Compressive Strength Of Re-Vibrated Concrete Containing Locust Bean Epicarp Extract And Bida Natural Stone As Coarse Aggregate

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Abstract:

The compressive strength of re-vibrated concrete containing locust bean epicarp extract and Bida Natural Stone (BNS) as coarse aggregate. one hundred and sixty-eight concrete cubes were produced in six batches, in which twenty-eight cubes was produce in each of this batches. However, two of these batches were at 0% LBEE + 100% OPC and 100% LBEE + 100%OPC, the rest are at cement reduction content of 5, 10, 15 and 20%, but all the others concrete mix ingredients remained constant. The epicarp used was at constant concentration of 0.1kg/l. The concrete mix adopted was 1 :2 :4 using ordinary Portland cement with water cement ratio of 0.5. The preliminary results show that the aggregate falls within the BS requirement. Concrete cubes were cast with re-vibration time lag intervals of 10minute for the period of 60minute re-vibration process and cured for 7 and 28days. When tested for their respective compressive strength, the result obtained shows that there is increase in compressive strength with increase in re-vibration time lag. The result also shows that introduction of LBEE increase compressive strength of concrete produced despite cement reduction up to 20%. The maximum compressive strength for all batches at 28days curing was obtained at 60 minutes. For batch B at 40-minute re-vibration time interval for and water cement ratio of 0.5 at constant concentration LBEE of 0.1kg/l. The maximum attained compressive strength for 28days curing was 36.27N/mm^2 for B (100% LBEE + 100% OPC) appears to be higher than 35.42N/mm^2 for A (0% LBEE+ 100% OPC). This indicates that the uses of LBEE has adversely enhanced the compressive strength of concrete when re-vibrated.

Keywords*:* Bida natural stone, Locust Bean Epicarp Extract, Ordinary Portland Cement, British standard

1.0 INTRODUCTION

Innovators throughout the construction industry are making great strides towards increased environmental sustainability by updating processes, improving designs, and selecting greener materials (Brett et al.,2015). Nigerian government has launched a mortgage refinance scheme for reconstruction of some part of the country affected by insecurity, the ways out are to replace a proportion of cement in concrete production with cheap and available pozzolanic materials from agro waste, the analysis of locust bean epicarp extract (LBEE) showed that the combination of its chemical constituents qualify it as pozzolana material. (Auta et al., 2015).

The epicarps, containing locust bean seeds, resemble that of a soya bean epicarp that starts out as a bright green and turns dry and deep brown as it matures on the tree. In the middle belt and Northern states of Nigeria the epicarp is used in the rural areas in compaction of floor, the epicarps are collected and soaked in water for at least four days and extract is the needed item which is used

to cast the mud blocks for building purposes. (Aguwa et al., 2012). On further investigation, the natives or rural dwellers have simple evidence to show that buildings made of locust bean epicarp extracts are not attacked by termites in termites infested areas in compare to those built without the epicarp extracts. These buildings and fence walls have been found to withstand different types of weather conditions such as rains, wind and heat over a long period of time (Auta et al., 2015). Hence this research work sets out to study cementation nature of LBEE in concrete production. In northern part of Nigerian, the seeds of locust bean are used for food and it is popularly known as Dawadawa. The fruit is also sweet and can be consumed directly by people while the epicarp is used in maki ng gums in the industries. Locust bean epicarp apart from being food is medicinal in relief of diarrheal. The bark is boiled to make tea for treatment of wounds and fever. Several authors have reported on its medicinal uses and treatments (Aguwa et al., 2016).

The repeated operation of vibration of the fresh concrete after a period, which is called re-vibration, which may be beneficial to improve the properties of concrete especially when successive layer of fresh concrete was placed and the upper layer of fresh concrete was partially hardened. Re-vibration after time re-arranged the aggregate particles and eliminates entrapped water, which may improve the tensile strength, compressive strength and bond strength between the reinforcing bar and the concrete. Plastic shrinkage cracks for the exposed concrete can also be eliminated by the operation of re-vibration. Re-vibration affect significantly by the time duration of re-vibration. Abbas (2017). The investigation on Effect of Re-vibration on the compressive strength of 56-aged RHA -cement concrete and it was reported that vibration of concrete has play a major role on the strength and quality concrete. It is also established that initial vibration can provide improved concrete-steel bond when compared with hand tapping with rod (Auta et al., 2015b). The report on flexural strength of re-vibrated reinforced concrete beam with saw dust ash as partial replacement for cement. They tested seven beams of size 150 x 150 x 600 mm reinforced with 12 mm diameter steel bar. The beams were re-vibrated for 20 seconds at an interval of 10 minutes successions up to one hour after initial vibration. They concluded that the re-vibrated had improved the flexural strength of reinforced beams (Auta et al.,2016). Auta. (2011) Analysed dynamic effect of re-vibration on the compressive strength of concrete using a mix ratio of 1:2:4 of OPC, he observed that at successful time lag intervals of 5 minutes each for 60 minutes, there was an appreciable rise in the compressive strength of the concrete. However, less is reported about the importance of re-vibration, the process in which a vibrator is reapplied to monolithic concrete at some time after initial vibration. Initial vibration of concrete may not totally eliminate defects, such as honey comb and voids leading to reduction in strength and performance of the concrete. But re-vibration eliminates defects (honey comb and voids) and thereby increasing the compressive strength of the concrete, improved concrete quality, increased bond, better impermeability, reduction in shrinkage and creep, reduction in surface and other voids as well as cracks in fresh concrete and so on. The time of re-vibration and water cement ratio plays an

important role in achieving a good re-vibration. But in this study the re-vibration time interval of 0, 10, 20,30,40,50,60 minutes and water cement ratio of 1:2:4 is considered.

Bida natural stone is of different sizes and shape like granite, BNS contains impurities which will definitely affect the strength of resulting concrete therefore, gravels need to be sieve and wash, (Shehu et al., 2016) reported that Granite materials have been found to be more suitable coarse aggregate as in the conventional concrete. Although, Bida natural stone has shown a tremendous performance in concrete works, there is very little information on this material in the technology of self-compaction concrete (Yusuf A. et al 2020) report that ever-increasing population calls for the need to source for alternative coarse aggregates suitable for use in concrete as quarry locations are not always close to construction sites. Since coarse aggregate accounts for the largest proportion of concrete and the least expensive, a research of locally available gravel with satisfactory engineering properties is important. Previous research reported that poor choice of aggregate, reactive, unsound and unsuitable aggregates are part of the causes of building failure. (Gideon O. B. et al., 2015) report that extensive research findings have advocated the use of locally-available materials to reduce the cost of infrastructure systems and thereby making building affordable to the middle and low–class residents. Hence, any advocacy for completely new or blended materials should be tested both structurally and mechanically to ascertain the short-time and long-time behaviours. This will certainly help to establish a well-define boundary or clearly spelt out limitation especially when local code of practice for design, construction and workmanship is yet to be published for Engineers and builders. Therefore, the aim of this work is to determine compressive strength of revibrated concrete containing locust bean epicarp extract LBEE and Bida natural stone BNS as coarse aggregate. Addition of LBEE as binder in the production of concrete has been established to have significant increase in the compressive strength of the concrete. (Auta et al., 2015). The objectives of the study include: carrying out physical and chemical properties of aggregate, Production of 168 concrete cube specimens containing LBEE and BNS, carrying out compressive strength test in concrete produce.

2.0 MATERIALS AND METHOD

2.1 Materials

The material that was used for production of the concrete are ordinary Portland cement. water, fine aggregate, Bida natural stone as coarse aggregate and locust been epicarp. The pounded Locust bean epicarp were soak in water for at least 4days, the soaked epicarp is allow to pass through 300microns B.S sieve for the remove of residue that will affect require function of LBEE. River sand obtained from river lanzuna in Niger state Nigeria were used as fine aggregate. The Bida natural stone was used as coarse aggregate material with particle size between 18 to 20mm. The water used was collected at Department of civil federal university of Technology Minna Niger state, Nigeria. This water is portable and can be used to make concrete as conformed with B.S requirement.

Plate 1: Locust bean fruit

Plate 2: Bida natural stone

2 .2 METHODS

The preliminary test carried out include specific gravity, sieve analysis, moisture content. The concrete mix design adopted was 1: 2: 4 and water cement ratio 0.5 were used. Slump test of fresh concrete was conducted and the results were presented table.

2.2.1 Production of Concrete Cube Specimens

The following equipment were used in production of concrete cubes: steel mould, metal base, steel rod, shovel and trowel the mould was placed on a hard surface and filled with concrete in such a way that entrapped air can be easily removed and to produce full compaction concrete cube of size (150 x 150 x 150) mm to avoid excessive segregation. The concrete is placed in the mould in three (3) layers and compacted using tapping rod of 16mm diameter. Each layer is tapped 25 blows of the standard 16mm rod, the final layer of cube was smooth at the trim with use of hand trowel and than revibrate using re-vibrating plate machine. The concrete cubes were allowed to set and harden for 24 hours before demould. They were transfer to curing tank fill with water and cure for 7 and 28days. At end of 7and 28days curing, the cube was removing and compressive strength test were determined accordance to BS 1881 of 1983.

2.2.2 Compressive Strength Test

The test was carried out in accordance to BS 1881 1983, to determine crushing strength of cube and subsequently to determine compressive strength of concrete. It was carried out using electrically power testing machine in the concrete laboratory, Civil Engineering Department, federal university of technology Minna, Niger state, Nigeria, and hundred and sixty-eight (168) concrete cubes were tested at7 and 28days curing.

3.0 Results and Discussion

From the result of test carried out on the engineering properties of aggregate and other materials for the concrete production were presented in table 3.1.

Table 3.1: Characteristic of fine aggregate

S NO	Test	Result	BS Requirement
1.0	Specific gravity	2.65	2.6 - 3.0
2.0	Bulk density (kg/m^3)	1635	1500 – 1700
3.0	Moisture content	2.54	5 - 15

Table 3.2: Characteristic of Bida natural stone (as coarse aggregate)

S NO	Test	Result	BS Requirement
1.0	Specific gravity	2.68	2.4 - 2.8
2.0	Bulk density (kg/m3)	1563.125	1300 – 1800
3.0	Moisture content	5.51	1 – 5
4.0	Water absorption	0.885	0.5 - 5

Table 3.3: Characteristic of fresh concrete

S NO	Test	Result
1.0	water cement ratio	0.5
2.0	Mix proportion	1: 2 : 4
3.0	Slumps	9.0, 0.0. 0.0. 2.0, 5.0, 0.0
4.0	Number of cubes cast	168
5.0	Maximum compressive strength after 28days Curing	36.27N/mm^2

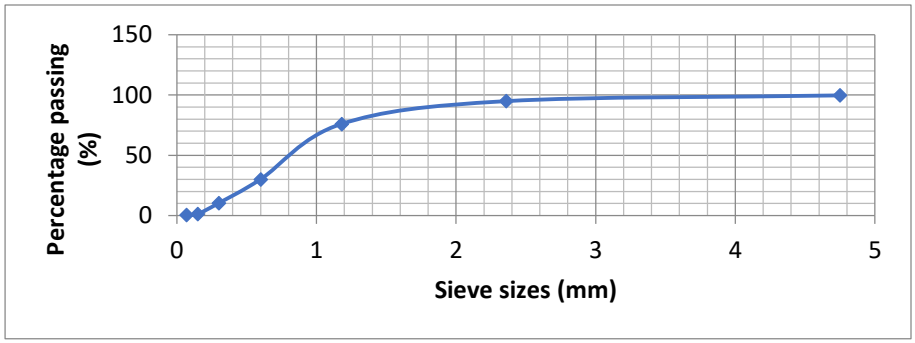

Figure 3.1 Sieve analysis of fine aggregate

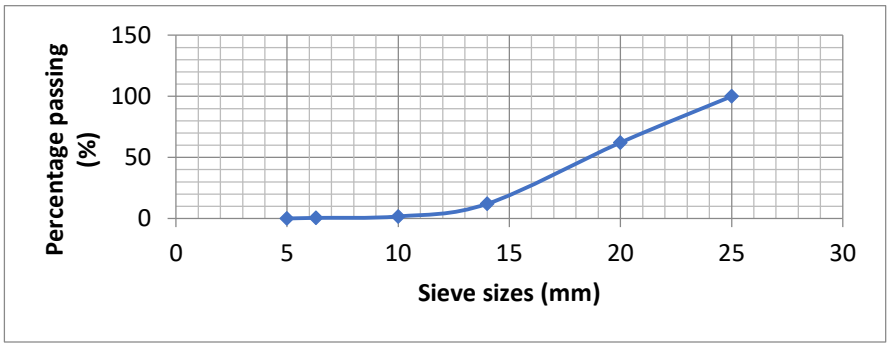

Figure 3.2 Sieve analysis of Bida natural stone (As coarse aggregate)

From the results of particle size distribution carried out in accordance to BS 812 Part 103, 1985 and presented in figure 1.0 and 1.1 shows that aggregate are well graded materials. the average specific gravity obtained for Bida natural stone (as coarse aggregate was 2.68 and that of fine aggregate is 2,65 which are found to be with the standard range of 2.4 – 2.8 and 2.6 – 3.0 respectively (BS 812 of 1995). The average moisture content obtained for Bida natural stone as coarse aggregate is 5.51 % and that fine aggregate is 2.54% respectively which has been found to be deviate from BS requirement of 1 – 5% and 5 – 15%. The average water absorption capacity for Bida natural stone was found to be 0.885% which is within standard range of 0.5 – 5% (BS 812 of 1995). The slump test that was conducted on the sample show that with introduction of locust bean epicarp extract as water in concrete result in reduced the slump and consequently lead to stiffness of concrete mix.

Table 3.4: Compressive strength for 7days curing

S/N	REVIBRATION INTERVAL (M)	COMPRESSIVE STRENGTH (N/mm^2) FOR 7DAYS					
		A	B	C	D	E	F
1	0	18.87	22.20	21.56	21.44	20.89	20.13
2	10	24.89	25.29	22.76	22.45	21.96	21.20
3	20	26.13	27.38	22.85	22.63	22.35	21.98
4	30	26.43	28.18	23.16	23.02	22.38	22.14
5	40	26.89	29.07	24.62	24.13	22.89	22.80
6	50	27.34	28.49	24.93	24.32	23.51	23.00
7	60	28.45	28.53	25.42	24.85	24.40	23.52

Table 3.5: Compressive strength for 28days curing

S/N	REVIBRATION INTERVAL (M)	COMPRESSIVE STRENGTH (N/mm^2) FOR 28DAYS					
		A	B	C	D	E	F
1	0	23.56	27.69	26.93	26.76	26.18	25.11
2	10	30.36	30.36	28.40	28.13	27.25	26.22
3	20	31.16	34.18	28.99	28.58	28.22	27.69
4	30	31.69	34.98	30.09	29.96	29.12	28.49
5	40	32.67	36.27	32.00	31.29	30.49	30.18
6	50	34.05	35.56	32.13	31.87	30.99	30.27
7	60	35.42	35.65	33.03	32.13	31.69	31.47

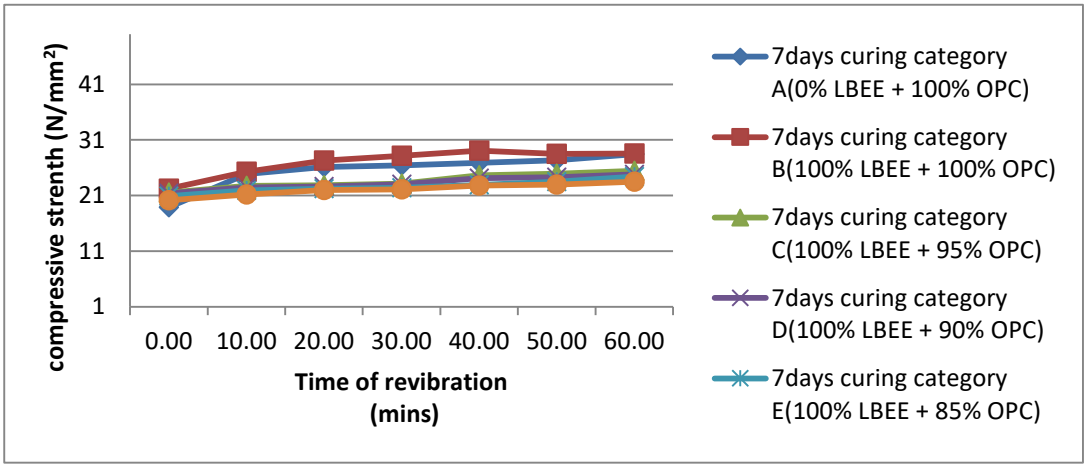

Figure 3.3: Compressive strength and re-vibration time lag for 7days curing

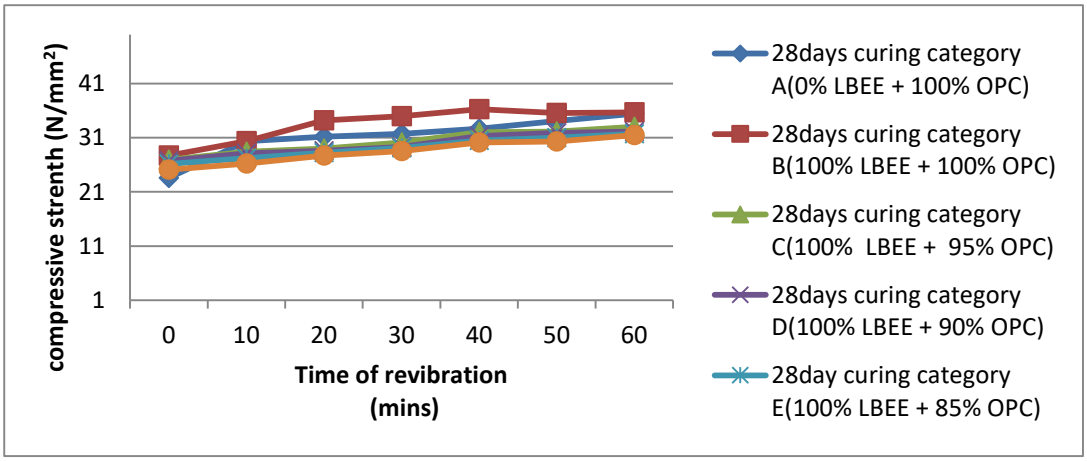

Figure 3.4: Compressive strength and re-vibration time lag for 28days curing

The compressive strength of concrete at various re-vibration time intervals of 10 minutes for 7- and 28-days curing are obtained and presented in table 3.4 and 3.5 and the graphical representation of compressive strength is in figure 3.3 and 3.4 respectively. It can be observed that compressive strength increases for all categories and control. The minimum compressive strength is obtained at 0 minute re-vibration 18.87N/mm^2, 22.20N/mm^2, 21.56N/mm^2, 21.42N/mm^2, 20.89N/mm^2 and 20.13N/mm^2 for control and other categories for 7days. The results also show that despite cement reduction up to 20% and introduction of LBEE the compressive strength obtained matches and even surpasses that of control specimens of the same age. The result obtained is similar to that of Auta S. M. (2011) on

dynamic effect of re-vibration which yield 11.96N/mm^2, 15.64N/mm^2, 18.31N/mm^2 for the 7days curing. The result also to that obtained by (Auta. et al., 2015) when rice husk ash is used as a pozzolana, the 7 and 28days strength yielded 5.63N/mm^2 and 10.81N/mm^2.

However, the maximum compressive strength is obtained at 60 minute re-vibration time intervals for control and some other categories expect category B (100% LBEE + 100% OPC) with the maximum compressive strength of 36.27N/mm2 at 40minute re-vibration time interval, it is also observed that the minimum compressive strength for 28days curing is greater than the maximum compressive strength at 7days curing for control and some other categories expect categories A and B. The time of re-vibration process is observed for 60minute which is below the initial. Setting time of the concrete following that the compressive strength of re-vibrated concrete will be on the increase provided the re-vibration process is done with in the initial setting time of the concrete thus enhancing the compressive strength of the concrete. The result also shows that the variation in compressive strength with non-revibrated concrete for 7 and 28days is up to 13.77 % and 16.71%.

4.0 Conclusion

The research work considered compressive strength of revibrated concrete containing locust bean epicarp extract and Bida natural stone as coarse aggregate and the following conclusion were arrived:

1. The compressive strength of the concrete increase as the curing age increase for all categories.
2. Re-vibration has increased the compressive strength, yielding maximum concrete strength of 36.27N/mm^2.
3. Bida natural stones can be used when the concrete of normal strength is required.

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