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Effect of Different Curing Regimeson the Compressive strength of Natural Hydraulic Lime 2 - Based Mortars

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ABSTRACT
The technique of mortar used in construction for several years has been a binding agent alongside concrete. This is the second most commonly used material in construction works all overtheworld. Lime has been used as an additive and a partial replacement to cement to obtain different characteristics of mortar regarding its bonding and compressive strength. Studies on mortar have been particularized on the aspect of compressive strength, flexure strength, method of preparation and different test condition. This report examines the use of hydraulic lime to investigate the most effective curing condition suitable for a particular lime mortar to achieve its maximum compressive strength within 28 days of curing. The hydraulic lime considered in this research work is Natural Hydraulic Lime 2 (NHL 2). The mortar samples were cast in strips of size 40mm by 40mm by 160mm using lime to sand ratio of 1:2 and Allerton park sand as the fine aggregate. The NHL 2 mortar mixes of the same lime-sand ratios were cured under various curing conditions simulating different weather condition. The curing conditions adopted in this experimental work are curing the lime based mortar samples under a 65% Relative Humidity, 95% Relative Humidity and the variation of the two degrees of relative humidity. Some samples were cured with mould for some days before removing them from the moulds to the curing chambers. The results of the investigation show that the compressive strength of lime mortar samples made with NHL 2 at the various curing regimes have the range of 0.3 MPa to 0.95 MPa. The minimum of the compressive strengths was obtained from the samples cured at 65% while the maximum was from the NHL2 mortar cured at 95% for the 26 days. In the course of this research work, the minimum number of days required of NHL 2 based mortar before removing from the mould was investigated as some sample were tested for 2,5,7 days by mere touch them. It was observed that the minimum required number of days is 7 days.

Keywords: Mortar**,** Natural Hydraulic Lime 2, Curing regimes and Compressive strength.

I. INTRODUCTION

Mortar is a combination of sand, cement and water. It serves as the binder between block of a structures. It could be of different mix ratios which actually results into different characteristic strength as mechanical property. It has been in use for ages and it is still one of the intrinsic parts of masonrynow. It is the most applied material used in the corrections of old masonry. These corrections depend on the studies of the typical properties of the original mortars and on the formulas for compatibility and durable repair mortar composite. Further demands and constraints have to be considered when dealing with architectural requirements.

Research work on mortars has traditionally focused on their chemical composition and the mineralogical composition, rather than focusing on their mechanical characteristics such as their strengths and some factors that influence these characteristics. But due to some problems that are not technically possible, these approaches have been subjected to limitations.

Recently, some new non-standard testing of mortars approaches and more developedtechniques have led to improvements in investigation of mechanical characteristics of mortars. These tests are the basic components for any masonry. Such results from the test can also be used in the conservation field for designing repair mortars that exhibit similar qualities to the original materials, which is compatibility with higher durability.

It has to be noted that when deciding on tests types for mortars, the purpose should be put into consideration. And this has to be based on the scientific purpose, for designing a compatible replacement or filling material, and for redesigning masonry structure or strengthening it for a change of use. Though, in all cases, the test will lack the required statistical significance because small sample size to be used is an essential problem. Methods for measuring mechanical property include and not limited to non-standard compression test.

Compression testing of mortar is to investigate how effective a mortar with a particular mix content ratio to lime, can withstand a direct stress without anydamage. Since it serves as the binding medium and interlocks between two blocks.

Testing of mortar in buildings is problematic. It is made clear that conventional standard mortar tests yield more or less meaningless results which are practically useless for assessing the safety of, or the threat to a structure. Mortar under service in structure is not subjected to compression inthe same wayto the test conditions. Manufacturingthe specimen most especiallycutting a cube for compression test has a significant influence on the properties of the sample. This is basedon the effects that would have been incurred on the surface of the sample which would tremendously reduce its strength. While on the other hand, manufacturing a small cube is very laborious and time consuming.

In this project, we would be focusing on the Compression strength as mechanical properties of the limemortars by examining the effect of different curing regimes on them. This would be done by applying anon- standard method of storage procedure which would provide useful data. This storage conditions would be an assumed situation of the two extreme conditions of weather in terms of relative humidity. This research work will give an idea of the suitable weather conditions for the application of NHL 2 based mortars.

Aim and objectives

The aim of this study is to analyze the effect of various Relative humidity on the compressive strength of NHL 2 based mortars.

The objectives of the work are to:

In this research work, the work is going to be based on varying the curing regimes at which the lime mortar would be cured, also to vary the compositions of lime mortar specimensto observe the effect on its compressive strength. This study is specifically designed to achieve the following objectives:

- **Physical tests**

  Determine the physical properties of the materials to be used, such as Sieve analyses of the sand, bulk density of aggregates and consistency.

- **Mechanical tests**

  Determine the mechanical property of the material, compressive strength of NHL 2 mortars to be precise when subjected to different curing conditions.

II. LITERATURE REVIEW

1.1 Mortar

As mentioned earlier, mortar is a combination of sand, binder such as lime or cement and water. It is applied as a thick paste and sets hard. It is the paste usually pozzolanic in nature used for binding together constructionblocksandfillspacesbetweenthem.Itcan alsobe usedtorepairwhentheoriginal application has crumbled or washed away. It is a mixture of aggregates generally with a grain sizeoflessthan4mm (sometimes less than8mm, e. g. mortarforspecial decorativerendersor floor screed mortar) and one or more binders and possibly additives and/or admixtures.

The application of mortar is of a very wide-spread range. It is difficult to find a definition taking into account all these different uses. From the technical point of view, mortar has to be defined by consideringits constituent elements. It is hard wearing and typicallylasts a verylongtime, even without any repair. The standard life span of modern mortar is around 20 – 30 years. It mayneed replacing or refreshing if it easily scraped out with a sharp knife.

1.1.1 Origin and occurrence of mortar

Application of mortar can be traced to thousands of years ago. The first mortar was made from mud or clay. These materials were used because of availabilityand low cost. The oldest mortar was based on lime and sand. The Egyptians utilized gypsum mortars to lubricate the beds of large stones when they were being moved into position. However, these materials did not perform well in the presence of high levels of humidity and water. (McKee, Harley J. 1973). Since then, building techniques have changed and new construction materials have been developed.

1.1.2 Some types of mortar

These types of mortar got their names from their mix most especially the name or type ofbinder used.

1.1.2.1Ancientmortars

The first set of mortars was made of mud and clay. Due to natural sufficiency of clay and lack of stone, construction made by the Babylonian were of baked bricks, using lime or mortar. According to Roman Ghirshman, other example of where the first evidence of humans using a form of mortar are the sun-dried at the Ziggurat of Sialk in Iran in 2900 BCE. About 125 BCE, kiln-fired and a strong mortar of bitumen were used in the ChghaZanbil

About 2600-2500.BCE, during the construction of early Egyptian pyramid, temple in Iran, limestone blocks were bound by mortars that consist of mud and clay or clay and sand. But in later Egyptian pyramids, the mortar in use was of either gypsum or lime. Gypsum mortar used to be soft, it is essentially a mixture of plaster and sand.

1.1.2.2.Portlandcementmortar.

Portland cement mortar (often known simply as cement mortar) is created by mixing Ordinary Portland Cement (OPC) with sand and water. It was invented in 1794 by Joseph Aspdin and patented on 1824, largely as a result of various scientific efforts to develop stronger mortars than existed at the time. It was during the late nineteenth century that it was popularized and owning to the first world war, by 1930 it had super sededlime mortar for new construction. This is because, Portland cement sets hard and quickly, allowing a faster pace of construction and also requires less skilled workers. In addition, Portland cement should not be used in repairing or patching up of older buildings constructed in lime mortar because of the difference in their properties for examples the flexibility, softness and breathability.

1.1.2.3 Polymercementmortar

Polymer cement mortars (PCM) are the materials which are made by partially replacing the cement hydrate binders of conventional cement mortar with polymers. The polymeric admixture includes latexes or emulsions, re-dispersible polymer powders, water-soluble polymers, liquid resins and monomers. It has low permeability and it reduces the incidence of drying shrinkage cracking, mainly designed for repairing concrete structures.

1.1.2.4. Limemortar

This is created by replacing impure lime stones in a kiln and the speed of set can be increased by using impure lime stones in the kilm, to form a hydraulic lime that will set on contact with water. This type of lime has to be kept dry. Another material like that is pozzolanic material such as calcined clay or brick dust. This may be added to the mortar mix. This will have a similar effect in the sense of making the mortar set reasonably quickly by reaching with water in the mortar. As earlier stated, lime mortar cannot be used in place of Portlandmortar and vice versa since cement mortar is harder and allows less flexibility. If used in place of each otherthat is placingcement mortaron lime mortar on the mortar, this could cause brickwork to crack where the two mortars are in contact.

Figure 1: Application of mortar

1.1.3. Compressive strength and flexural strength of mortars

This is the most important property of hardened mortar. It is taken as the maximum compressive load that the mortar can carry per unit load without developing cracks. This strength of mortar is often measured at the 28th day of curing. A standard thickness of mortar is crushed to determine the strength, alternatively, cast of standard cylinder sizes are used. The standard method described in BS EN 1015-11:1999. requires that the test specimen should be cured at preferable relative humidity and at a regulated temperature. Crushing immediately after it has been removed from the curing atmosphere.

1.1.3.1 Factors affecting mortar mechanical strengths

Various factors affect the strength of mortar. On the basis of compressive strength and flexural strength, the factors can be classified under the following

- Constituent materials
- Method of preparation
- Curing
- Test conditions

1.1.4 Effect of constituent materials

The contributory effect of the properties of the constituting materials of mortar such as binder, water and aggregates cannot be over-emphasized. Strength of mortar is primarily depending on the water to binder ratios.

1.1.4.1. Binder: These are material that serves as binding medium for aggregate. There are various types of binder such are Cement, hydraulic and hydrated lime.

1.1.4.2. Cement: The effect of cement on the mortar mechanical strength for a given mix proportion is determined by its fineness and chemical composition through the process of hydration. Thegain in strength of a higher percentage of fineness is mostlynoticeable at an earlyage. After 28 days, the relative gain in strength is much reduced.

Apparently, cements containing a relatively high percentage of tri-calcium silicate ($3CaOSiO_2$) gain strength much rapidlythan those rich in di-calcium silicate ($2CaOSiO_2$). However, at later ages, the difference in corresponding strength values is small. There is also a tendency for concrete made with low treated cements to develop a slightly higher strength due to the formation of a better quality gel structure in the course of hydration.

1.1.4.3. Hydrauliclime: All the chemical reactions are based on the hydraulic, which is the chemical combination of lime, burnt clay based on silicate, or silicate-aluminate minerals. If these materials are natural, the consequential lime is called Natural Hydraulic Lime (NHL).We can also produce hydraulic lime from pure calcium carbonate with the addition of some quantity of pozzolans and the resultant lime is called Artificial Hydraulic Lime.
The chemical reactions are two;

- Hydraulic reaction, which depends on the quantity of hydraulically reactive component with the presence of enough water.
- Carbonate reaction that absorbs the carbon dioxide and releases water leads the hardening of the compound. The carbonation occurs in all lime mortars

Hydraulicity is important for the strength of the substance but also it is important for the speed of reaction (reactivity) that influenced beneficially the stability of the mortar the first days.
A carbonation reaction is observed in manyhydraulic lime mortars and is in proportion of their hydraulic set. Therefore, the highest hydraulicity of the binders have the lowest carbonation requirements. (Alan M. Forster, 2004)

Table 1: The approximate ratio of carbonation set to hydraulic set in some basic binders.

Typeof binder	**Grade of carbonation (%)**	**Grade of hydraulic(%)**	**Compressive Strength(N/mm2)**
Nonhydraulic lime	100	0	2-3
NHL2	50-55	45-50	2-7

NHL3.5	20-25	75-80	3.5-10
NHL5	15-20	80-85	5-15
OPC	0	100	35+

We do not have the same hydraulicity for every kind of hydraulic lime. It depends on the proportion of clay minerals and the availability of them for reaction. Also, the fire has an important place in the affection of hydraulicity because it depends on the temperature and the duration of the firing process. In addition, essential is the rate of cooling.

Reactivity can be influenced by the fineness of the particles where the materials have been ground becausethe freshlyground materials are morereactivethanolder materials. In addition, an important thing in the affection of reactivity is the storage in humid conditions because itcan allow the hydration procedure to start.

Generally, the high firing temperature increases the degree of hydraulicity and reduces the reactivity (the compound does not readily react with water). On the other hand, the low temperature increases the degree of reactivity but it can reduce the hydraulicity reaction

The three grades of Natural Hydraulic lime are:

- Feebly hydraulic lime (NHL 2) has less than 12 % clayand for that it makes a slowerset. It is approximate for being used in internal plaster in mortar for bricks (soft stone)
- Moderately hydraulic lime (NHL3.5) contains 12 % - 18 % clay and as a result it has a faster set than NHL 2. It is appropriate for external renders and mortars.
- Eminently, hydraulic lime (NHL5) contains upto 25%claythatprovided a fast set. Itis appropriate for external flauching and mortars in extreme conditions where high strength and low breathability is required

1.1.4.4. Hydratedlime: It is readily available at the local builder's merchant and can be used to increase the workability of cement mortar. It is mostly in schools and training centres where it is mixed with sand (no cement) to make a mortar that doesn't set, ideal for teaching brick work.

Naturally, it is assumed that hydrated lime is the key ingredient, they know by experience that they will need cement to make it set.

1.1.4.5. Water: This is added to binders in mortars to form a paste which acts as the binding medium between aggregates. The amount of water in a given quantity of mortar has its effect on the workability of the mortar. This amount of water required in making mortar has to be regulated.

Mortar containing the minimum amount of water required for hydration will definitely develop its maximum strength at anygiven ageifit could befullycompacted.Whilefacilitatingplacing and compaction water in excess of that required for full hydration produces a somewhat porous structure resulting from loss of excess water even for a fully vibrated mortar.

1.1.4.6. Aggregates (sand): - The size, shape, surface texture and cleanliness of the aggregates affect the bond strength in the aggregate matrix interface. Aggregates" shape and surface texture affect the tensile strength more than the compressive strength. Aggregates have been classified into geological types, limestone e.t.c. from a consideration of both workability and density, concrete mat be regarded as a suspension of coarse particles in a matrix of cement mortar.

The properties of the aggregate known to have significant effect on mortar behaviour are its strength deformation, durability, toughness, hardness, volumechange, porosity, relative density and chemical reactivity.

III. MATERIALS AND METHODS

Here is a brief discussion on the materials used and the tests carried out on both the materials and the samples made of them. The preliminary tests were carried out to determine the physical properties of the materials prior to mix (batching)

2.1 PRELIMINARY TESTS

These tests were carried out in accordance with that given in detail BS EN 1015-11:1999 (methods of test for mortar for masonry purposes)

2.1.1 Sieve analysis

This was carried out to determine the grade of sand (Allerton park) used as the fine aggregate. This involves the use of sieves, weighing balance and trays. The sand sample to be analyzed was air dried to remove any form of moisture. Then, 277.84g of the sand was poured into the top sieve and the mechanical shaker was set to 5 minutes for proper shaking of the sieves. Sieve sizes used were ranging from 3.35 mm – 0.063 mm.

2.1.2, Bulk density

This was carried out on the Natural Hydraulic Lime 2 NHL 2. And the fine aggregate sand (Allerton park). This physical measure should be taken in order to determine the proportions of materials to be mixed to achieve a particular flow of mortar. This density value was input into a design mix spread sheet to determine the proportions. The equipment used were cylindrical one litre vessel, a connecting piece with a closure flap and a hopper with the sprung closure lever used for holding and releasing the closure flap.

2.1.3 Consistence (Flow test)

This is test carried out in order to determine the exact quantity of water to be use in the mix in order to achieve the required flow (165 mm) for the Lime mortars. This was carried out prior to the main mix for sample specimen, using a small amount of materials in proportion with the required ratio. This test was carried out according to BSEN 1015-3-1999

2.2. MATERIALS

Materials used were majorly NHL 2, Sand (Allerton park) and Water. The water used was to allow the workability of the mix. Also, by the process called Hydration mixes wih the binder to solidify to the desired shapes of containers confined with.

2.2.1 BINDER

This is a material in powdered form that undergoes hardening when it reacts with water. At such it is used in mixing with water and sand to make mortar. Also reacts with water, sand and coarse aggregate to form concrete. Types of binder require in the purpose of this research work is Natural Hydraulic Lime 2.

2.2.2 WATER

Water is used to mix the aggregates (sand) and lime to form mortar. It reacts with lime to form paste which creates the binding effect between the aggregates. For this project, the particular flow to be used is 165 mm ± 10 mm. To calculate the quantity of water to achieve this flow requires carrying out flow test for each mix.

2.3 APPARATUS

Figure 2: Set of sieves

Figure 3: Bulk density apparatus

Figure 4:Weighing balance

Figure 5:Flow test apparatus

Figure 6:Electrical vibrating machine

Figure 7: Humidity cabinet (Pharma1300)

2.4 BATCHING

There is an Excel Microsoft application used in calculating the proportions of materials in order to achieve a required mix ratio of mortar sample. It is a programmed page that would just require the densities of materials of the number of samples to be made, to give in weights the quantity of materials required to make the approximately the numbers mortar specimens needed.

Calculation of mixes for mortars					
Density of Roman cement(kg/m^3)		Sand			
Density of sand(kg/m^3)	1607				
Density of lime(kg/m^3)	550				
Mix proportions cement	0				
Mix proportions lime	1				
Mix proportions sand	1				
Proportion retarder(%)					
w/b	1.320			**Densities**	**Total**
				Gartenau	865
Mass of cement (kg)	0.000			Ott NHL5	545
Mass lime(kg)	1.014			WP sand	1755
Mass sand (kg)	2.962	3.976		SB NHL2	497
Mass retarder(g)	0.00			SB NHL 3.5	550
Mass water(kg)	1.338			Sand	1607
Total mass	5.314			CL90	405
Total volume	2.797				
Target flow16.5cm					
			Samples		
			Work able life		
			Vis cometer		0.0005
Totalvolofsamples (m^3)	0.003686		Air content		0.001
			40mm beams		0.0008
			Steel beam sets		0.0026
			Brick beams		0.0019
			70mm mould		0.0002
					0.0023

Figure 8: Mix design spread sheet

2.4.1 CASTING OF MORTAR SMAPLES

The typical size of a beam is 40 mm by40 mm by160 mm. These would comprise lime–mortars made with NHL 2 limes with mix ratio 1:2 (Sand/Lime).

Some samples are to be put under the condition of curing for two days in their moulds. That is a day at 95% rh and the second dayat 65% rh.

2.5 CURING

This is a method of conditioning lime mortar samples in order to achieve its maximum strength. This is by exposing them to some affecting conditions during their hardening process. The standard for doing this storage according to BS EN1015-11:1999 and is represented in the table below

Table 2: Preparation and condition of storing sample (BS EN 1015-11:1999)

Type of mortar	Storage time at a temperature of 20˚C±2˚C in days		
	Relative humidity		
	95%± 5% or in polyethylene bag		65%± 5%
	In the mould	With the mould removed	With the mould
Air-limemortars	5	2	21
Mortars with other hydraulic binders	2	5	21

Equipment and tools required
Polyethylene bagswiththe cutter and sealer. Flat boardstoplace samples after stripping, thisis to avoid any form of deformation. Damped tissue paper used in the polyethylene bags to achieve a 95% relative humidity and humidity cabinet (Pharma 1300).

2.5.1 CURING PROCEDURE

In this research work, curing of samples was carried out considering two major conditions, 65% ± 5% and 95% ± 5% relative humidity. Relative humidity of different percentages was achieved in various ways such as making use of humidity chamber, polyethylene bags with damped tissue paper. During the curing of the lime mortar samples, 65% relative humidity for samples still in mould were carried out by exposing the samples to an opened air at a temperature of about 20˚C ± 2˚C which was actually a temperature controlled room. Stripped samples for 65% relative humidity were taken into the humidity cabinet regulated to 65%.

In achieving curing of samples at 95% relative humidity, both stripped and samples in mould were put inside of a sealed polyethylene bags with damped tissue paper. The damped paper in each bag causes a condition assumed as 95% relative humidity inside of the polyethylene bags.

Figure 8:Samples in moulds

This research work also covers investigating of number of days in bag that the lime mortar would take before it can be easily stripped. Samples were tested after 2 days, 5 days and 7 days to know the minimum necessary number days in bag that they could be stripped from their moulds. These samples were observed by mere touching to observe when they could be stripped without any noticeable damage.

Table 3:Table describing number of days for curing

Samples Mould	Number of days at 95%rh before stripping	Curing regimes after stripping
1	2,5or7 days	26, 23 or21 @ 95%rh

2	2,5or7 days	26, 23 or21 @ 65%rh
3	2,5or7 days	12,9or7@95%,then14days@ 65%rh
4	2,5or7 days	19,16or14@95%,then7days@ 65%rh
5	2,5or7 days	5,2or0@95%,then21days@ 65%rh

Second batch of the lime mortar samples were cured in mould for two days simply by curing them at 95% rh the first 24 hours then cured at 65% rh the second 24 hours before stripping then a different curing regime starts on each mould. Here these samples were all cured for 28 days. After the first two days, the three moulds were cured at 95% rh, 65% rh and some at both 65% and 95%. This curing regime is tabulated in the table below.

Table4:Curing regimes of two days in mould

Sample mould	Curing regime after stripping
1	26days@95%rh
2	26days@65%rh
3	12days@95%rh,then 14days@65%rh

From the observation in the laboratory, the NHL 2 mortars were only strippable after 7 days.

2.6 COMPRESSIVE TEST

In this project work, compressive test on the NHL 2 mortar samples is the major test to be carried out to determine the compressive strength of the lime mortars at various curing ages. It was done in accordance to BS EN 1015-11:1999.

1.6.1 Equipment and tools required

INSTRON machine and the components: These are required to carry out the mechanical tests. This machine is capable of testing the compressive strength of sample and it can also test the flexural strength. There are components to be fixed on the machine depending on which of the tests to be carried out.

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Figure 9: INSTRON machine (Pharma 1300)

Vernier caliper: - This was also used to measure the thickness of samples.

2.6.2 Procedure

The component for compression test was clean also and properly fixed. Also, necessary steps in setting up the machine were taken. In this test, only the widths of the samples were taken. After which they were placed in the machine in such a manner that the load is applied to one of its faces (which has been cast against the steel of the mould). The samples were carefully aligned so that the load is being applied to the whole width of the faces in contact with the platens in which the load is being applied. After placing the sample, load was applied without shock and increased continuously until failure occurs. Record of the maximum load applied on each sample was taken divided by the cross sectional area. The mean of these three sample's result was calculated and this is the compressive strength of the lime mortar.

IV. RESULTS

This chapter will present and analyze the data obtained from the compressive tests discussed in the previous chapter. There will be descriptive graphical analysis to buttress the obtained values from the laboratory tests.

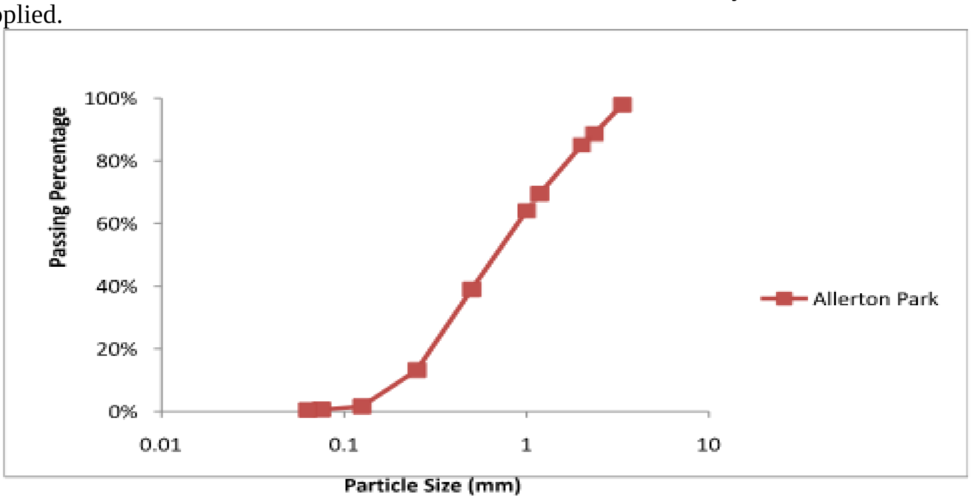


Figure10:Particle size distribution curve

Bulk density of **Sand (Allerton Park)**

Table 5:Density of Allerton Park sand

Sample	Weights of sand samples. Weights(g)	Volume (litres)	Density of Sand samples(g/litres)
1	1596.69	0.99665	1602.06
2	1593.52		1598.88
3	1598.59		1603. 96
4	1613.02		1618.65
5	1610.24		1615.65
6	1599.87		1605.35

Bulk density of **NHL2**

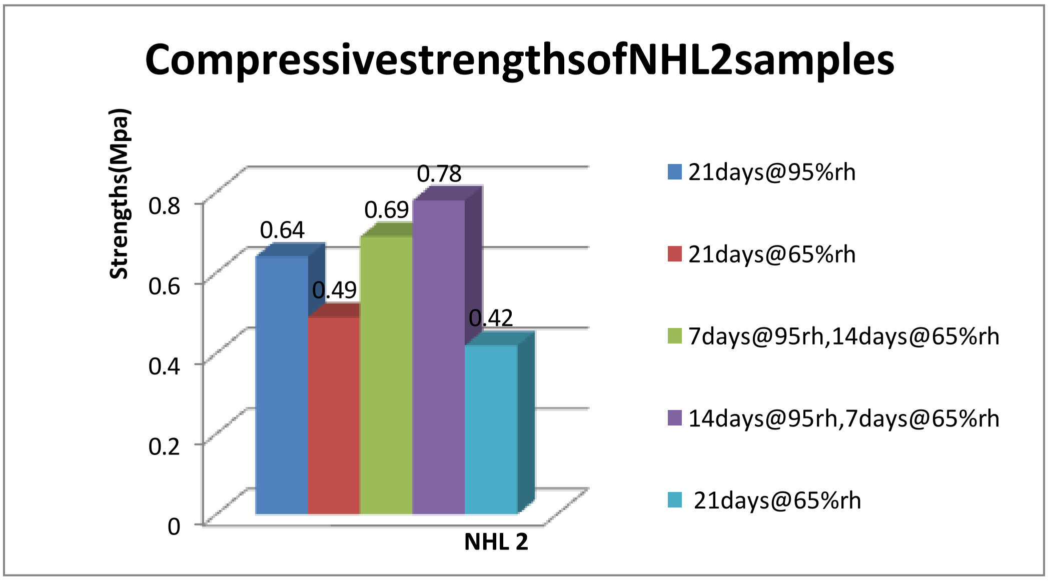
Table 6: Density of NHL2

Sample	Weights of NHL2 samples Weights(g)	Volume (litres)	Densities of NHL2 samples. Densities(g/litres)
1	507.11	0.99665	508.815
2	499.99		501.671
3	486.37		488.005
4	487.77		489.41
5	491.75		493.403
6	496.41		498.079

From the table, the average density of NHL2=**496.563g/litres**

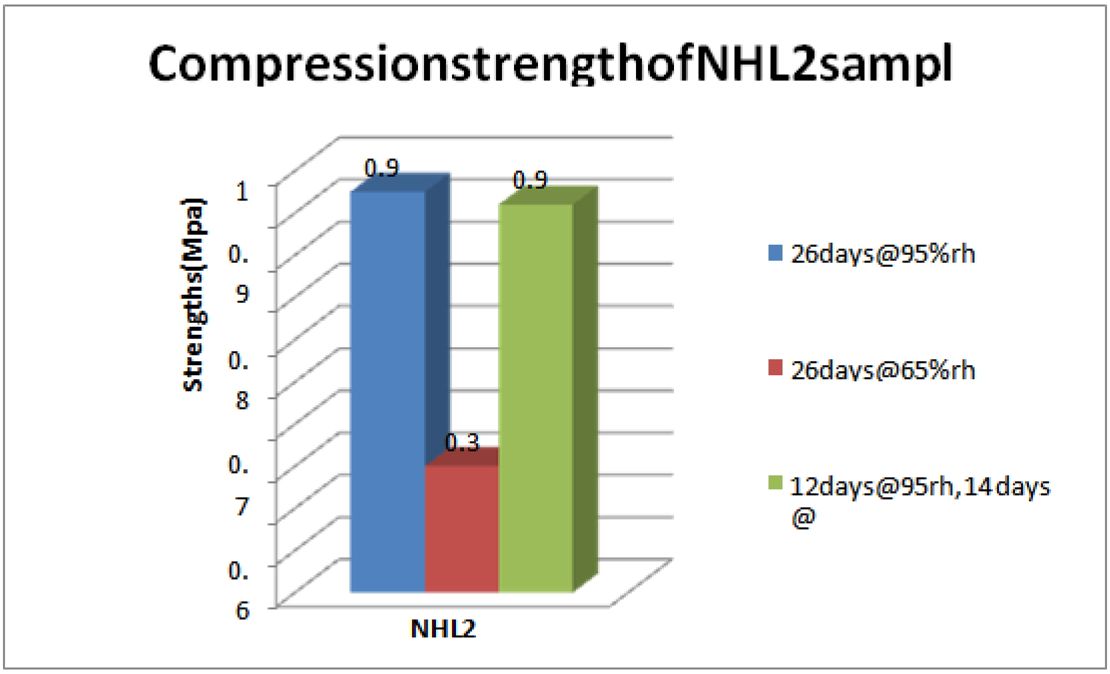
3.1.1. COMPRESSIVE STRENGTHS OF SAMPLES

Each of the NHL 2 mortar samples were tested for five different types of curing regimes**,** such as 65%, 95% rh or variation of both conditions for the remaining days of curing after stripping.



From the results above, it is shown lime mortars made with NHL 2 with lime-sand ratio 1:2 develop its maximum compression strength, when it is initially cured in mould at 95% for 7 days before stripping, then cured at 95% rhfor 14 days and 65% for another 7 days. Curing regime 21 days at 65% developed the weakest strength both in compression and in flexure.

These are the results of samples cured in moulds for 2 days: 1st day at 95%rh then the second day at 65% rh.



This result shows that the three NHL 2 lime mortar samples after been cured in mould for 2 days, were cured in three different curing regime. The results show that samples cured at 95% for 26 days have the maximum strengths for compression.But samples cured at 65% for 26 days developed the weakest strength in compression.

V. DISCUSSION

This discussion is on a carried out research work on how various curing regimes on the same type of NHL 2 based in terms of materials and sand/lime ratio affect the mechanical properties of thelime mortars such as the compressive.

From the analysis of the result, the compressive strength of lime mortar samples made with NHL 2 (control experiment) at the curing regimes have the range of 0.3 MPa to 0.95 MPa. These values were obtained from the samples cured in mould for two days (i.e a day at 95% then second day at 65%rh) before finally cured in various ways for the remaining part of the curing days. The minimum of the strengths was obtained from the samples cured at 65% while the maximum is from the NHL2 mortar cured at 95% for the 26 days.

VI. CONCLUSION

This project report entails the effect of different curing regimes on thestrength of LimeMortar. It was aimed at determiningthe effect on strength of the lime mortars byvaryingthe numberof days in which lime mortars of different limes were cured. This was based on finding a suitable curing regime that yields the maximum compressive strength in Natural Hydraulic Lime 2 mortars. This has been a successful research as it has shown that lime mortars made with NHL 2 and subjected to different curing conditions will develop different compressive strengths. It has also depicted the curing condition that results in the development of maximum compressive strength of the NHL 2 based mortars.

Maximum compressive strength of the NHL 2 based mortar was achieved when cured 14 days at 95 % Relative Humidity then 7 days at 65% Relative humidity.

RECOMMENDATION

Due to the importance of compressive strength of mortars in block laying, NHL 2 lime is recommended for block laying projects in regions of high Relative Humidity as it was observed that NHL 2 based mortar sample cured at 95% relative humidity and even combination of 95% Relative humidity for 14 days and 65% Relative humidity for 7 days emerged with the highest strength of all the various curing regimes experimented.

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