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Experimental Study on the Elastic Properties of Lime-Cement Concrete

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ABSTRACT

In this investigation, elastic properties of lime-cement concrete was experimented. Properties of concern were the modulus of elasticity (MOE), modulus of rigidity (MOR) and Poisson ratio. Several mix proportions having some inclusion of hydrated lime (between 10% and 30%) in place of Portland cement were considered. Concrete produced were normal weight in nature. A maximum of 3 specimen were cast for each mix proportion and then subjected to compressive and flexural tests after curing for28 days.150mm x 150mm x 150mm concrete cubes were used for the compression test. While, 150mm x 150mm x 300mm concrete beams were used for the flexural testing. An optimum MOE reading of $30.708264\times10^3 N/mm^2$ *was achieved at a mix proportion of 0.8125:0.1875:2.225:4.445 [Portland cement (PC): Hydrated lime (HL): Sand: Granite] with corresponding water-cement (w/c) of 0.562. This result reveals an optimum percentage inclusion of HL of 18.75%. On the other hand, least value of MOE of* $20.264\times10^3 N/mm^2$ *was noticed to occur at a mix ratio of 0.9:0.1:3:6 with w/c ratio of 0.6. Minimum and maximum values of Poisson ratio determined were 0.151 and 0.216. The highest value of MOR obtained was* $13.386\times10^3 N/mm^2$*. While minimum MOR value was recorded at* $8.803\times10^3 N/mm^2$*.Generally, the more percentage of PC replaced with hydrated lime, the more elastic the concrete become depending on the mix proportion. Elastic properties of lime cement concrete is lower than that of laterized concrete.*

KEYWORDS;- *Modulus of elasticity (MOE), Modulus of rigidity (MOR), Poisson ratio, Compressive strength, Hydrated Lime (HL), Water-cement (w/c) ratio.*

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I. INTRODUCTION

The study of the properties of concrete cannot be overstressed in as much as it is a compound substance that has achieved universal concession as a construction material. Concrete is a combination of three fundamental components which are the binding material (i.e. cement), aggregates and water [1]. The combination can be poured into any container, where it hardens into a long lasting matter. Although, concrete is adopted globally, it is deficient in countering tensile stresses that act on it. It is breakable, having very low ductility. On loading, this quality makes the concrete show inelastic and elastic strains. It also encounters shrinkage strains on cooling or drying. When it is controlled, the shrinkage strain leads to complex stress patterns that most of the times, result to cracking [2].The extent of the opening cracks barely overshoots a small number of microns. But with the loads, these cracks spread and open up. As a result of stress concentration, supplementary micro-cracks are initiated. These cracks are the main reason for elastic deformation in concrete [3]. This means that conventional concrete is incapable of accommodating large deformations. This study seeks to minimize this problem by the inclusion of hydrated lime in the production of cement concrete.

A foundational criterion in the design of concrete structure is the determination of the modulus of elasticity of the concrete. Modulus of elasticity is a materials property that describes its stiffness. It is one of the most important properties of solid materials like concrete [4]. This property measures the resistance given by materials against getting deformed by a load of any nature. It is important since it helps the engineer know about the utility of the material as well as the quality of stress that the material can undergo without getting very much deformed. Even though concrete is non-linear in behavior, an estimation of the elastic modulus is necessary for determining the stresses induced by strains associated with the environmental effects. It is used in determining stresses developed in simple elements and also complicated structures [2].

In contemporary years, building designation require a specific elastic modulus of concrete to be met in order to check uncontrolled distortions and sway [5].The specific establishment of the modulus of elasticity of concrete is very paramount for structures that have benchmark of deformability that must not be compromised. Modulus of elasticity (MOE), is frequently utilized in classifying reinforcement and non-reinforced structural members, establishing the quality of reinforcement, assessing stresses for perceived strains and is particularly prime in the design of pre-stressed concrete material [6]. As the elastic modulus of concrete increases, the material becomes stiffer and brittle. Similarly the modulus of rigidity (MOR) which is used to determine how elastic or bendable a concrete is if sheared (i.e. being pushed parallel from opposite sides) is studied in this investigation. This was achieved by obtaining the poisson ratios for the different mixes considered.

Hydrated lime (HL) is calcium hydroxide ($Ca(OH)_2$). It is obtained by hydrating quick lime CaO using equipment known as hydrators. The quick lime is obtained by burning calcium carbonates ($CaCO_3$) at temperature around 900^0C [7]. Generally, hydrated lime is in form of a dry white powder with an absolute density close to $2.2Mg/m^3$. The addition of hydrated lime in mortar mix results to a lot of advantages such as; ease of mixing the mortar, ease of use, improved water retention, improved air content and reduction in cost. This addition has shown that lime-rich mortar is able to withstand a higher degree of deformation before failure. This means that the inclusion of some lime allow for some accommodation of movement either under compressive or shearing loads, unlike those of cement rich mixture [7].

A few researches on the modulus of elasticity (MOE) of various types of concrete are presented in this work. [8], reported that the modulus of elasticity of concrete was increased by the addition of both silica fines and hydrated lime. A 2% increase in the MOE of hydrated lime concrete over fly ash concrete was observed. [3] carried out an experimental study of modulus of elasticity for fiber reinforced concrete. They worked with an M60 concrete grade and included steel fibers (SF), polypropylene fibers (PF), Cabon fibers (CF), PF + SF, PF + CF, CF+SF and PF+CF+SF respectively. Values of MOE ranging from $3.48x10^4N/mm^2$ to $4.35x10^4N/mm^2$ were determined. The mix having PF+CF+SF+M60 gave the highest MOE value of $4.35x10^4N/mm^2$. They concluded that steel, carbon and polypropylene fibers are all viable additions in concrete. These fibers made the interfacial transition zone of the concrete stronger, thereby increasing the modulus of elasticity of fiber reinforced concrete. [6] also studied the modulus of elasticity of steel fiber reinforced concrete. From their work, they reported that the inclusion of steel fibers in concrete increased the modulus of elasticity. This confirmed the findings of [3]. They proposed an optimum fiber volume of 1.5% and reported that fibers with aspect ratio of 71 gave better results when compared to those of 50. At constant aspect ratio of the fiber, they observed that the MOE of steel fiber reinforced concrete increased with an increase in the fiber volume fraction.

[9] worked on the topic “Evaluation of static modulus of elasticity depending on concrete compressive strength”. They reported that the composition of concrete did not only affect the compressive strength but strongly influenced the concrete modulus of elasticity. They further recommended that the existing dependencies on compressive strength values in determining empirically the MOE of concrete as stated in the [10] should be reassessed to reflect the currently applied raw materials such as blended cement, mineral admixtures and highly plasticizer for cement production.

An investigation on the effect of cylinder size on the MOE and compressive strength of concrete from dynamic and static test was conducted by [11]. They reported that for normal strength concrete, the two sizes of cylinders investigated (i.e. 150mm x 300mm and 100mm x 200mm) did not show any significant differences in the test results. Size effect was observed for high strength concrete greater than 40MPa. The 100mm x 200mm cylinders had slightly higher dynamic elastic modulus of about 10% than those from the 150mm x 300mm cylinder. Dynamic elastic modulus was extremely greater than the static elastic modulus. [12] also confirmed that Young modulus of concrete obtained dynamically are clearly higher than those obtained with static method. They observed that the Young modulus of self-compacting concrete (SCC) with basalt aggregates is higher than those with natural aggregate. Both concrete had similar compressive strength.

[13] studied the functionality of hydrated lime as an admixture. They reported that low lime content Portland cement –lime mortar were significantly stiffer than the plasticizer mix. But, when the quantity of lime and cement were same, plasticizer mortar were stiffer. Low lime content mortar was also observed to be stiffer at all ages even though they were weaker in compression than the portland cement mortar. [14] worked on the 28 day MOE and MOR of laterized concrete. He considered three mix ratios namely; 1:3:6, $1:1^1/_2$:3 and 1:2:4 at w/c of 0.5, 0.6, 0.75 and 0.75 respectively. He stated that the MOE of laterized concrete falls within the range of 7000Mpa and 9500Mpa. While, that of MOR is within the range 5000Mpa and 6000Mpa. The MOE of the concrete improved as the mix became richer. Poisson ratio for laterized concrete ranged from 0.25 to 0.35.

In order to use hydrated lime (HL) - saw dust ash (SDA) cement concrete for structural works, [15] recommended an optimum 10% replacement of Portland cement with 75% HL and 25% SDA for a mix ratio of 1:2:4. Highest modulus of elasticity obtained was $24673.88N/mm^2$ at 28 days and $25914.01N/mm^2$ at 56 days. These occurred at 0.58 water-cement ratio.They observed that increase in the proportion of SDA increased the MOE the concrete.

II. MATERIALS

Water, granite chippings, river sand, Portland cement and hydrated lime were used in producing the cement-lime concrete. The water adopted for this work was drinkable and acquired from the Federal Polytechnic, Nekede, Owerri, Nigeria. River sand was procured from Otamiri River in Owerri-West, Imo State, Nigeria. Granite chippings were sourced from Okigwe in Imo State. From the particle size distribution analysis conducted, it was seen that the two aggregates used for the study were poorly graded having almost uniform particle sizes respectively. A fineness modulus of 3.79 was recorded for the river sand. Average bulk densities for the river sand and chippings are 1660kg/m^3 and 1700kg/m^3 respectively.

Chemical analysis test done on the hydrated lime revealed that the calcium oxide (CaO) content was at 93%. This was well above the 75.56% CaO content required for hydrated lime to be used as a construction material [16]. Its silicon oxide content was at 2.38% with a pH value of 8.6. The grade 43.5 Portland cement of brand name "Dangote" was used. CaO content for the Portland cement was at 67.62%. While, a silicon oxide content and pH of 20.39% and 9.2 were observed respectively.

III. METHODS

The following methods were conducted;

Compressive strength test

Concrete cubes of dimensions of 150mm x 150mm x 150mm were prepared and hydrated for a period of 28 days by totally submerging them in water tanks at room temperature. A maximum of 3 cubes were cast for each mix proportion. Compressive strength test was then conducted on each specimen. This was achieved by the use of a universal testing machine. The procedure with respect to [17], was adopted in determining the failure loads of each concrete cube presented. From these loads, the compressive strengths of the concrete cubes were acquired using the equation (1);

$$\delta_c = {}^{Q}/_{A} \qquad (1)$$

Where,
δ_c = Compressive strength in N/mm^2
Q = Load in Newton (N)
A= Cross section area of specimen in mm^2.

Tensile strength test

Tensile strength test in the form of flexural strength test was carried out in order to estimate the tensile stress (δt) at cracking in flexure on concrete beam specimen of sizes 150mm x 150mm x 600mm according to [19] as depicted in equation (2)

$$\delta t = QL/bd^2 \qquad (2)$$

where;
δt = modulus of rupture (N/mm^2).
Q = maximum applied load indicated by the testing machine (N).
L =span length (mm). b= average width of specimen (mm).
d = average depth of specimen (mm).

Determination of modulus of elasticity

Modulus of elasticity for the cement-lime concrete was estimated using the formula given by [18] as shown in equation (3), and the results obtained are recorded in Table 2.

$$E_c = 43\rho^{1.5}(\delta_c)^{0.5} * 10^{-6} \qquad (3)$$

where,
E_c= modulus of elasticity (10^3N/mm^2); ρ = density (N/mm^3)
f_c^1 = compressive strength (N/mm^2).

Determination of poisson ratio

Poisson ratios for the various concrete mixtures was obtained in order to determine the values of MOR of the concrete. Equation (4) was used to achieve this task.

$$\mu = \delta_t / \delta_c, \qquad (4)$$

where,
μ = poisson's ratio
δ_c = compressive strength at cracking (N/mm^2)
δ_t = tensile stress at cracking in flexure (N/mm^2)

Determination of modulus of rigidity

Similarly the modulus of rigidity (MOR) for the different mix proportions of lime-cement concrete were obtained by using the equation (5) [4]. Results obtained are shown in Table 2.

$$G = E / 2(1 + \upsilon) \qquad (5)$$

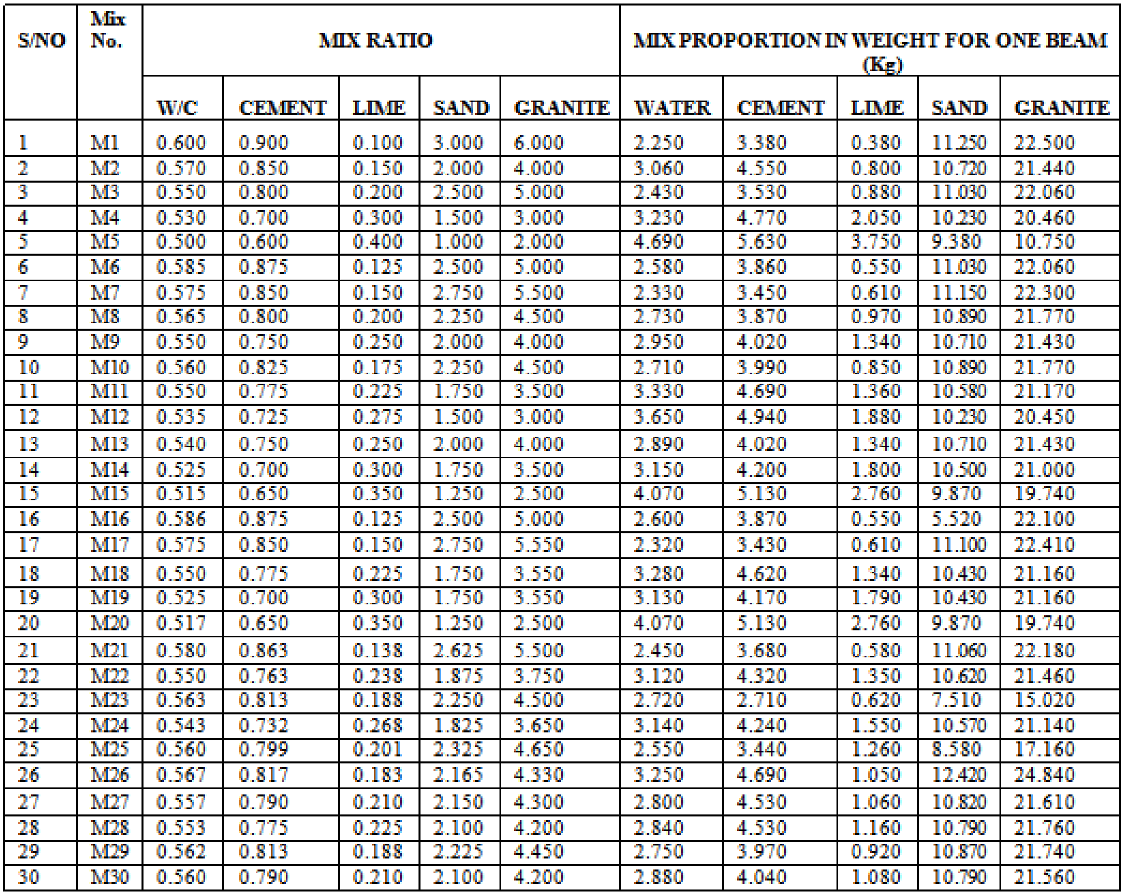
where,
G = modulus of rigidity (N/mm^2)
E = modulus of elasticity (N/mm^2)
υ = poisson's ratio.

Table 1 and Table 2 present the mix ratios adopted for the experimentation. While, results obtained are shown in Table 3 and Fig 1.

Table 1: Mix proportions for concrete cubes

S/NO	Mix No.	MIX RATIO					MIX PROPORTIONS IN WEIGHT FOR ONE CUBE (Kg)				
		W/C	CEMENT	LIME	SAND	GRANITE	WATER	CEMENT	LIME	SAND	GRANITE
1	M1	0.600	0.900	0.100	3.000	6.000	0.510	0.765	0.085	2.550	5.100
2	M2	0.570	0.850	0.150	2.000	4.000	0.692	1.032	0.182	2.429	4.857
3	M3	0.550	0.800	0.200	2.500	5.000	0.550	0.800	0.200	2.500	5.000
4	M4	0.530	0.700	0.300	1.500	3.000	0.819	1.082	0.464	2.318	4.637
5	M5	0.500	0.600	0.400	1.000	2.000	1.063	1.275	0.850	2.125	4.250
6	M6	0.585	0.875	0.125	2.500	5.000	0.585	0.875	0.125	2.500	5.000
7	M7	0.575	0.850	0.150	2.750	5.500	0.538	0.781	0.138	2.527	5.054
8	M8	0.565	0.800	0.200	2.250	4.500	0.620	0.878	0.220	2.468	4.936
9	M9	0.550	0.750	0.250	2.000	4.000	0.668	0.911	0.304	2.429	4.857
10	M10	0.560	0.825	0.175	2.250	4.500	0.614	0.905	0.192	2.468	4.936
11	M11	0.550	0.775	0.225	1.750	3.500	0.748	1.054	0.306	2.380	4.760
12	M12	0.535	0.725	0.275	1.500	3.000	0.827	1.121	0.425	2.318	4.637
13	M13	0.540	0.750	0.250	2.000	4.000	0.656	0.911	0.304	2.479	4.857
14	M14	0.525	0.700	0.300	1.750	3.500	0.714	0.922	0.408	2.380	4.760
15	M15	0.515	0.650	0.350	1.250	2.500	0.922	1.163	0.627	2.237	4.474
16	M16	0.585	0.875	0.125	2.500	5.000	0.590	0.880	0.130	2.500	5.000
17	M17	0.575	0.850	0.150	2.750	5.550	0.526	0.777	0.137	2.513	5.073
18	M18	0.550	0.775	0.225	1.750	3.550	0.743	1.046	0.304	2.361	4.790
19	M19	0.525	0.700	0.300	1.750	3.550	0.708	0.944	0.405	2.361	4.790
20	M20	0.517	0.650	0.350	1.250	2.500	0.922	1.163	0.627	2.237	4.474
21	M21	0.580	0.863	0.138	2.625	5.500	0.556	0.826	0.132	2.514	5.027
22	M22	0.550	0.763	0.238	1.875	3.750	0.706	0.978	0.305	2.406	4.812
23	M23	0.563	0.813	0.188	2.250	4.500	0.617	0.891	0.257	2.469	4.937
24	M24	0.543	0.732	0.268	1.825	3.650	0.713	0.961	0.352	2.395	4.791
25	M25	0.560	0.799	0.201	2.325	4.650	0.597	0.852	0.215	2.479	4.957
26	M26	0.567	0.817	0.183	2.165	4.330	0.643	0.927	0.278	2.455	4.910
27	M27	0.557	0.790	0.210	2.150	4.300	0.636	0.902	0.240	2.453	4.907
28	M28	0.553	0.775	0.225	2.100	4.200	0.644	0.903	0.262	2.446	4.891
29	M29	0.562	0.813	0.188	2.225	4.450	0.623	0.899	0.208	2.464	4.929
30	M30	0.560	0.790	0.210	2.100	4.200	0.652	0.920	0.245	2.446	4.891

Table 2: Mix proportions for concrete prototype beams



S/NO	Mix No.	MIX RATIO					MIX PROPORTION IN WEIGHT FOR ONE BEAM (Kg)				
		W/C	CEMENT	LIME	SAND	GRANITE	WATER	CEMENT	LIME	SAND	GRANITE
1	M1	0.600	0.900	0.100	3.000	6.000	2.250	3.380	0.380	11.250	22.500
2	M2	0.570	0.850	0.150	2.000	4.000	3.060	4.550	0.800	10.720	21.440
3	M3	0.550	0.800	0.200	2.500	5.000	2.430	3.530	0.880	11.030	22.060
4	M4	0.530	0.700	0.300	1.500	3.000	3.230	4.770	2.050	10.230	20.460
5	M5	0.500	0.600	0.400	1.000	2.000	4.690	5.630	3.750	9.380	10.750
6	M6	0.585	0.875	0.125	2.500	5.000	2.580	3.860	0.550	11.030	22.060
7	M7	0.575	0.850	0.150	2.750	5.500	2.330	3.450	0.610	11.150	22.300
8	M8	0.565	0.800	0.200	2.250	4.500	2.730	3.870	0.970	10.890	21.770
9	M9	0.550	0.750	0.250	2.000	4.000	2.950	4.020	1.340	10.710	21.430
10	M10	0.560	0.825	0.175	2.250	4.500	2.710	3.990	0.850	10.890	21.770
11	M11	0.550	0.775	0.225	1.750	3.500	3.330	4.690	1.360	10.580	21.170
12	M12	0.535	0.725	0.275	1.500	3.000	3.650	4.940	1.880	10.230	20.450
13	M13	0.540	0.750	0.250	2.000	4.000	2.890	4.020	1.340	10.710	21.430
14	M14	0.525	0.700	0.300	1.750	3.500	3.150	4.200	1.800	10.500	21.000
15	M15	0.515	0.650	0.350	1.250	2.500	4.070	5.130	2.760	9.870	19.740
16	M16	0.586	0.875	0.125	2.500	5.000	2.600	3.870	0.550	5.520	22.100
17	M17	0.575	0.850	0.150	2.750	5.550	2.320	3.430	0.610	11.100	22.410
18	M18	0.550	0.775	0.225	1.750	3.550	3.280	4.620	1.340	10.430	21.160
19	M19	0.525	0.700	0.300	1.750	3.550	3.130	4.170	1.790	10.430	21.160
20	M20	0.517	0.650	0.350	1.250	2.500	4.070	5.130	2.760	9.870	19.740
21	M21	0.580	0.863	0.138	2.625	5.500	2.450	3.680	0.580	11.060	22.180
22	M22	0.550	0.763	0.238	1.875	3.750	3.120	4.320	1.350	10.620	21.460
23	M23	0.563	0.813	0.188	2.250	4.500	2.720	2.710	0.620	7.510	15.020
24	M24	0.543	0.732	0.268	1.825	3.650	3.140	4.240	1.550	10.570	21.140
25	M25	0.560	0.799	0.201	2.325	4.650	2.550	3.440	1.260	8.580	17.160
26	M26	0.567	0.817	0.183	2.165	4.330	3.250	4.690	1.050	12.420	24.840
27	M27	0.557	0.790	0.210	2.150	4.300	2.800	4.530	1.060	10.820	21.610
28	M28	0.553	0.775	0.225	2.100	4.200	2.840	4.530	1.160	10.790	21.760
29	M29	0.562	0.813	0.188	2.225	4.450	2.750	3.970	0.920	10.870	21.740
30	M30	0.560	0.790	0.210	2.100	4.200	2.880	4.040	1.080	10.790	21.560

Table 3: Test results

Mix no.	Av. Density (Kg/m^3)	δc (N/mm^2)	δt (N/mm^2)	MOE (10^3 x N/mm^2)	Poisson Ratio	MOR (10^3 x N/mm^2)
M1	2449	15.12	2.28	20.264	0.151	8.803
M2	2514	18.50	3.86	23.313	0.209	9.641
M3	2489	17.86	3.62	22.566	0.203	9.379
M4	2499	22.00	3.49	25.196	0.159	10.87
M5	2558	19.56	2.96	24.604	0.14	10.791
M6	2521	20.85	4.37	24.853	0.21	10.27
M7	2539	22.70	3.91	26.211	0.172	11.182
M8	2558	22.17	3.98	26.194	0.181	11.09
M9	2504	21.56	3.23	25.018	0.15	10.877
M10	2616	23.81	4.39	28.074	0.164	12.059
M11	2568	23.34	4.26	27.034	0.183	11.426
M12	2464	21.33	3.58	24.29	0.168	10.398
M13	2499	16.22	2.77	21.634	0.173	9.222
M14	2499	16.16	2.94	21.594	0.183	9.127
M15	2449	19.00	2.67	22.716	0.141	9.954
M16	2578	20.85	4.51	25.701	0.216	10.568
M17	2578	22.45	3.27	26.669	0.146	11.636
M18	2509	26.68	4.02	27.913	0.151	12.126
M19	2469	16.20	2.82	21.233	0.174	9.043
M20	2471	19.15	2.70	23.113	0.141	10.128
M21	2607	23.56	5.03	27.782	0.214	11.442
M22	2528	23.87	3.85	26.703	0.161	11.5
M23	2529	28.50	4.36	29.195	0.153	12.66
M24	2548	23.94	3.67	27.06	0.153	11.735
M25	2517	29.85	4.15	29.666	0.139	13.023
M26	2528	27.80	4.28	28.818	0.154	12.486
M27	2509	24.58	4.10	26.792	0.167	11.479
M28	2509	28.90	3.02	29.051	0.105	13.145
M29	2548	30.83	4.52	30.708	0.147	13.386
M30	2460	21.45	4.16	24.299	0.194	10.175

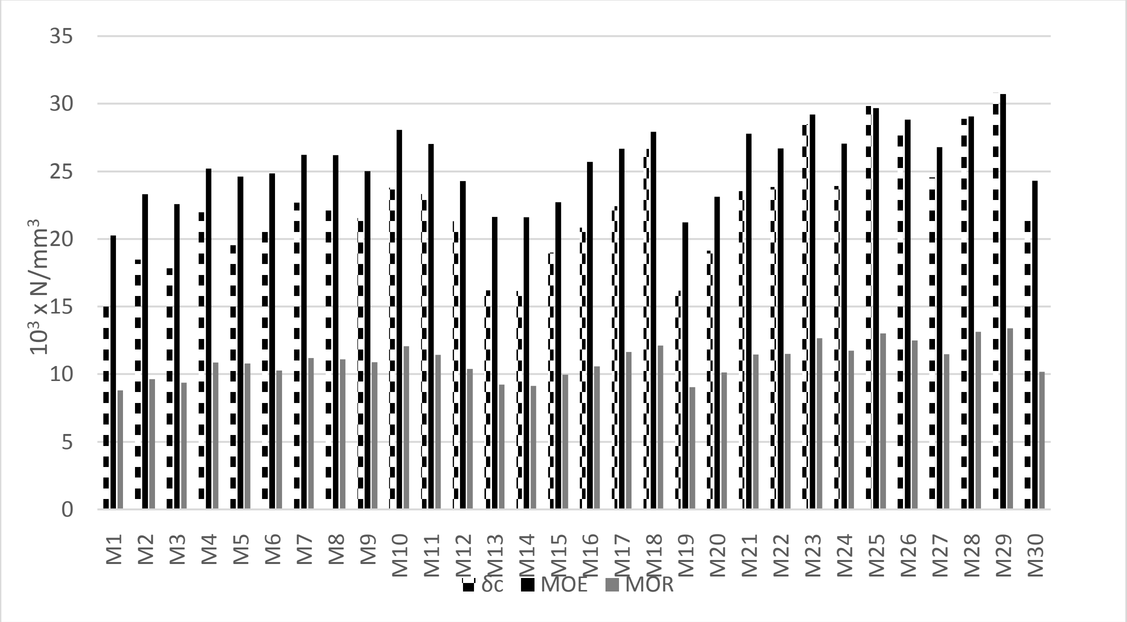


Fig 1: Comparison of the compressive strength (δc) against MOE and MOR of lime cement concrete

According to [4]normal weight concrete falls within the range of 2240Kg/m^3 to 2400Kg/m^3. This means thatgenerally, concrete experimented is normal weight in nature as depicted in Table 3.From Fig 1, a highest MOE reading of 30.708264x10^3N/mm^2 was achieved. The mix proportion at this instance was 0.8125:0.1875:2.225:4.445 (PC: HL: Sand: Granite) at water-cement (w/c) ratio of 0.562. This result reveals an optimum percentage inclusion of HL of 18.75%.On the other hand, least value of MOE of 20.264x10^3N/mm^{2}happened at a mix ratio 0.9:0.1:3:6 with w/c ratio of 0.6.Higher values of MOE means a stiffer concrete that will not easily deflect under flexure.

Minimum and maximum values of Poisson ratio determined were 0.151 and 0.216.These results concur with the report of [4] that the Poisson ratio of normal weight concrete is between 0.2 and 0.24.The Poisson ratios obtained can be said to fall within the lower limits of the range for normal weight conventional concrete. This means that hydrated lime cement concrete willaccommodate bending actions better than the conventional concrete. The lesser the value of the Poisson ratio of concrete, the more the concrete will be able to resist the action of bending. This means that concrete with higher strength against bending, will have a lower value of Poisson ratio.

Highest value of MOR obtained is 13.386 x 10^3N/mm^2 at mix ratio 0.8125:0.1875:2.225:4.445 with w/c ratio of 0.562. Least MOR value of 8.803 x 10^3N/mm^2 was recorded at 0.9:1:.3:6 mix proportion with w/c ratio of 0.6. This happened at a 30% PC replacement with HL. MOR values from this study were far lesser than those of MOE as shown in Fig 1. This is because it takes a smaller force for concrete to bend under shear deformation than under elastic deformation. The reason is due to the formation of micro cracks found in the concrete as a result of stress concentration.

From Fig 1, the values of compressive strengths and their corresponding MOE and MOR values, reveal that the stress required to cause crushing failure is usually less than that needed for elastic deformation. However, it is substantial than the stress required for a shear deformation to happen.Taking account of the values of MOE and MOR from the works of [14], it is perceived that MOE values ranged from 7000MPa to 9500Mpa. While, MOR values are from5000MPa to 6000Mpa. Matching these results with those obtained from this work, it can be said that the elastic properties of laterized concrete are better than those of lime cement concrete.

IV. CONCLUSION

Concrete produced from this study are normal weight. The mix ratio that generated the least stiff concrete that can accommodate more deforming stress is 0.9:0.1:3:6 at 0.6 w/c ratio. However, this gave the least compressive strength of 15.12N/mm^2. Therefore, it is the duty of the concrete designer to come up with a mix design that satisfies the major property requirements as stipulated for any concrete work. The best replacement of PC with HL that yielded the stiffest concrete occurred at 18.75% having a mix proportion of 0.8125:0.1875:2.225:4.445 (PC:HL:sand:granite) at w/c combination of 0.562. Values of MOE, MOR and Poisson ratio observed at this point are 30.708264 x 10^3N/mm^2, 13.386 x 10^3N/mm^2 and 0.147 respectively.Corresponding compressive strength value is 30.708N/mm^2.

It is identified that the stiffer the concrete is, the higher the compressive strength values.MOR values from this study were far lesser than their corresponding MOE readings. This means that the stress needed to cause crushing failure is recognized to be less than that required to start an elastic deformation. But, substantial than the stress needed for a shear deformation to happen.From the results obtained, it is observed that the more percentage replacement of PC with hydrated lime, the more elastic the concrete becomes depending on the mix proportion. Lime cement concrete possess lesser elastic properties thanlaterized concrete.

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