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Replacement of Cement by Lime Powder

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ABSTRACT:

This experimental study presents the variation in the strength of concrete when replacing cement by lime powder also replacement by from 0% to 30% in steps of 10%. M20 grades of concrete are taken for the study keeping a constant slump of 60mm. The compressive strength of concrete cubes at age of 7 and 28 days is obtained at room temperature. Split tensile strength of concrete are found at the age of 28 days. From the test results it is found that the maximum compressive strength, tensile strength are obtained only at 30% replacement. Mixtures as a good substitute for Natural River sand at 30% replacement with additional strength than control concrete.

Keywords- ***Concrete, compressive strength. Lime powder***

INTRODUCTION

Why Mix Lime with Concrete?

Lime concrete, produced by this mix, makes a good base for load bearing walls, columns, or laying under floors because it has a degree of flexibility that regular concrete does not. It also has a certain waterproof property to it that prevents subsoil dampness in floors and walls. Additionally, lime concrete can be made easily and cheaply while still providing a durable material that resists weathering and wear and tear.

Utilization of industrial and agricultural waste products in the construction industry has been the focus of research for economical and environmental reasons. In this paper, Lime sludge, a paper and pulp industry waste product, has been chemically, physically and thermally characterized, in order to evaluate the possibility of its use as construction materials. X-ray Fluorescence and X-ray diffractometry studies for the determination of composition and presence of crystalline material and Thermo Gravimetric Analysis to identify the phase transition of lime sludge, as well as physical and mechanical properties and its pozzolanic activity have been conducted. It is concluded that the acceptance of this waste product by the construction industry could be decided depending on the application, keeping in view of the limitations on the mechanical strength.

Properties of LIME

Calcium hydroxide(Lime) is relatively insoluble in water, with a solubility product Ksp of 5.5×10^{-6}. It is large enough that its solutions are basic according to the following reaction:

$$Ca(OH)_2 \rightarrow Ca^{2+} + 2\ OH^-$$

At ambient temperature, calcium hydroxide (portlandite) dissolves in pure water to produce an alkaline solution with a pH of about 12.4. Calcium hydroxide solutions can cause chemical burns. At high pH value (see common ion effect), its solubility drastically decreases. This behavior is relevant to cement pastes. Its aqueous solutions is called limewater and is a medium strength base that reacts

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with acids and can attack some metals such as aluminium (amphoteric hydroxide dissolving at high pH) while protecting other metals from corrosion such as iron and steel by passivation of their surface. Limewater turns milky in the presence of carbon dioxide due to formation of calcium carbonate, a process called carbonatation:

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

When heated to 512 °C, the partial pressure of water in equilibrium with calcium hydroxide reaches 101 kPa (normal atmospheric pressure), which decomposes calcium hydroxide into calcium oxide and water.[7]

$$Ca(OH)_2 \rightarrow CaO + H_2O$$

Table 1: Chemical properties of LIME

s.no	Compound	Content
1	SiO_2	59.0
2	Al_2O_3	21.0
3	Fe_2O_3	3.70
4	Cao	6.90
5	Mgo	1.40
6	SO_3	1.0
7	K_2O	0.9
8	Loi	4.62

Lime as the first cement:

Since long, Lime has been used to make things like plaster and mortar. Lime is usually made by burning of limestone.Chemically; lime itself is calcium oxide (CaO) and is made by roasting calcite ($CaCO_3$) to remove carbon dioxide (CO_2). Lime is also called calx or quicklime. Quick Lime is very caustic and can even dissolve human bodies.

When lime is mixed with water, lime slowly turns into the mineral portlandite(dense) in the reaction $CaO + H_2O = Ca(OH)_2$. Lime is mixed with an excess of water so it stays fluid, this is called slaking and the lime resulting is called slaked lime. Slaked lime continues to harden over a period of weeks. Lime has to be mixed with sand and other ingredients to take form of slaked lime cement, that can be used as mortar between stones or bricks in a wall or spread over the surface of a wall There, over the next several weeks or longer, it reacts with CO_2 in the air to form calcite again(artificial limestone)

Lime Provides A Comfortable Environment

Porous and open textured materials such as lime plasters, help to stabilize the internal humidity of a building by absorbing and releasing moisture. This makes for a more comfortable environment and reduces surface condensation and mould growth.

The Use Of Lime Has Ecological Benefits

- Lime has less embodied energy than cement.
- Free lime absorbs carbon dioxide in the setting process of carbonation.
- It is possible to produce lime on a small scale.
- The gentle binding properties of lime enable full re-use of other materials.
- A very low proportion of quicklime will stabilize clay soils.
- Small quantities of lime can protect otherwise vulnerable, very low energy materials such as earth construction and straw bales.

LITERATURE REVIEW

(Hwang, Noguchi & Tomosawa, 2004) based on their experimental results concerning the compressive strength development of concrete containing Lime, the authors concluded that the pores in concrete reduce by addition of Lime as replacement of sand.

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(Siddique, 2003) carried out experimental investigation to evaluate mechanical properties of concrete mixes in which fine aggregate (sand) was partially replaced with class F Lime. Fine aggregate was replaced with five percentages (10%, 20%, 30%, 40% and 50 %) of class F Lime by weight. The test result showed that the compressive strength of Lime concrete mixes with 10% to 50% replacement with Lime were higher than control mix at all ages. Also the compressive strength of concrete mixes was increasing with increase in Lime ercentages. This increase in strength due to replacement of fine aggregate with Lime was attributed to pozzolanic action of Lime. The splitting tensile strength also increased with increase in percentage of Lime as replacement of fine aggregate. The tests on flexural strength and modulus of elasticity also showed improvement in the results as compared to control concrete.

(Namagg & Atadero, 2009) described early stages of a project to study the use of large volumes of high lime in concrete. Authors used Lime for partial replacement of cement and fine aggregates. Replacement percent from 0% to International Conference on Biological, Civil and Environmental Engineering (BCEE-2014) March 17-18, 2014 Dubai (UAE) 50% was tested in their study. They reported that concrete with 25% to 35% Lime provided the most optimal results for its compressive strength. They concluded that this was due to the pozzolanic action of high Lime.

(A.V.S SIVARAM)Changes of pH and Ca concentration Usually cementitious materials are alkaline, which has high pH values and Ca ions. On the other hand demineralized or pure water has a low pH and Ca ions (for pure water; pH is around 7.00 and Ca ion is almost zero) compared to cementitious materials. Therefore, when cementitious materials contacted with water, calcium ion as well as pH increased in the water. Haga et al. [20] observed the pH and Ca concentration changes using different water to cement ratio samples. They noticed that for higher water to cement ratio samples, higher amount of Ca was found in the leachant for the initial leaching period. The pH and Ca concentration of leachant, for the Ordinary Portland cement (OPC) samples with W/C of 0.8 and 1.0 increased as the leaching period was increased. However, after a certain period (56 days) the pH and the concentration of Ca showed a tendency to converge into a constant value, which indicates the equilibrium state of the aqueous and solid phases.

EXPERIMENTAL INVESTIGATIONS

In this investigation an attempt has been made to study the effect of Lime on physical properties of concrete when it is used as replacement of cement. The property of concrete used, the procedure used for mixing and tests conducted are represented in this module.

The mixing has been done in the laboratory. The properties considered in this study are strength and workability. The experimental program is broadly divided into following categories, viz.

1. Workability characteristics

a)Slump

b)Compaction factor test

2. Strength characteristics

a)Compression test

MATERIALS USED

CEMENT

Cement can be defined as the bonding material having cohesive & adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly.

Ordinary Portland Cement (O.P.C)

It is hydraulic cement. It is used in the making of concrete with property of setting and hardening, of which when the chemical properties react with water, O.P.C does not disintegrate in water as it sets and hardens in water.

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Ideal applications

1. Gives more flexibility to architects and engineers to design sleeker and economical sections
2. On being mixed with other aggregates, O.P.C begins to serve a dual purpose. One, it provides for the concrete products to be workable when wet and two, it provides them to be durable when dry.
3. It is extensively used by retaining walls and the precast concrete block walls as a major component to build a strong foundation of concrete.
4. Almost negligible chloride content results in restraining corrosion of concrete structure in the hostile environment
5. Produces highly durable and sound concrete due to very low percentage of alkalis, chlorides, magnesia and free lime in its composition.
6. It is also brought into usage in mortars, plasters, screeds and grouts as a material which can be squeezed into gaps to consolidate the structures.

Advantages

- Roadways, runways, flyovers and bridges
- For heavy defense structures like Bunkers
- Pre-stressed concrete structures
- Residential and commercial buildings
- Pre-casted cubes

TESTS ON CEMENT

(a) Field Test

It is sufficient to subject the cement to field tests when it is used for minor works. The following are the field tests.

1. Have a good look at the cement. The lumps must not be present. The color of cement should be greenish grey.
2. Drill your hand into the cement bag, you should feel cool.
3. Take a pinch of cement in between your fingers, it should give you smooth and gritty feeling.
4. Take a handful of cement and throw it in a bucket full of water, the particles should float for sometime before they sink.

(b) Laboratory Testing

- Fineness test
- Setting time test
- Strength test
- Soundness test
- Heat of hydration test
- Chemical composition test

FINAL SETTING TIME

Once the concrete is placed in the final position, compacted and finished, it should lose its plasticity in the earliest possible time so that it is least vulnerable to damages from external destructive agencies. This time should not be more than 10 hours which is often referred to as final setting time. Final needle is used for determining final setting time.

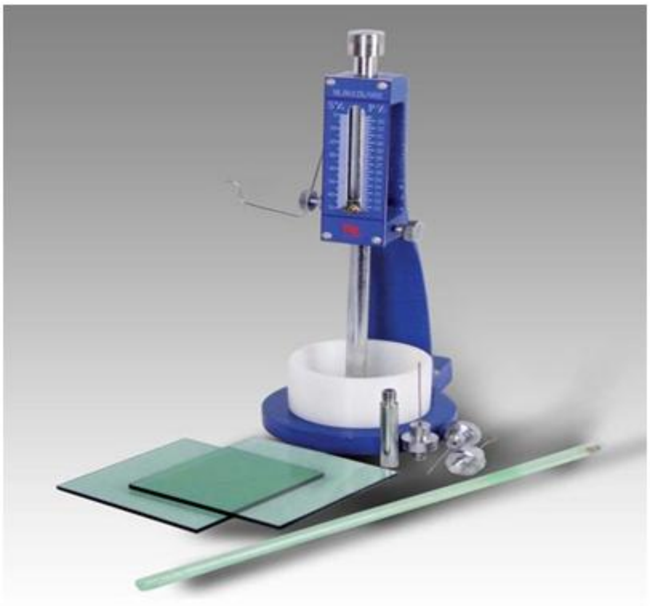

Fig 3.1 VICAT APPARATUS

Table: 3.1 Shows The Properties of Cement

s. no:	Characteristics	Values obtained	Standard values
1	Normal consistency	33mm	33 to 35 mm
2	Initial setting time	40 min	Not be less than 30 mins
3	Final setting time	300 min	Not be greater than 600 mins.

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AGGREGATES

Construction aggregate, or simply "aggregate", is a broad category of coarse particulate material used in construction, including sand, gravel, crushed d stone, slag, recycled concrete and geo-synthetic aggregates. Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material.

Fine Aggregate

The aggregate which passes through 4.75mm IS Sieve are termed as Fine Aggregate. They play a role of filling the voids in the concrete mix. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape.

Coarse Aggregate

Coarse aggregate is a material that will pass the 80mm sieve and will be retained on the 4.75mm sieve. As with fine aggregate, for increased workability and economy as reflected by the use of less cement, the coarse aggregate should have a rounded shape. Larger pieces offer less surface area of the particles than an equivalent volume of small pieces. Use of the largest permissible maximum size of coarse aggregate permits a reduction in cement and water requirements.

WATER

Water is one of the most important elements in construction but people still ignore quality aspect of the element. The water is required for preparation of motor, mixing of cement and concrete and for curing work etc... During construction the quality and quantity of water has much effect on the strength of mortar and cement concrete in construction work. The required quantity of water is used to prepare mortar or concrete, but in practice it is seen that more water is mixed to make the mix workable. This is a bad practice and additional water weakens the strength of cement paste. Extra water also weakens adhesive quality.

Quality of Water

The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing. The pH value of water should be not less than 6. A popular yard sticks to the suitability of water for mixing concrete is that, if water is fit for drinking it is fit for making concrete. This does not appear to be a true statement for all conditions. Mixing and curing with sea water shall not be permitted.

- To neutralize 200 ml sample of water. Using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NAOH.
- To neutralize 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCL

SAND

Sand is an inorganic material. It consists of small angular or rounded or sharp grains of Silica. Sand is formed by decomposition of sand stone under the effect of weathering agencies. Various sizes or grades of sand are formed depending on the amount of wearing.

Characteristics of Good Sand

- Should consist of coarse, angular, sharp and hard grains.
- Should not contain any organic matter.
- Should be chemically inert.
- Must be strong and durable.
- Size of grains should be such that, next line they pass through 4.75 mm I.S. sieve and are entirely retained on 75µ I.S sieve.

The following tests were conducted to determine the properties of sand

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Natural Sand

- This sand contains impurities like silt, silica etc.
- Natural Sand is made from different type of stones so; binding strength varies.
- Natural Sand which is available today, don't have fines below 600 microns in proper gradation. So, voids in the concrete are not filled properly & also increases cement consumption.
- Natural and gives low compressive strength as compare to Artificial Sand.
- As the voids are not filled properly, strength of the concrete is not achieved.
- As every truck of Natural Sand has different fineness modules, every time concrete mix design have to be changed.
- Natural Sand is available in less quantity so; it is costlier.
- Because of sand dragging, riverbeds had become deep. It is harmful to thenature.
- Natural Sand contains pieces of bones, woods etc. So it is not suitable as per Vastushastra.

TESTS CONDUCTED ON SAND

SIEVE ANALYSIS

The portion of sand retained on 4.75mm sieve for the analysis. The quantity of sample to be taken shell depends upon the maximum particle size contained in the sand.

Separate the sample into various fractions by sieving through the 4.75mm, 2.36 mm, 1.18mm, 600µm, 300µm, 150µm and pan. While sieving through each sieve agitate the sieve so that the sample rolls in irregular motion over the sieve.

Any particle may be tested to see if they will fall through but they shall not be pushed through. If the soil appears to contain over 5% moisture, determine the water content of the material.

When the soil sample contains less than 5% of moisture it is not necessary to determine the moisture content for dry weight computation and make all determinations on the basis of wet weight only. If the soil contains more than 20% of gravel particles and the fines are very cohesive with considerable amounts adhering to the gravel after separately wash the gravel on 4.75mm sieve using sodium hexametaphosphate if necessary.

Fig 3.2 Sieve shaker

Table 3.2 Sieve Analysis For Fine Aggregate

S. NO.	SIEVE NO.	MASS RETAINED (gms)	%RETAINED	% PASSING	CUMULATIVE % RETAINED
1	4.75	95	9.5	90.5	9.5
2	2.36	112.5	11.25	79.25	20.75
3	1.18	118.5	11.85	67.4	32.6
4	600µm	105.5	10.55	56.85	43.15
5	300µm	313	31.3	25.55	74.45
6	150µm	251	25.1	0.45	99.55
7	Pan	4.5		_	
				ΣF =	280

Modulus of fine aggregate = ΣF/100=2.8

TESTS CONDUCTED FOR CONCRETE MIX

Workability

Workability is the property of concrete which determines the amount of useful internal work necessary to produce full compaction. (or) the "ease with which concrete can be compacted hundred

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percent having regard to mode of compaction and place of deposition.
A concrete mix is said to be workable when it satisfies the following five properties.
1) Easy to mix
2) Easy to transport
3) Easy to place
4) Easy to compact
5) Easy to finish

The workability is one of the physical parameters of concrete which affects the strength and durability and the appearance of the finished surface. The workability of concrete depends on the water cement ratio and the water absorption capacity if the aggregates. If the water added is more which will lead to bleeding or segregation of aggregates. The test for the workability of concrete is given by the Indian Standard IS 1199-1959 which gives the test procedure using various equipment's. In our case we have used slump cone test and compaction factor test for measuring the workability of concrete. We have measured the height of the fall of the cone of concrete for various water-cement ratios and recorded the values for ordinary concrete.

- Slump cone test
- Compacting factor test

Slump Cone Test
The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability. It is a term which describes the state of fresh concrete. It refers to the ease with which the concrete flows. Workability of concrete is mainly affected by consistency i.e., wetter mixes will be more workable than drier mixes, but concrete of the same consistency may vary in workability. It is also used to determine consistency between individual batches. The test is popular due to the simplicity of apparatus used and simple procedure.

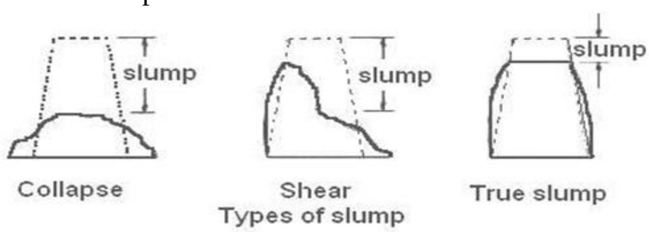
The apparatus for conducting the slump test essentially consists of metallic mould in the form of a frustum of a cone having the internal dimensions as under.

Bottom Diameter	: 20 cm
Top Diameter	: 10 cm
Height	: 30 cm

Fig 3.9 Slump Cone Apparatus

Test Procedure
In slump cone the container is filled with concrete in three layers. Each layer is tamped 25 times with a standard 16mm diameter steel rod and 600mm height. The top surface is struck off by means of a screening and rolling motion of the tamping rod.

Immediately after filling, the cone is slowly lifted and the unsupported concrete will now slump. The decrease in the height of the center of the slumped concrete is called "Slump". Instead of slumping evenly all round as in a "True Slump". One half of the cone slides down an inclined plane is a "Shear Slump". Mixes of stiff consistence have a "Zero Slump". If any specimen shears off laterally or collapses, the test should be repeated.



Types of slump

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COMPACTION FACTOR TEST

The compacting factor test is designed primary for use in the laboratory but it can also be used in the field. It is more precise and sensitive than the slump test and is particularly useful for concrete mixes of very low workability. Such dry concrete are insensitive to slump test. The diagram of the apparatus is shown in figure3.10.

The compacting factor test has been developed at the road research laboratory U. K. And it is claimed that is one of the most efficient tests for measuring the workability of concrete. This test works on the principle of determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height. The degree of compaction called the compacting factor is measured by the density actually achieved in the test to density of same concrete fully compacted.

Test Procedure

- The sample of concrete to be tested is placed in the upper hopper up to the brim.
- The trap-door is opened so that the concrete falls in to the lower hopper.
- Then the trap-door of the lower hopper is opened and the concrete is allowed to fall in to the cylinder.
- The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane scale.
- The concrete is filled up exactly up to the top level of the cylinder.
- It is weighed to the nearest 10gms. This weight is known as “weight of partially compacted concrete”.
- The cylinder is emptied and then refilled with the concrete from the same sample in layers approximately 5cm deep.
- The layers are heavily rammed or preferably vibrated so as to obtain full compaction.

The top surface of the fully compacted concrete is then carefully struck of level with the top of the cylinder and weighed to nearest 10gms. The weight is known as “weight of fully compacted concrete”.

$$\text{compaction factor} = \frac{\text{weight of partially compacted concrete}}{\text{weight of fully compacted concrete}}$$

It can be realized that compacting factor test measures the inherent characteristics of the concrete which relates very close to the workability requirements of the concrete and as such it is one of the good tests to depict the workability of concrete.

The compacting factor equipment has been shown below in fig3.10

Compaction Test Apparatus

COMPRESSIVE STRENGTH TEST

Concrete has relatively higher compressive strength, but very poor in tensile strength. The different mix of concrete gives various strength, according to the IS 10262: 1982 gives the characteristic and design strength values for various grades of concrete. The strength attained by the mix must be tested by its compressive strength of the samples which are made in the standard mould of size 150mm X 150mm X 150mm and then the cubes are kept for curing and the compressive strength test was done according to IS 516: 1959 for 7days, 14days and 28days for ordinary mix and for the partial replaced samples.

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Universal Testing Machine

Concrete Mix

Nominal mix concrete is prepared by approximate proportioning of cement sand and aggregate to obtain target compressive strength. Concrete grade up to M25 can be mixed using nominal mix method for ordinary construction purposes. Design mix concrete is prepared by proportioning materials based on codal procedure (in india it is IS 456 & IS 10262).

Based on strength, concrete is classified into different grades like M5, M7.5, M10, M15 etc., M stands for Mix and the number stands for characteristic compressive strength(fck) of the concrete in 28 days in direct compression test. If the ratio for M20 concrete is 1:1.5:3 then 1 part cement, 1.5 part sand and 3 part aggregate (crushed stone) in volume is batched for mixing.

GRADE	MIX RATIO
M 5	1 : 5 : 10
M 7.5	1 : 4 : 8
M 10	1 : 3 : 6
M 15	1 : 2 : 4
M 20	1 : 1.5 : 3

MIX DESIGN (ACI committee 211.1-91 method)

Design of concrete mix needs not only the knowledge of material properties and properties of concrete in plastic condition; it also needs wider knowledge and experience of concreting. Even then the proportion of the materials of concrete found out at the laboratory requires modification and readjustments to suit the field conditions.

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. The purpose of designing as can be seen from the above definitions in two-fold. The first object is to achieve the stipulated minimum strength and durability. The second object is to make the concrete in the most economical manner.

DESIGN STIPULATIONS FOR PROPORTIONING (Conventional Sand)

- Grade designation = M25.
- Type of cement = OPC 53 grade.
- Maximum nominal size of aggregate = 20 mm.
- Maximum water cement ratio = 0.47
- Slump = 50mm(Workability).
- Degree of supervision = good.
- Type of aggregate = crushed angular aggregate.
- Chemical admixtures = not recommended.
- Strength of concrete at 28 days = 20N/mm2.
- Fineness modulus = 2.8.
- Specific gravity of fine and coarse aggregate = 2.65 and 2.7.

Step1:- Calculation for mean strength.

Mean strength $F'_{ck} = F_{ck} + TS$.

Where T = Tolerance factor

= 1.65

S = Standard deviation

As for IS Code 1026:2009

For m_{20} grade S = 4

$$F'_{ck} = 20+1.65(4).$$

$$= 26.6\ N/mm^2.$$

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Step2:- Selection of water cement ratio.

Since OPC is used, according to IS456:2000, w/c ratio = 0.55.

Based on experience adopt w/c ratio = 0.5.

0.5 < 0.55.

Hence ok.

Step3:- Calculation for cement content.

Cement content = water content/water cement ratio.

Water content .186 lit (according to code).

Volume of water = (weight/sp.gravity of water)X(1/1000)

= (186/1)X(1/1000)

= 0.186 m3

Cement content = 186/0.5

= 372Kg/m3.

Volume of cement = (weight/sp.gravity of cement)X(1/1000)

= (372/3.15)X(1/1000

= 0.118 m3

Volume of aggregates =Total volume –{volume of (cement+water)}

= 1-(0.118+0.186)

= 0.696 m3

Step4:- Proportioning of volume of coarse aggregate.

Since 20mm coarse aggregate is used, for fineness modulus of 2.80, the dry rounded bulk volume of coarse aggregate is 0.696 per unit volume of concrete. But it is highly workable, so it should reduced by 10%.

Therefore,

0.696 × (10÷100) = 0.626.

Volume of coarse aggregate = 0.62

Therefore,

Weight of coarse aggregate = 0.62×.626×2.7×1000

=1047 kg/m3

Volume of fine aggregate = 0.43

Weight of fine agg =0.62×0.43×2.6×1000

=693 kg/m3

Step 5:- Site correction

% of water absorption for fine agg and coarse agg is 1% and 0.6%

Fine aggregate .(1/100)×693 =6.9

Coarse aggregate .(0.6/100)×1047=6.28

Total amount = 6.9+6.28

=13.18 m3

Step6:- Weight of all ingredients.

Weight of cement = 372Kg/m³.

Weight of water = 199.18 lit

Weight of C.A = 1040 Kg/m³.

Weight of F.A = 686 Kg/m³.

Proportions:

Cement : F.A : C.A : water

372 : 686 : 1040 : 199.1

1 : 1.84 : 2.79 : 0.53

Results

The following are the results of compressive strengths of all concrete mixes prepared by replacing cement by Lime with various percentages. The strengths of all concrete mixes are determined a 7, 14, 28 days of curing in water. The following are the tables showing all the results.

Compressive Strength for All Samples

SAMPLE NO.	% OF LIME	COMPRESSIVE STRENGTH (N/mm²)		
		7 days	14 days	28 days
Sample 1	0	14.2	16.7	21.5
Sample 2	10	13.5	15	20.95
Sample 3	20	14.265	17.08	22.4
Sample 4	30	15.76	16.73	24.41

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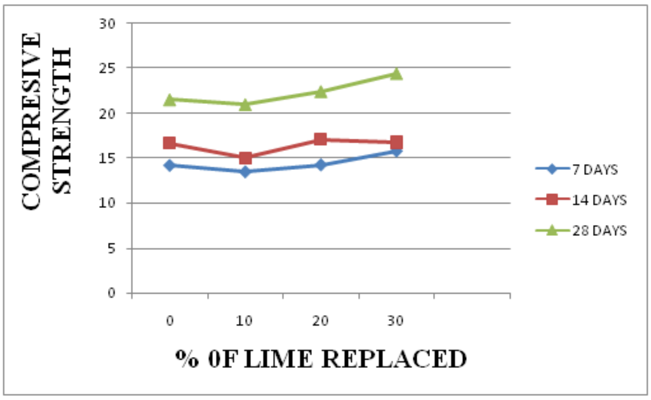

Graph 7.1 showing compressive strength at various days of curing vs % of Lime7.4.2 Discussion on Compression Value

The compressive strength for the concrete mix gradually increased with the increase in % of Lime added up to 30% of cement replaced by Lime

As the table and graphs shows the concrete mix prepared by replacing the 30% of cement by the Lime is having the more compressive strength. If there is a need of concrete with high compressive strengths in same grade of concrete the mix with 30% Lime can be adopted.

But through graphs we cannot judge the exact % at which the compressive strength is highest. Through the graph it can be said that the high compressive strength mix can be get at the percentage between 20 and 30. But through our experiment we adopt that high compressive strength mix can be obtained by replacing 30% of cement by Lime.

High compressive strength can be seen in the concretes with 60% of Lime replaced in the place of cement

CONCLUSION

Replacement of natural cement by 30% artificial Lime gives the maximum compressive strength.

The concrete mix is more workable when 30% of cement is replaced by Lime as the slump values and compacting factor values are high when compared to conventional mix.

Finally the concrete mix with 30% of cement replaced by Lime gives the best mix with high compressive strength with high workability.

Considering, the acute shortage of river sand, huge short coming on cement, high cost, greater impact on damages and environmental effects, The Construction Industry shall start using the Lime to full extent as alternative, reduce the impacts on environment by not using the cement.

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