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CONCRETE LINTEL PERFORMANCE WITH LECA FOR IBS

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PROBLEM STATEMENT

According to research held by R.N Raj Prakash and A, Krishnamoarti (2017), study shows that it is very difficult to produce stable lightweight concrete and it is due to the fact that most Lightweight Aggregate (LWA) absorb water in a quick pace. It is inefficient to use aggregates in the immersed, surface-dry condition. Also, water compound for aggregates should be minimized with a specific end purpose to ensure the concrete density remains low.

The next problem, according to Nagashree B and Dr. S. Vijaya 2015, one of the factors of high permanent load is due to concrete self-weight. In according to this, research has been done by researchers to reduce dead load by choosing materials that give concrete low density while maintaining and improving concrete strength

While according to Payam Shafigh and Fathollah Sajedi (2010), the continuous environmental problems, along with decrease in number of conventional aggregates existing has led researchers to use by-products or solid waste materials to produce concretes.

PAST RESEARCH

Research Title	Author	Summary	Findings
Effect of Curing Condition on Some Properties of Cement Stabilized Lateritic Interlocking Bricks	Manasseh Joel Joseph E. Edeh	The effect of three different curing conditions on the compressive strength and water absorption of lateritic interlocking bricks, produced with laterite stabilized and cement content was investigated. The study is aimed at providing an alternative to the conventional method of curing interlocking bricks. The three curing conditions used in the study are "A" (covering of bricks with tarpaulin after sprinkling with water twice a day) "B" (complete immersion in water	-best curing method to be done to obtain best strength for our LECA concrete block and any concrete -best curing method in different condition of sites

		"C" (complete covering with air and water tight polythene bags). Laterite used in the production of interlocking bricks was as an A-2-7 soil, using the AASHTO system of soil classification.	
Investigation on various construction material LECA, thermal insulated and conventional blocks	Nandhakumar R. Partiphan G. Thangeeswari T. Karthikraja S. Gangadurai B.	Among the various construction materials, LECA (light weight expanded clay aggregate) is a versatile material due to its unique properties and is utilized in many applications. LECA blocks are highly impermeable and have high performance properties. Thermal insulated blocks are well suited for high rise buildings to withstand high temperature. It requires less steel and concrete for structural members due to its lower density. The LECA is mixed with grade M30 with 50% and 100% of replacement. The molded concrete blocks were tested to determine the strength and workability of the blocks under various experimental conditions and different time periods such as 7 days and 28 days. The tests such as compression test and water absorption test were conducted. From the experimental investigation, we will be able to conclude the best among these blocks based on their strength.	LECA performance with 50% content+ normal aggregate and 100% content+0 normal aggregate Mix ratio idea for LECA Comparing the performance of normal aggregate concrete and LECA partial and fully concrete performance Normal concrete are strong and LECA (fully) concrete are weak, but with the right mix (partial), it can achieve better performance than normal concrete
Production of Concrete Block Using Recycled Aggregate	Eathar Thanon Dawood	The main materials that used in this study are cement, sand, gravel, water, superplasticizer (Conplast SP423) as well as, the sawdust and/or PVC waste materials. Thus, the study includes two stages; the first stage deals with the production of concrete specimens with different percentages of sawdust and/or PVC waste materials as	Possible additive in the concrete mixture to improve compressive strength

		partial replacement of the total aggregate in the Possible additive in the concrete mixture to improve compressive strength mix. The strength of compression and airdry density were tested. The second stage of this study includes the production of concrete block using these waste materials. The produced concrete block units have been tested in compressive strength, density and absorption. The results show that the use of 8% to 10% of PVC waste and combination of PVC waste and sawdust are selected for the production of concrete block units. The decrease in the weights of concrete block due to sawdust and/or PVC waste materials encourages the engineers or researchers to produce such concrete block by the use of these materials in the manufacture. The produced hollow block units produced from the uses of 4% PVC waste + 4% sawdust shows best result, while 5% PVC waste + 5% sawdust comes second.	
Physical and Mechanical Properties of Light-weight Expanded Clay Aggregate (LECA)	Azhani Zukri Ramli Nazir Khairun Nissa Mat Said Hossein Moayedi	This paper focused on the properties of LECA aggregates supplied by LEXCA Sdn. Bhd. through laboratory tests in accordance to the standard specifications. The properties of several LECA produced from different country and production plants are also reviewed for comparative purpose. In addition, the material properties evaluated from previously conducted research also was discussed. It was found that, even though LECA was produced from the same raw materials, it	Performance of lightweight aggregates other than LECA without being mixed in concrete (raw aggregate form) Performances of LECA from different manufacturing sites LECA can be classified as gravels The smaller the lightweight aggregate particle

		has certain range of property values. The properties of LECA show their suitability and potential for replacing natural aggregates in many civil engineering works.	size, the higher the density. LECA aggregate will absorb 30% moisture by mass of dry aggregate
A Comparison study of Fresh and Hardened Properties of Normal Weight and Lightweight Aggregate Concrete	Payam Shafigh Lee Jin Chai Hilmi Bin Mahmud Mohammad A. Nomeli	This study compares the engineering properties of normal weight concrete with those of concrete with two types of lightweight aggregates, namely, oilpalm boiler clinker (OPBC) concrete and lightweight expanded clay aggregate (LECA) concrete. OPBC is a porous solid waste from the palm oil industry, while LECA is an artificial and impenetrable material. The conventional coarse aggregates in a high-strength normal weight concrete were replaced by each of these lightweight aggregates, and the effect of such substitution on the fresh and hardened properties of the concrete was studied. The test results revealed that the OPBC concrete outperforms the LECA concrete in terms of workability, mechanical properties, and specific strength. The LECA concrete achieved its ceiling strength in 7 days, while the OPBC concrete still had strength gain by time. The LECA concrete demonstrated a greater drying shrinkage than both the normal weight and OPBC lightweight concretes between 14 days and 90 days. The use of OPBC must therefore be promoted to produce a cleaner and greener concrete that can benefit the construction and agricultural industries.	OPBC performance compared to LECA Another clue to mix ratio of our LECA concrete Boundary of LECA performance in concrete mixes Lightweight aggregate concrete compared to normal aggregate concrete Use of superplasticizer in concrete Mix used in this previous study was grade 70

Experimental Investigation on Mechanical Properties of Lightweight Concrete Using LECA	T. Sonia R. Subashini	This research used LECA with various percentages to substitute the coarse aggregate and various percentage of fly ash as replacement of cement in concrete. Water cement ratio used was 0.48. The normal aggregate replacement percentage was 20%, 40%, 60%, 80% and 100%. While 15%, 20% and 25% of fly ash replacement percentage for cement concrete. The concrete mix ratio was 1:1.4:2.4 and 1:1.86:0.52. The concrete mixes were casted in standard cube mould and cylinder mould. The casted moulds were cured for 28 days before brought out from water for 24 hours before testing. The tests done are slump test, compressive strength test and split tensile test. The LECA concretes shows better results when replaced with 40% and 60% of coarse aggregate compare to conventional concrete.	In strength performance of 15% replacement of fly ash content with 40% replacement of coarse aggregates concrete for better results to ensure its optimal proportion. The density of concrete is found to decrease with the increase in percentage replacement of normal aggregate by LECA.
Experimental Study on Lightweight Concrete Using LECA and Cinder as Coarse Aggregate (2015)	Nagashree B. Dr. S. Vijaya	Research was done to study the compressive strength and tensite strength, along with workability to fine the correlation between these three for Leca and Cinder as course aggregate for concrete	Slump test shows that 40% Leca with 60% cinder shows best slump compared to other percentage. Despite highest compressive and tensile strength are at 0%Leca and 100% cinder, with accordance of slump test, 40% Leca and 60% cinder are chosen as the best mix percentage in the study

RESEARCH METHODOLOGY

Before the lintel is made, the design has been designed to identify the appropriate features of the lintel and its functions. The design is intended to describe the project to be implemented and to provide more detailed information to produce a quality lintel. The size of concrete lintel that will be produce is 70 mm × 100 mm × 1200 mm.

The data collection procedures (compressive strength test and flexural strength test) were implemented with specific objectives in mind. The tests were initiated with the aim of gaining the data of the lightweight lintel structure to determine if the lightweight lintel structure could be used in the real construction situation.

Data collected from experiments conducted on lintel are reported in the appropriate table using Microsoft Excel. Comparison of results between blocks containing different percentage of LECA for all experiments will be studied and reported in graphic form using Microsoft Excel. This is because the relationship between the experimental data and the material composition of the block is obtained from the block using LECA sample process is studied and discussed and also reported in graph form.

PROPOSED SOLUTION

In accordance to weight problem, we highlighted lightweight materials as a solution. While in accordance to environmental problem and depletion of conventional aggregate, we highlighted by-products material as a solution. With lightweight aggregate and by-products as highlights, we found out LECA, an aggregate which is made by burning clay in rotary kiln over 1.150 °C. According to all past research and also our observation in site, LECA has a very low density when compared to conventional aggregates, which makes it to be a choice to replace aggregate.

LECA according to Nagahree B and Dr. S. Vijaya (2015),is non Destructible, non-combustible and have resistance to attack from dry and wet-rot, also from insects attack. This will affect the artistic value of the concrete as it preserves the concrete surface.

BENEFITS TO ECONOMY / COUNTRY / COMMUNITY / NATURE

In term of economy, the cost of construction industry will reduce due to the reduced weight of concrete by using LECA. Transportation of LECA as raw material is low due to their weight, and Pre-fabricated concrete structure containing LECA can be transported in a larger quantity. Labour usage in attaching concrete members may also be reduced as the concrete containing LECA has lower weight than conventional concrete.

While in term of community, with the use of LECA in concrete and it's trait of good thermal insulation, and sound insulation, Sound pollution may be reduced with the use of this concrete. Energy can also be saved in heating or cooling building. Heat that goes into LECA concrete flows better than conventional concrete, which makes them store less heat compared to conventional concrete.

Next, in term of nature, LECA which is made of clay, the depletion is much lower than conventional concrete. Therefore, the worry of it being fully consumed is little and will slow the depletion of conventional aggregate.

IMPLEMENTATION METHOD

In using LECA as course aggregate, specific mix proportion must be used to obtain specific strength. According to Payam shafigh and Muhammad A. Nomeli (2017), test results of 100% LECA aggregate, when compared to 100%OPBC aggregate and 100%normal aggregate concrete, shows that LECA has the lowest strength among the three. This gives us clue that 100% Leca is not suitable for our mix proportion. Hence, we referred to the other researchers for better mix proportion.

Table shows LECA proportions in concrete mixes done by several researchers, used by us to find out and compare which mix is best.

Author	Mix concrete	Compressive strength	Density or weight
R.N Raj Prakash et al (2017)	0%LECA100%Normal 20%LECA80%Normal 40%LECA60%Normal 60%LECA40%Normal	32Mpa 29Mpa 25Mpa 19Mpa	8.4kg 7.1kg 6.9kg 6.5kg

	80%LECA20%Normal 100%LECA0%Normal	15Mpa 13Mpa	5.2kg 5kg
Muhammad A. Nomeli (2017)	100%LECA 100%Normal 100%OPBC	15Mpa 70Mpa 55Mpa	2370 kg/m3 2121 kg/m3 1603 kg/m3
T. Sonia et al (2015)	0%LECA100%Normal 20%LECA80%Normal 40%LECA60%Normal 60%LECA40%Normal 80%LECA20%Normal 100%LECA0%Normal	34.6N/mm2 30.22 N/mm2 28.56 N/mm2 26.4 N/mm2 23.57 N/mm2 21.77 N/mm2	2477 kg/m3 2194 kg/m3 1996 kg/m3 1868 kg/m3 1739 kg/m3 1597 kg/m3
Dr. P. Prakash and Anil Kumar R. (2015) M30	0%LECA100%Cinder 10%LECA90%Cinder 20%LECA80%Cinder 30%LECA70%Cinder 40%LECA60%Cinder 50%LECA50%Cinder 60%LECA40% Cinder 70%LECA30%Cinder 80%LECA20% Cinder 90%LECA10%Cinder 100%LECA0% Cinder	38.6N/mm2 37.9N/mm2 37.4 N/mm2 36.8N/mm2 36.5 N/mm2 30.4 N/mm2 27.2 N/mm2 26.2 N/mm2 25.1 N/mm2 24.5 N/mm2 23.2 N/mm2	2364 kg/m3 2309 kg/m3 2229 kg/m3 2182 kg/m3 1910 kg/m3 1837 kg/m3 1773 kg/m3 1690 kg/m3 1636 kg/m3 1541 kg/m3 1506 kg/m3

According to T. Sonia and R. Subashini (2015), it is shown that LECA reduces density as the use of LECA increases, while it also reduces strength of concrete as the use of LECA increases. But according to the table above, it is shown that LECA shows balanced result between density and strength between 40% use to 60% use. Therefore, we use 50% as a border and thus, our study tests the density and strength of LECA concrete cubes at 48% LECA with 52% conventional aggregate, and 52%LECA with 48% conventional aggregate. Despite our study are on concrete lintel, it is believed that such LECA mix proportion may be applicable in other concrete products.

In term of mixing, as LECA absorbs water, additional water must be added into the mixing aside the water-cement ratio to keep the concrete from being too dry. Cautious is important as adding too much water will make the concrete fail.

CONCLUSION

The primary goal for this project is to produce lightweight lintel structure using LECA. A particular type of lightweight concrete called structural lightweight concrete is the one which is comparative lighter than conventional concrete but at the same time strong enough to be used for structural purposes. It, therefore, combines the advantages of normal weight concrete and discards the disadvantages of normal weight concrete. This lintel structure using LECA will be tested and data will be gathered to determine the success.

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