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POTENTIAL OF UREA FERTILIZER (UF) AS A RETARDING ADMIXTURE IN PLAIN CONCRETE

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ABSTRACT
In this study, the use of Urea fertilizer (UF) as a retarding admixture in plain concrete was investigated. Six different mixes of proportion 1:2:4: and a water/cement ratio of 0.5 with (0, 1, 2, 3, 4 and 5%) by weight of urea fertilizer dosage in the concrete mix was adopted. Concrete cubes of 150mmx150mmx150mm made from the mix proportion and dosage of urea fertilizer were cast, cured and tested after 7, 14 and 28 days. It was observed from the study that urea fertilizer acts as a retarder in concrete production. The workability increased as the content of the urea fertilizer in the concrete increased. The compressive strength of the concrete decreased as the content of the urea fertilizer in the concrete increased. The final setting time increased from 20 hours to 50 hours at 5% UF content. The compressive strength decreased by approximately 57% from the control value to the 5% urea fertilizer content. The optimum UF content for standard concrete works is 0.5% which will give a compressive strength of 24 N/mm^2

Key Words: *concrete, compressive strength, retarder, urea fertilizer, workability*

INTRODUCTION
Concrete is a composite material used in different engineering purposes. It is composed of coarse aggregate, fine aggregate, water which are all bonded together by a binder cement. Most concrete used are lime based concretes such as Portland Lime Cement concrete. Concrete made with other hydraulic cements, asphalt concrete used for road surfaces is also a type of concrete where cementing material is bitumen.(https://en.wikipedia.org/wiki/concrete, 12/02/2018).

Concrete is the most widely used construction material. Due to its numerous advantages such as workability, good fire resistance, low cost and easy maintenance, however these vast properties of concrete has made researchers and scholars to investigate materials that can be added to improve the mechanical properties of the concrete.

Concrete is an economical construction material which is employed in a wide variety of applications on the ground, underground and under sea level. It is used in the foundations, pavements, storage tanks, piles, buildings, dams and other structures. Durability, compressive strength, impermeability, abrasion resistance, and resistance to environment attacks are important properties of concrete. Durability is the capacity of concrete to resist

deterioration from heating and cooling, freezing and thawing, and action by chemicals such as fertilizers. Concrete that is durable requires the integration of design, materials and construction. It depends on the materials used, full compaction and adequate curing (Wong et al, 2013).

Urea is an inexpensive form of nitrogen fertilizer with NPK (Nitrogen-phosphorous-potassium) with ratio of 46-0-0. Although urea is naturally produced in humans and animals, synthethic urea is manufactured with anhydrous ammonia. Urea is made when carbon dioxide is reacted with anhydrous ammonia. This happens under intense pressure at 350^{O}c. Dry urea is very soluble and must be kept away from moisture until its use. (https://homeguide.sfgate.com/urea-fertilizer, 12/02/2018).

(Wong,et al, 2013) observed that different types of fertilizers will attack concrete and heavily damage it. They established that factors that affect the susceptibility of concrete to damage include chemical composition of its ingredients and physical factors such as porosity, density and permeability at the time of its exposure to corrosive agents. The maximum damage of concrete is reported to be caused by ammonium salt.

(Wong et al, 2013) studied the effects of aggressive ammonium nitrate on the durability properties of concrete using sandstone and granite aggregate. They observed that a decrease in compressive strength and an increase in porosity were found through the conducted experiments.

(Lea , F.M., 1965) reported that the reaction between ammonium nitrate and concrete was reported as potentially aggressive. This is due to he removal of calcium hydroxide, the hardened cement paste will be decalcified causing the pH value to decrease.

(Maltais et al, 2014) concluded that the durability of concrete subjected to aggressive environments is affected by transport properties, which are influenced by the pore system.

(Amin and Bassuoni, 2018) studied the performance of concrete with blended binder in ammonium-sulphate solution. The results revealed that the type of binder along with the dosage and nature of SCM (Supplementary Cementitious Materials) dictated different modes and levels of deterioration and subsequently the physio-mechancial trends of concrete were characterized by softening with (single binders) or without (blended binders) significant expansion.

(Anin and Bassouni, 2018) also observed that PLC (Portland Limestone Cement) may slightly improve the resistance of concrete to ammonium-sulphate attack, whereas among the blended binders tested, binary binders comprising 5% silica fume, %% nanosilica or 30% fly ash improved the resistance of concrete to this type of chemical attack.

(Carde and Francois, 1997) from the result of their research concluded that ammonium nitrate which is a salt like ammonium-sulphate reduces the strength of concrete essentially due to the removal of calcium hydroxide during the leaching process by ammonium nitrate solution. Calcium hydroxide is the hydration product which replaces the space occupied by cement and water during hydration process. The calcium hydroxide reacts with ammonium nitrate yielding calcium nitrate and ammonia which are easily dissolved in water

Potassium nitrate which is a salt can give rise to chemical deterioration of concrete from leaching and decomposition of cement hydration products. (Hoffman,1980, Kurdowski et al, 1997, Heukamp et al, 2001).

This study investigated urea fertilizer as a potential admixture (retarder) in plain concrete.

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MATERIALS AND METHODS

Cement

Portland Limestone Cement (PLC) manufactured by DANGOTE INDUSTRIES Plc was used. The cement used in the study was (Grade 42.5). It conformed to (BS EN-197, 2011).

Fine Aggregate

Naturally occurring river sand obtained from Imo River in Oyigbo Local Government Area of Rivers State was used. The maximum size was 4.75mm. Impurities were removed and it conformed to the requirements of (BS 882,1992).

Coarse Aggregate

Coarse aggregate used is crushed angular and rough textured granite obtained from CRUSHED ROCK INDUSTRIES Plc at Isghiagu io Ebonyi State, South Eastern Nigeria. Maximum size was 20mm. It conformed to (BS 882, 1992).

Urea Fertilizer (UF)

Urea Fertilizer **(UF)** was used in this work . It is highly soluble in water. It has a crystal prismatic state and it is colourless to white. It was obtained from a chemical supplier in Mile 3 area of Port Harcourt. It is also referred to as ammonia.

Water

Potable water used was obtained from the Civil Engineering Laboratory of the Rivers State University, Port Harcourt. The water conformed to (BS 3148, 1980).

METHOD

Mix Design

The concrete mix ratio was 1:2:4.by weight (cement:fine aggregate: coarse aggregate) with water/cement ratio of 0.5.

Slump Test

The workability of all concrete mixtures was determined through slump test utilizing a metallic slump mould. The difference in level between the height of mould and hat of the highest point of the subsidized concrete was measured and reported as slump. The slump tests were performed according to (BS 12350-2, 2009).

Setting Time of Concrete

The setting time of the concrete was measured by extracting some portion of concrete (mortar portion) by subjecting to wet sieving through 4.75mm sieve. The test was performed in accordance with (BS EN 196-2, 1995).

Compressive Strength

The compressive strength of the concrete with (0, 1, 2, 3, 4 and 5%) UF (Urea Fertilizer or ammonia) were determined after 7, 14 and 28 days curing period. The 0% UF was the control experiment. The test was performed in accordance with (BS EN 12390-3, 2009).

RESULTS

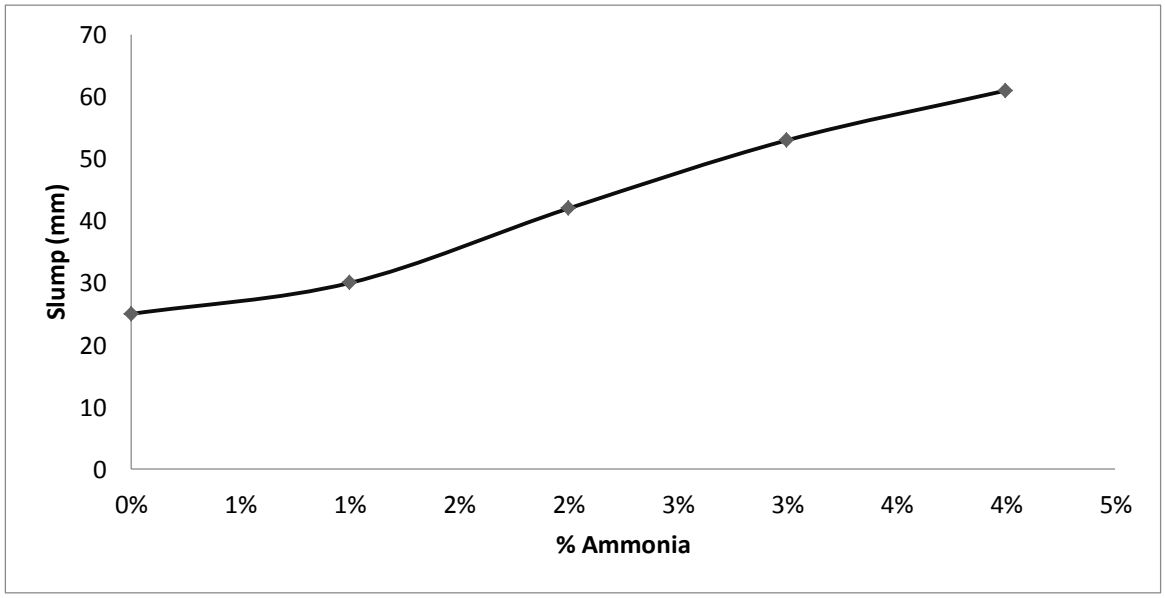

Figure 1 - Slump against percentage ammonia

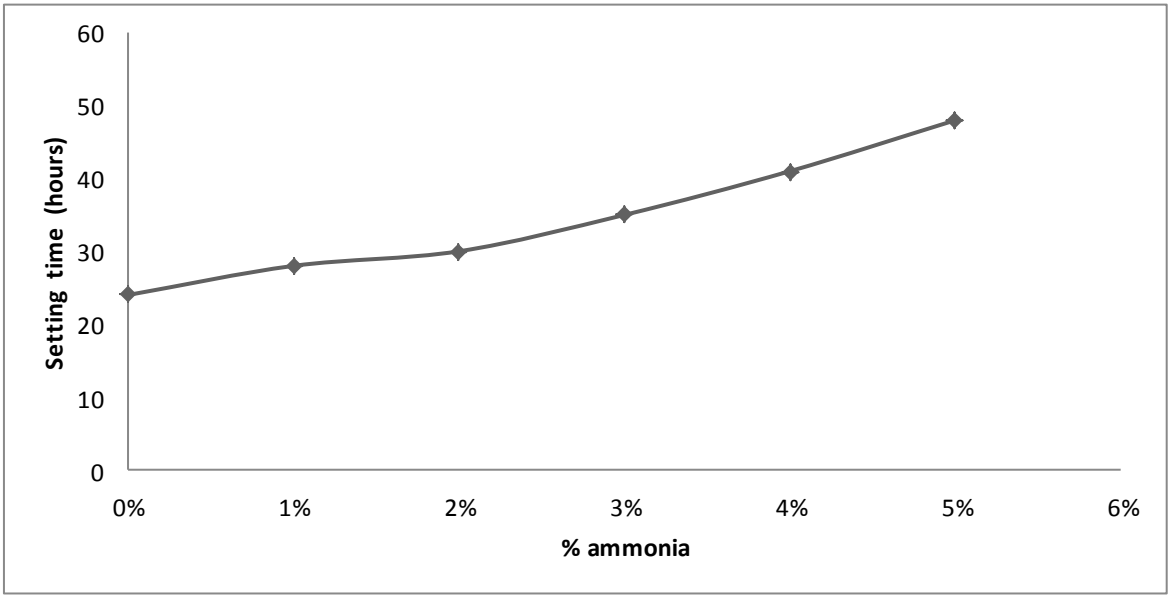

Figure 2 - Setting time against percentage ammonia

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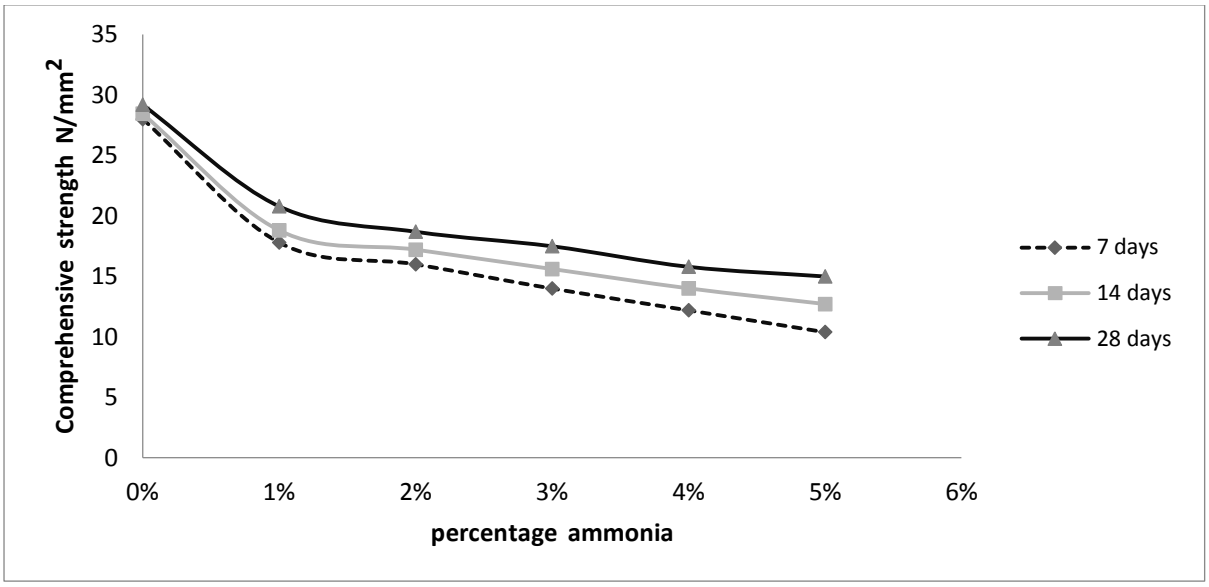

Figure 3: Compressive strength versus percentage ammonia

DISCUSSION

Slump Test

Figure 1 shows the plot of the slump values for the concrete with various percentage of UF. The slump values increase as the UF content increases. The UF dissolves in the concrete and the increase in fluidity leads to an increase in workability of the concrete. Maximum slump of 60mm was obtained at 4% UF content.

Setting Time

Figure 2 is the graph of the setting time versus the percentage of UF in the concrete. The final setting times increases as percentage of the UF content is increased. The UF dissolves in the concrete and the increase in fluidity leads to an increase in setting time of the concrete. The final setting time increased from 20 hours to 50 hours at 5% UF content.

Compressive Strength

Figure 3 shows the plot of the compressive strength after 7, 14 and 28 days of curing for the (0, 1, 2, 3, 4%, 5 and 6%) UF content. At all ages of curing the compressive strength of the concrete decreased as the percentage of the ABF content increased. The UF as salt can give rise to chemical deterioration of concrete from leaching and decomposition of cement hydration products. This result follows a similar pattern of result obtained by [8-10]. The compressive strength decreased by approximately 57% from the control value to the 5% urea fertilizer content. The optimum UF content for standard concrete works is 0.5% which will give a compressive strength of 24 N/mm^2

The following conclusions were made from the result of the experiment.

1. Urea fertilizer increases the setting time of concrete.
2. Slump/Workability of the concrete increased as the UF content increased.
3. Compressive strength at all ages of curing decreased as the percentage of ABF content in the concrete increased.

4. Urea fertilizer can be used as retarder in foundation of buildings for the blinding of the foundation in cases that require slow setting with no consideration for strength.

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