding, the samples were cured in water for 7, 14, and 28 days respectively.

Compressive strength tests were carried out on the concrete cubes moulded using (100 x 100 x 100) mm wooden moulds with varying percentages of grewia gum (1,1.5and 2) respectively by weight of cement. Flexural strength tests were carried out on the 100 x 100 x 500mm concrete beams. Similarly, tensile strength tests were carried out on concrete cylinders with a radius of 50mm and height of 200mm. Some of the samples were cast using 0% by weight of grewia gum to serve as the control specimen. A total of 36 cubes, 36 beams and 36 cylinders were cast with each percentage increment having 9 cubes, 9 beams and 9 cylinders respectively.

MATERIALS USED

Ordinary Portland Cement (binder), fine aggregates (river sand), coarse aggregates (crushed stones), grewia gum and portable water for mixing were used in the course of the practical. Series of tests were carried out on the materials to determine to identify their categories and suitability.

Grewia Gum

The Grewia used in this research was obtained from Keran District of Pankshin local government were the plant widely grows, the inner stem and leaves of Grewia were cut and dry for 72 hours in open air at the Department of Pharmaceuticals Sciences, University of Jos. Through the leaves and stems of Grewia using 96% ethanol, a quantity of approximately 500g was size reduced and soaked in 15 l of de-mineralized water for 48 hours to extract the gum, a clean cloth is used to filter out debris from the gum. The gum sample was pulverized using sieve size mesh corresponding to 1.19, 1.0, 0.595, 0.149, and 0.105mm in succession, and the sample from the sieve size 0.105mm were collected and stored in airtight bags until required usage.

Fine Aggregates

The fine aggregate used for this experiment was river sand sourced from Jengre in Bassa Local Government Area of Plateau State of Nigeria. Sieve analysis, specific gravity as well as bulk density tests were carried out on the sand used for the research in order to classify and obtain other parameters.

Coarse Aggregates

The coarse aggregates gravel used for this research work were machine crushed 12mm average size and were obtained from Jolex Construction Nig Ltd, which is located in Mista Alli, Bassa Local Government Area of Plateau State of Nigeria.

Cement

The cement type used in this research was Bua cement of ordinary Portland cement (OPC), 42.5 grade bought from a local supplier at Katako market, Jos, Plateau State, Nigeria. The tests carried out on the cement specimen include the initial and final setting times.

METHODS

Grewia Gum Extract as an Admixture

This research concentrates on the investigating of the strength properties of high strength concrete produced with grewia gum extract admixture as accelerator. The extract of grewia gum contains chemicals such as calcium, iron, silicon, manganese, phosphorus, titanium etc. Based on the research carried out, grewia gum extract can be used to a significant level as an accelerating admixture which can be used to accelerate the setting time of concrete. In order to ascertain the viability of the use of grewia gum extract as an admixture in concrete, a number of laboratory tests on the physical properties, particle size analysis, chemical analysis, specific gravity, etc. were carried out on the material.

Chemical Analysis of Grewia Gum Extract

The chemical analysis of grewia gum extract used in this research was carried in the chemical and physical laboratories of the National Metallurgical Development Centre, Jos. It was found to be having a high content of CaO of 46.60% which is responsible for the strength and an increase in setting time in cement. Grewia gum extract was also found to contain 4.30%, 4.93% and 23.50% of SiO_2, Fe_2O_3 and K_2O are respectively; Other oxides found are P_2o_5 (1.00%), SO_3 (0.65%), TiO_2 (0.30%), Cr_2O_3 (0.20%), MnO (0.33%), NiO (0.07%), CuO (0.20%), ZnO (0.08%), SrO (0.90%), Rb_2O (0.10%), ZrO_2 (0.07%) and BaO (0.36%). Al_2O_3 and V_2O_5 were found to be lacking.
Table 1 shows the results of the chemical analysis of grewia gum extract admixture while Figure 1 shows a chart for the distribution percentages.

Table 1: Major Oxides Composition of the Grewia Bicolor Plant (Chemical ED - XRF Method)

Parameters in (%)

S/N	SAMPLE	Al_2O_3	SiO_2	P_2o_5	So_3	K_2O	CaO	TiO_2	V_2O_5	Cr_2O_3
1	GREWIA BICOLOR PLANT	ND	4.30	1.00	0.65	23.50	46.60	0.30	ND	0.20
		MnO	Fe_2O_3	NiO	CuO	ZnO	SrO	Rb_2O	ZrO_2	BaO
		0.33	4.93	0.07	0.20	0.08	0.90	0.10	0.07	0.36

Source: (Jintere, 2019). Unpublished

Key % = Percentage

ND = Not Detectable

Loss of Ignition (LOI) was not determined

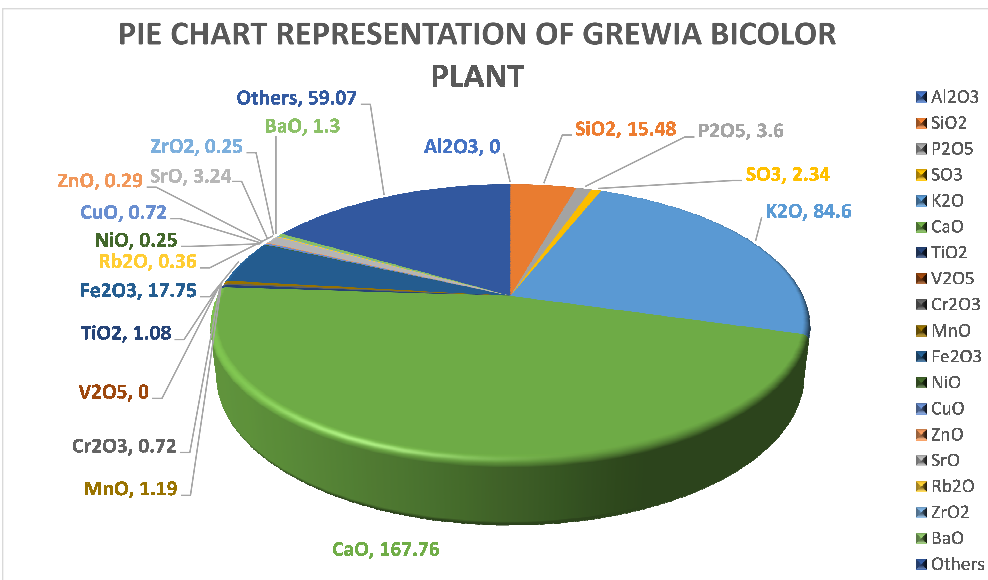

Figure 1: Pie Chart Representation of Grewia Bicolor Plant

Hardened Concrete

Compressive Strength Test

Bua cement, sharp river sand and crushed granite were used. The coarse aggregates and sand met the specification of BS EN 12620:2002+A1:2008. Tap water used for curing was obtain from the university mains safe for drinking. Cubes were cast in 100mm x 100mm

x 100mm wooden mould. Water cement ratio of 0.50 was adopted and the cubes were evaluated at 7, 14 and 28 days respectively.
In respect to the determination of the compressive strength, the cubes were first brought out of water and kept for about 20 – 30 minutes for the water to drip off. They were then taken to the crushing machine in accordance with BS 1881-124:2015+A1:2021. Testing Concrete;

Methods for Analysis of Hardened Concrete

Flexural Strength Test

In the test of flexural strength of concrete beams, certain procedures were followed and apparatus used.

Splitting Tensile Strength Test

A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. It is an indirect method of testing tensile strength of concrete. In direct tensile strength test, it is impossible to apply true axial load. There will always be some eccentricity present. Another problem is that stresses induced due to grips. Due to grips there is a tendency for specimen to break at its ends. The length of the specimens shall not be less than the diameter and not more than twice the diameter. For routine testing and comparison of results, 100mm in diameter and 200mm long.

RESULTS

Fresh Concrete

Workability

Workability tests (slump and compacting factor test) were carried out on the fresh concrete mix with grewia gum extract. The values of the four mixes workability test lie below the range (15-30) which is a low workability as specified in Table 2 using replacement of 0%, 1%, 1.5% and 2.0% grewia gum extract was workable in high strength concrete. The slump and compacting factor test results are presented in Table 3:

Table 2: Description of Slump Workability

Description of Workability	Slump(mm)
No-Slump	0
Very low	5-----10
Low	15----30
Medium	35----75
High	80----155
Very High	160----collapse

Table 3 shows the water-cement ratio, slump and compacted factor and uncompacted factor values for high strength concrete made with grewia gum extract. A free water/cement ratio of 0.5 was used for all the mixes (different percentage replacements). The slump ranges from 5mm to 25mm; Control mix had a slump of 25mm, 1% admixture of grewia gum extract had a slump of 10mm, while 1.5% and 2% admixture of grewia gum extract had a slump of 5mm. As the percentage decreases for all the various mix, the compacting factor was seen to fluctuate with no progressive increase or decrease; but with the control sample having the highest compacting factor of 1.70. It can be deduced that grewia gum extract reduces the workability of concrete because as the percentage replacement of the cement with grewia gum extract increases, the slump reduces at a constant free water/cement ratio of 0.5.

Table 3: Workability of High Strength Concrete With Grewia Gum

Grewia Gum Percentage%	W/C	Slump (mm)	Compacted Factor	Un-compacted Loose	Description of Workability
0%	0.50	25	16.60	14.90	Low
1%	0.50	10	16.08	14.58	Very Low
1.5%	0.50	5	15.36	13.68	Very Low
2.0%	0.50	5	15.72	14.26	Very Low

Table 4: Results for Setting Time Test

Mix identity Cement sample	Water/Cement Ratio	Grewia gum Content (%)	initial setting time (Hour minutes)	final setting time (Hour minutes)
CS1	0.55	0%	1:45	3:55
CS2	0.55	1%	1:20	3:15
CS3	0.55	1.5%	1:05	2:55
CS4	0.55	2.0%	1:00	2:45

Table 4 shows the result for the setting time of cement past made for the various types of mix. The results obtained for the initial setting time for the ordinary Portland cement (OPC) sample without grewia gum extract and a water/cement ratio of 0.50 was 1 hour 45 minutes and final setting time of 3 hours 55minutes. For CS2 the initial setting time for the (OPC) past made with grewia gum extract at 1%, with water/cement ratio of 0.50 was 1 hour 20 minutes and the final setting time was 3hours 15 minutes. For CS3 the initial setting time for (OPC) made with Grewia gum at 1.5% with water/cement ratio of 0.50was 1 hour 5 minutes and the final setting time of 2 hours 55 minutes. For CS4 the initial setting time for (OPC) made with grewia gum at 2.0% with water/cement ratio of 0.50was 1 hour and the final setting time of 2 hour 45 minutes. The setting time, fall within the allowable limits produced by ASTM C150 / C150M - 20 (Standard Specification for Portland Cement). The table further shows that the initial and final setting time of the cement past produced increase with increase in the amount of grewia gum extract. The consistency of the control mix was 32.5% water of the cement used by volume. This result shows that grewia gum extract increase the setting time of concrete as contained in the findings.

HARDENED HIGH STRENGTH CONCRETE TEST

Results for Density of Cubes

Table 5: Density Results for Cubes

Percentage replacement (%)	Curing age (days) Density Of Cubes		
	7	14	28
0%	2,490	2,650	2,660
1%	2,340	2,230	2,340
1.5%	2,190	2,200	2,207
2.0%	2,100	2,150	2,160

Densities of the cubes cured in water are as shown in Table 5 above. The relationship in the results presented for the cured cubes shows that the density of the cubes with 1.0% grewia gum extract as admixture is higher than that with 1.5%, and 2%. 36 concrete cubes of size 100mm, x 100mm, x 100mm were cast using the partial replacement of 0%, 1%, 1.5% and 2.0% with grewia gum extract at the hydration period of 7, 14 and 28 days, completely cured inside water all of which was test for compressive strength.

Results for Density of Beams

Table 6: Density Results for Beams

Percentage replacement (%)	Curing age (days) Density of Beams		
	7	14	28
0%	2,356	2,378	2,388
1%	2,288	2,376	2,382
1.5%	2,360	2,426	2,500
2.0%	2,514	2,552	2,598

Densities of the beams cured in water are as shown in Table 6 above shows the relationship in the results presented for the cured beams shows that the density of the beams with 2.0% grewia gum extract is higher than that with 1%, and 1.5%. 36 concrete beams of dimension 100mm x 100mm x 500mm were cast using the partial replacement level of 0%, 1%, 1.5%, and 2.0% of grewia gum at the hydration period of 7, 14 and 28 days which were cured and tested for flexural strength.

Results for Density of Cylinders

Table 7: Density Results for Cylinders

Percentage replacement (%)	Curing age (days) Density of Cylinder		
	7	14	28
0%	2,550	2544	2,566
1%	2,250	2,313	2,471
1.5%	2,556	2,575	2,617
2.0%	2,563	2,588	2,637

Densities of the cylinders cured in water are as shown in Table 7 above shows the relationship in the results presented for the cured cylinders shows that the density of the cylinder with 2.0% grewia gum extract is higher than that with 1%, and 1.5%. 36 concrete cylinders of length 200mm and diameter of 100mm were cast using the partial replacement level of 0%, 1%, 1.5%, and 2.0% of grewia gum extract at the hydration period of 7, 14 and 28 days which were cured and tested for splitting tensile strength.

Results for Compressive Strength

Table 8: Results for Compressive Strength Test of High Strength Concrete Cubes

Percentage replacement Grewia gum extrtract (%)	Curing age (days) Strength of cubes(N/mm^2)		
	7	14	28
0%	26.8	32.0	43.1
1%	27.3	34.8	45.3
1.5%	11.5	21.3	22.8
2.0%	10.5	20.3	21.0

The compressive strength of the cubes with different percentage replacement of grewia gum extract as admixture in concrete, were tested after each hydration age of 7, 14 and 28 days respectively. The results of the compressive strengths are presented in Tables 8. From the table above, 0% of grewia gum extract had strength values of 26.8N/mm^2, 32.0$N/mm^2$and 43.1N/mm^2after curing in water for 7, 14 and 28days respectively. There is progressive increase in strength of each sample at each age of hydration. The compressive strength of Portland cement high strength concrete with 1% addition of grewia gum extract cured in water (H_2O) and crushed at hydration period of 7, 14 and 28 days are 27.30N/mm^2, 34.80$N/mm^2$and 45.3N/mm^2.The compressive strength of Portland cement high strength concrete with 1.5% addition of grewia gum extract cured in water (H_2O) and crushed at hydration period of 7, 14 and 28 days are 11.50N/mm^2 , 21.30$N/mm^2$and 22.8N/mm^2.The compressive strength of Portland cement high strength concrete with 2% addition of grewia gum extract cured in water (H_2O) and crushed at hydration period of 7, 14 and 28 days are 10.5N/mm^2, 20.3N/mm^2 and 21.0N/mm^2.

The relationship in the results presented for the cubes shows that the compressive strength of the cubes with 1.0% replacement of grewia gum is higher than that with 1.5% and 2%.

Results for Flexural Strength

Table 9: Results for Flexural Strength Test of High Strength Concrete Beams

Percentage replacement (%)	Curing age (days) Strength of beams(N/mm^2)		
	7	14	28
0%	5.50	6.50	5.63
1%	7.13	7.31	7.63
1.5%	5.63	6.25	6.25
2.0%	6.25	6.45	5.25

The flexural strength of the beams with different percentage replacement of grewia gum as admixture in concrete, were tested after each hydration age of 7, 14 and 28 days respectively. The results of the flexural strengths are presented in Tables 9. From the table above, 0% of grewia gum extract had strength values of 5.50N/mm^2,6.50N/mm^{2}and 5.63N/mm^{2}after curing in water for 7, 14 and 28 days respectively. The flexural strength of Portland cement high strength concrete with 1% addition of grewia gum extract cured in water (H_2O) and crushed at hydration period of 7, 14 and 28 days are 7.13N/mm^2,7.31N/mm^{2}and 7.63N/mm^2.The flexural strength of Portland cement high strength concrete with 1.5% addition of grewia gum extract cured in water (H_2O) and crushed at hydration period of 7,14 and 28 days are 5.63N/mm^2, 6.25N/mm^{2}and 6.25N/mm^2.The flexural strength of Portland cement high strength concrete with 2% addition of grewia gum extract cured in water (H_2O) and crushed at hydration period of 7, 14 and 28 days are 6.25N/mm^2, 6.45N/mm^2 and 5.25N/mm^2.

The relationship in the results presented for the beams shows that the flexural strength of the cubes with 1.0% replacement of grewia gum is higher than that with 1.5% and 2%.

Results for Splitting Tensile Strength

Table 10: Results for Splitting Tensile Strength Test of High Strength Concrete

Percentage replacement (%)s	Curing age (days) Strength of Cylinders(N/mm^2)		
	7	14	28
0%	3.11	4.06	5.12
1%	3.18	4.22	5.94
1.5%	2.63	2.79	3.50
2.0%	2.25	3.34	3.50

The Splitting Tensile Strength of the cylinders with different percentage replacement of grewia gum extract as admixture in concrete, were tested after each hydration age of 7, 14 and 28 days respectively. The results of the Splitting Tensile Strength are presented in Tables 10. From the table above, 0% of grewia gum extract had strength values of 3.11N/mm^2, 4.06N/mm^2 and 5.12N/mm^2 after curing in water for 7, 14 and 28 days respectively. The Splitting Tensile Strength of Portland cement high strength concrete with 1% addition of grewia gum extract cured in water (H_2O) and crushed at hydration period of 7 and 14 days are 3.18N/mm^2, 4.22N/mm^{2}and 5.94N/mm^2.The Splitting Tensile Strength of Portland cement high strength concrete with 1.5% addition of grewia gum extract cured in water (H_2O) and crushed at hydration period of 7, 14 and 28 days are 2.63N/mm^2, 2.79N/mm^{2}and 3.50N/mm^2.The Splitting Tensile Strength of Portland cement high strength concrete with 2% addition of gum extract cured in water (H_2O) and crushed at hydration period of 7,14 and 28 days are 2.25N/mm^2, 3.34N/mm^2 and 3.50N/mm^2.

The relationship in the results presented for the cylinders shows that the Splitting Tensile Strength of the cubes with 1.0% replacement of grewia gum extract is higher than that with 1.5% and 2%.

SUMMARY OF FINDINGS

From this research the properties of individual constituent making up the concrete were determined. Also, the properties of the wet concrete and hardened concrete were assessed. The density and strength properties were also determined. The major findings are highlighted below;

1. The chemical analysis of grewia gum extract used carried out in the chemical and physical of the National Metallurgical Development Centre, Jos, showed it as having a high content of CaO of 46.60% which is responsible for the increase in strength and also the increase in setting time of cement.
2. The result of sieve analysis shows that the fine aggregate used for the experiment is a well graded sand and falls within zone 1 of BS EN 12620:2002+A1:2008. The fine aggregate had a specific gravity of 2.66 and bulk densities of 1691.5Kg/m^3, and 1589.5 Kg/m^3 loose. This result falls within the lower limits for natural aggregate which have specific gravities between 2.6 and 2.7 (2011).
3. The coarse aggregate used had a specific gravity of 2.55 and bulk densities of 1431.35Kg/m^3, and 1311.95Kg/m^3 loose, which clarified it as normal weight aggregates.
4. The specific gravity of grewia gum extract was determined to be 1.9.
5. The specific gravity of cement used was determined to be 3.14.
6. The workability values for the fresh concrete for all percentage replacements of grewia gum extract showed a low description of workability for both slumps and compacting factor tests.
7. The cubes, beams, and cylinders with 2.0% replacement of grewia gum at the hydration period of 28 days, had the highest density.
8. There was an increase in the compressive strength of cubes with an increase in curing age of cubes.
9. There was an increase in the flexural strength of beams with increase in the curing age of beams.

10. Findings from this research work concludes that 1.0% replacement of grewia gum gave the highest strength higher than that of the control mix, and mixes containing 1.5% and 2.0% grewia admixture.

CONCLUSIONS

In order to investigate the strength properties of high strength concrete, different mixes were prepared with 0%, 1%, 1.5% and 2% grewia gum extract admixture with a mix ratio 1:1.9:1.9 and water/cement ratio of 0.50. The compressive strength, flexural strength and splitting tensile strength test were carried out on each mix at 7, 14 and 28 days. From the mixes, it was observed that the strength of high strength concrete increased when Grewia gum extract was added by 1% replacement level in the concrete mix. From the mixes, it was observed that the strength of high strength concrete decreases as the percentage replacement of grewia was increased to 1.5% and 2%.

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