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Study The Lightweight Concrete By Using, Brick Ballast And Aluminium Powder

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ABSTRACT:-

The compressive strength and flexural strength of the lightweight concrete are relatively equal to the normal or conventional concrete.

The main advantages are that there can be a reduction of dead load in some extent can build faster building rates in construction and minimize in handling and haulage costs. It can be considered as a versatile and important material in construction in modern days. The applications such as multi-storey frames and floors, prestressed and bridges, partition walls, roof of building and all types of elements. The major properties of the lightweight concrete are compressive strength, its water absorption, density of supplementary materials and using of the water-cement ratio to produce adequate cohesions between water and cement. It can maintain the large voids and cement films. Use of too much water can causes cement to run-off from aggregates to form film layer, subsequently it will weaken the strength.

1. Introduction :

The materials which have been used for the lightweight concrete are cement, fine aggregates, coarse aggregates, brick ballast as light weight aggregate, silica fume & cow dung ash as admixtures and aluminium powder as air entraining agent. Brick ballast is low specific gravity and porous material that can absorb water in high percentage. So, brick ballast used as light weight aggregate that replaced the natural aggregate. The adding of aluminium powder as air entraining agent which react with cement and slurry mix makes the cellular structure and fill with the hydrogen agent which increases the volume of concrete with low density. The admixtures silica fume and cow dung ash improves the various concrete properties.

Concrete Moisture Testing Differences

The weight advantage of lightweight concrete may provide the best benefit, but the same feature that reduces the weight–the pores in the aggregate or foam, or in the air introduced during mixing–also become additional spaces within the concrete that can trap and retain moisture.Unless a self-desiccant or another chemical material that locks moisture into the slab is also introduced, the water from the initial mix and hydration process must eventually find its way to the surface to evaporate away. Certain admixtures like cow dung ash retain moisture for longer periods, and the sheer volume of the many additional pores of the aggregate will also increase the amount of water retained, as well as the weight that additional moisture would cause until it is released. Because lightweight concrete has this increased capacity for moisture absorption, it can take two to three times longer than regular aggregate concrete to dry. This can present real challenges for the builder or contractor tasked with keeping the building schedule on track and under budget if this characteristic of lightweight concrete was not accounted for during the design and planning stage. The delays can be significant setbacks to the schedule or additional costs for dehumidification processes and equipment.

Need of study

The mixtures of cement, sand, coarse aggregates and water are conventional practice concrete work. As in this technologies world the work focuses to reuse waste material, develop sustainable materials which can minimize the work process and get maximum output in the field work. Till date no efforts have been study lightweight concrete by using brick ballast as lightweight aggregate, silica fume & cow dung ash as admixtures with aluminium powder as air entraining agent. The need of study on this project are how the brick ballast, admixtures i.e. silica fume and cow dung ash both improve the concrete properties along with air entraining agent i.e. aluminium powder.
The paper was discussed the physical characteristics of expanded slate rotary kiln lightweight aggregates for the producing high strength of lightweight concrete. The properties like splitting tensile strength, compressive strength and other properties are significantly affect the concrete properties. The production of concrete, transportation, placing and pumping is also affected. By the using of silica fume, lightweight aggregates and natural aggregate with cement the compressive strength is getting 47 MPa to 80 Mpa in 30 to 50 day and splitting tensile of 3.5-4.5 Mpa in 35 days. By the use of lightweight aggregate the dead load and concrete densities get reduce and properties like fire resistance, ease of placing, handling and transportation are

increased. The compressive strength of 82.75 Mpa are achieved in average of 28 days by using the cement, type I, Cow dung ash, class F, normal aggregates keeping water cement ratio of 0.32. It can be utilized in office buildings and residential in order to achieve long clear span.

The use of highly porous light-weight aggregates substantially reduced the dead load while enhances the other properties of concrete. The significant contribution is that a low water- cement ratio decreases the pores present in hardened cement state.

Summary of Reviews

Generally the lightweight concrete is lighter than the conventional concrete, these are produced by the lightweight aggregate, expanding agent, foaming agent, organic and inorganic natural aggregate. The main advantages of lightweight concrete are:

i. Reducing the dead load of concrete with improving other concrete properties whileincreasing the volume of concrete mixtures.
ii. The overall construction cost is reduced by size reduction of structural elements, reducing the volume of concrete and required less steel reinforcing.
iii. The lightweight aggregate provides porosity which lead to a source of water for internal curing and continued increases the strength of concrete.
iv. It has been used for structural elements as piers, slab, beams, bridge deck, partitionwall element etc,.

Adding of admixtures such as corrosion inhibitor, plasticizer, micro silica, cow dung ash, magnesia, air entraining agents etc improved the quality of concrete properties.

Scope of the Study

Many researchers have been done on the lightweight concrete in different corner of the countries. The reviewed paper described about application of Lightweight concrete and properties of materials. Lightweight concrete offers design flexibility and substantial costs saving. The scopes of study are:

- Less in dead load.
- 20% to 40% lighter than the conventional concrete.
- Good fire resistance.
- Good compressive strength.
- Reasonable flexural strength.
- Good quality of concrete mix.
- Ease of placing for handling and placing.

Research process

The study which gives the necessary training in arranging and gathering materials for the field work and also training in techniques for the collection of data appropriate to problem is said to be research methodology. The following are the methodologies which have been worked:

i. Data Collection: The collection of necessary information and data collection related to the Lightweight concrete. Collected important journal and thesis paper which have been done before.
ii. Abstraction of data: Abstracting and journals indexing of the data collected and bibliographies of the some paper have been discussed in the literature reviews.
iii. Selection of Materials: The Structural lightweight concrete are mostly using the mixtures of cement, lightweight aggregates, natural aggregates, air entraining agents, and admixtures. The following are material selected for the project execution:
   a. Cement
   b. Natural Aggregates
   c. Brick ballast

Silica Fume:-

It is a relatively recent arrival cementing supplementary materials. It was originally introduced as a pozzolana. It is also referred as microsilica or condensed silica fume and it is by-product of the manufacture of silicon and ferrosilicon alloys from high purity quartz and coal in submerged-arc electric furnace. Typical silica contents are as follows: silicon metal-94- 98%, ferrosilicon-90%. The specific gravity of silica fume is generally 2.20, but it is slightly higher when the silica content is lower. The diameter of particle size of silica fume is mostly ranging between 0.03 and 0.3 micrometer. It has a very low bulk density: 200 to 300 kg/m^3. Silica fume is available in the densified form of micro-pellets with bulk density of 500 to 700 kg/m^3. The general physical properties of concrete when silica fume is added are:

i. Permeability is reduced.
ii. The heat of hydration is decreased or retarded.
iii. More resistance to erosion due to water action and reduced thawing and freezingaction.
iv. Resistance to sulphate.
v. Increase the strength of concrete.

Adding of silica increase water demand as the heat of hydration are low and imparts cracking, if water-cement ratio is not well maintained. The chemical properties are given in Table 9.

Table 8: Physical and Chemical Properties of Cow dung ash

Chemical and Physical properties in Mass percentage (%)	Mass Percentage (%)
Specific gravity	2.61
Specific surface area (sq.cm/g)	8400
Silica	45.00-60.00
Aluminium	20.00 – 36.0
Manganese	0.11 -0.31
Iron	3.05 – 4.00
Sulphur	0.11-0.55
Potassium	0.50-1.50
Calcium	4.50 – 10.50
Sodium	0.25– 0.90

Table 9: Physical and chemical properties

Properties (Mass Percentage %)	Mass Percentage (%)
Specific gravity	2.21
Specific surface area(sq.cm/g)	210000
Silica	90.00
Iron oxide	0.50
Aluminium oxide	1.50
Calcium oxide	2.20
Manganese	1.50
Sulphur	0.60
Potassium	0.7

Air-Entraining Agent

The mineral agents which are mixes with concrete mixtures, the agent react with calcium hydroxide present in cement and produce hydrogen gas. This gas when present in mix gives cellular structure and escape on hardened state which form air voids in concrete. Therefore make concrete lighter than normal concrete. Aluminium powder is used as the air- entraining agent because it produces hydrogen gas in the form of bubbles when mixed with lime slurry and increases the volume of the concrete. This hydrogen gas popping out during mixture and escape after setting. It is added during the last stage of mixing.

Water

It acts as lubricant for the coarse and fine aggregates and acts chemically with the cement to form the binding paste for the aggregates and reinforcement. Water is also used for curing the concrete after it has been cast into the forms. Water used for both mixing and curing should be free from injurious amount of deleterious materials. Generally portable water is considered satisfactory for mixing and curing of concrete.

Concrete Mix Design

The proportioning of concrete is the process of selection of relative proportions of cement, sand, coarse aggregate and water to obtain a desired concrete quality. The mix proportioning conforming as per “Recommended guidelines for concrete mix design” IS:10262-1982. The proportioning of cement, sand, coarse aggregate, fine aggregate and water generally should have enough workability, maximum density and can be easily placed in the formwork.

Laboratory Investigation

The various casting, curing and testing procedure which has been taken for the project are discussed below. In this section, the experimental data are analyzed as per design mix concrete, representing various data in graphical.

Casting of Mould

For controlling the quality of concrete work, proper methods of casting should be adopted as it is depend on the fresh concrete mix properties. The cube, cylinder and beam moulds are taken for the sample casting. The total number of mould casted is 27, and 9 samples mould for cube, cylinder, and beam respectively

A simple and practical way of controlling the water content is by means of a slump test carried out by a contractor, explained below.

To conduct this test a Slump Cone of steel: 30cm high, 20cm diameter at the base, 10cm diameter on the top and provided with handles is used. Concrete is filled in the cone in layers of 7.5cm at a time, each layer being tamped 25 times with a metallic tamping rod 16mm in diameter and 60cm long. Just after the slump cone has thus been filled then it is lifted. The extent to which the concrete drops is called the slump. It is measured from the top of the cone to the top of the concrete after the cone has been removed.

Figure 4: Sample Casting

All the moulds shall be stripping without vibration and shock to avoid the damage of concrete sample. Before remove the mould, bolts and nuts shall be removed by carefully. After removed the mould the samples are kept in the curing tank for gain the desired strength in respective days.

Figure 5: Demoulding

Testing of Specimens

For greater achieving of efficiency of the used material, sample testing is very important to determine the compressive strength, flexural strength and durability of samples. The test methods conforming IS : 516 – 1959 for strength of concrete. The test is conducted under compression testing machine (CTM).

Figure 6: Cube and Cylinder testing

As concrete is primarily strong in compression and in actual construction, the concrete is used in compression. This apparatus is use to test for compressive strength of the concrete, which is very important in quality control of concrete. The cube mould of 15 cm size is to be used as per IS: 516 for testing at 7 days, 28 days etc.

RESULT & DISCUSSION

Adding of Silica fume and cow dung ash

Silica fume and Cow dung ash minimize the amount of cement which will be economical but the excess use of these admixtures can lead to reduced the desired target like compressive strength, durability, fire resistance and even can failure in the element of structure. These admixtures will enhance the concrete properties if we use proper proportioning. This proportioning will be performing as per the mix design that made.

Replacing cement by 5% and 10% of silica fume results the increase in compressive strength, reduces permeability, good workability, less bleeding and segregation. 5% and 10%of silica gave good results overall as compared to the normal or conventional practices. It is found that the 10% of silica fume adding to cement result relatively improved the properties of concrete such as compressive strength, permeability and workability.

Also 5% and 10% of cow dung ash results that the longer strength gaining, lower shrinkage, good finishing surface, enhances the initial setting time of concrete. It is found that 10% cow dung ashreplacing cement has decreases the initial setting time as more content of cow dung ash increases the setting time of concrete.

As silica fume and cow dung ash are adding 5% and 10% of cement weight respectively, the total admixtures adding for Mix 2 is 10% and Mix 3 is 20% of cement weight respectively. So, the Mix 2 results in low initial setting time, fast gaining of compressive strength, morepermeability and good workability as compared to Mix 3, because the percentage of admixtures adding to the cement is more and both silica fume and cow dung ash are accelerating admixtures.

Adding of Brick Ballast:

As brick is the universal building material, which is cheaper than other material, less lifting material, ease of placing handling and transportation. The brick is porous material whichhas a bulk density of 16 to 18 kN/m^3 generally and has a compressive strength of 3.50 kN/m^2 and crushing strength of 7 N/mm^2 to 14 N/mm^2.

In the project, the wasted brick at construction sites are broken into a 10mm to 20mm ofsize. This is uses as lightweight aggregates by replacing 50% of natural coarse aggregate. As brick ballast is light in weight, it decreased the weight of concrete mix. Since, it is porous material the water absorption are more and results more demand in water content in the mix, but presence of aluminium powder nullify the water demand in the mixtures.

Compressive Strength

Concrete is primarily strong in compression. The Compression Testing Machine is use to test for compressive strength of the concrete, which is very important in quality control of concrete. The cube mould of 15 cm and cylinder of 150mm diameter and 300 mm height is used for the testing of hardened specimens conforming as per IS: 516 f at 7 days, 14days and 28 days. The following shows the experimental results of compressive strength for conventional concrete and lightweight concrete.

The value of experimental work is as follows:

Table 18: Compressive Strength Vs Days

Days	Compressive Strength (N/mm^2)		
	Mix 1	Mix 2(5%)	Mix 4(10%)
7	3	3.2	4.7
14	13.7	9.3	11.8
28	25	17.1	17.6

Table 19: Compressive Strength against Admixture adding (%)

Aluminium Powder (%)	Silica fume (%)	Cow dung ash (%)	Normal Mix	Mix 2	Mix 3
0	0	0	3	0	0
3	5	5	13.7	10.5	11.8
5	10	10	25	21.3	23.73

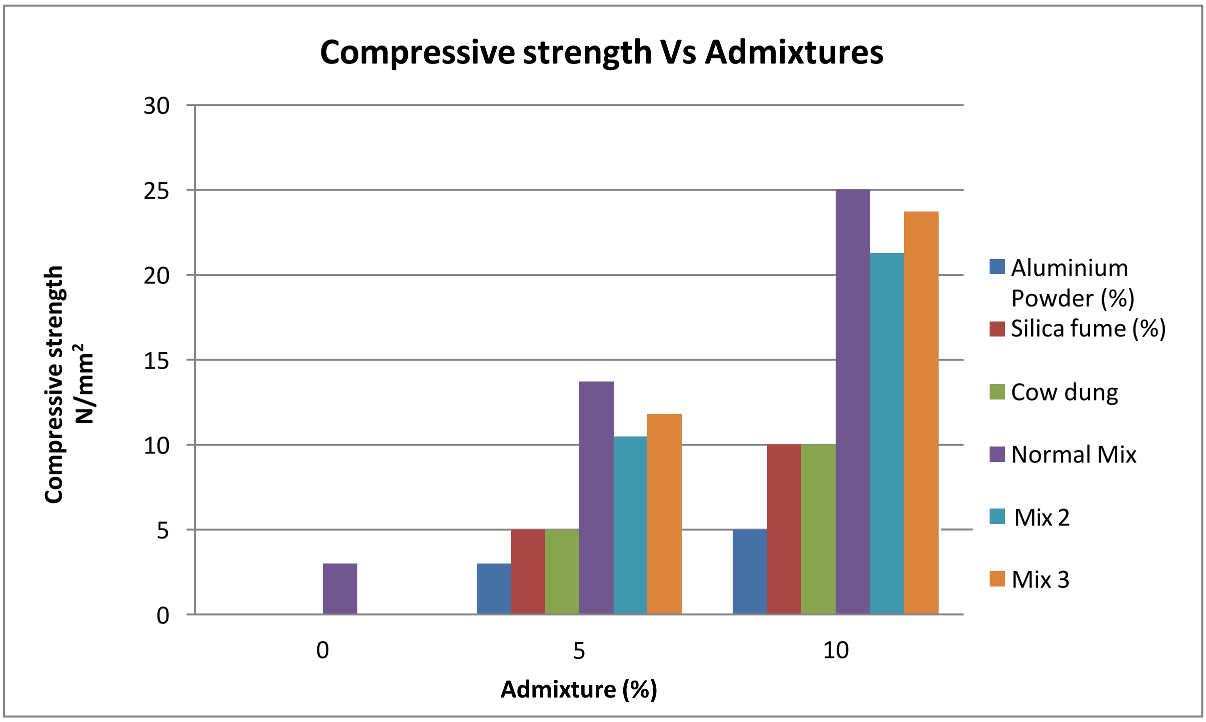

Figure 9: Compressive Strength Vs Admixtures(%)

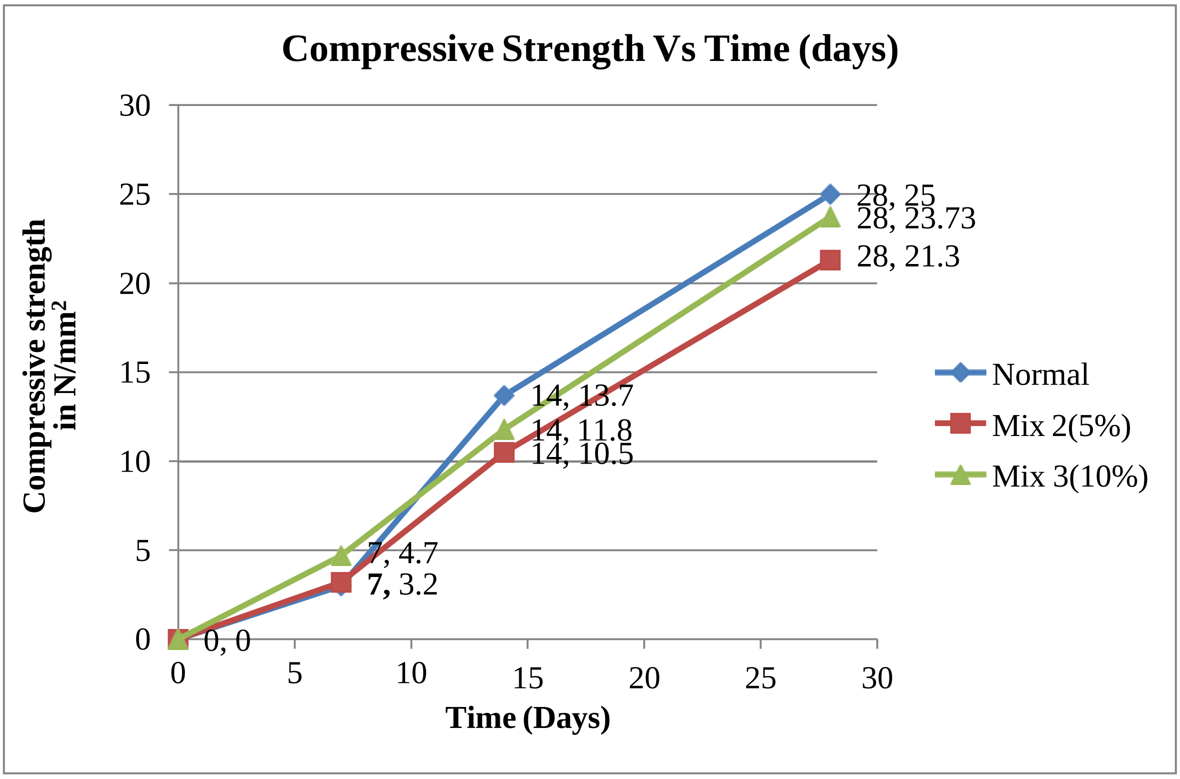

Figure 10: Compressive Strength Vs Age

Flexural Strength

The beam size of 500mmx100mmx100mm is used to determine the flexural strength of concrete. The testing of concrete conforming IS: 516, for the method of testing procedure. The various results as per test specimens are as follows:

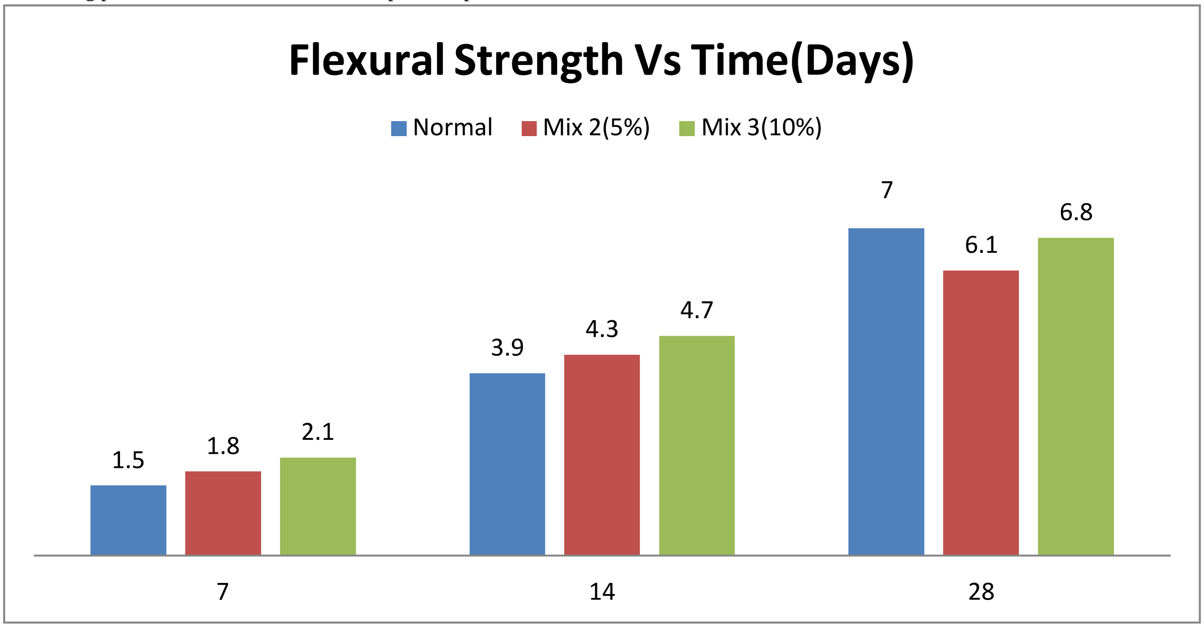

Figure 11: Flexural strength Vs Age

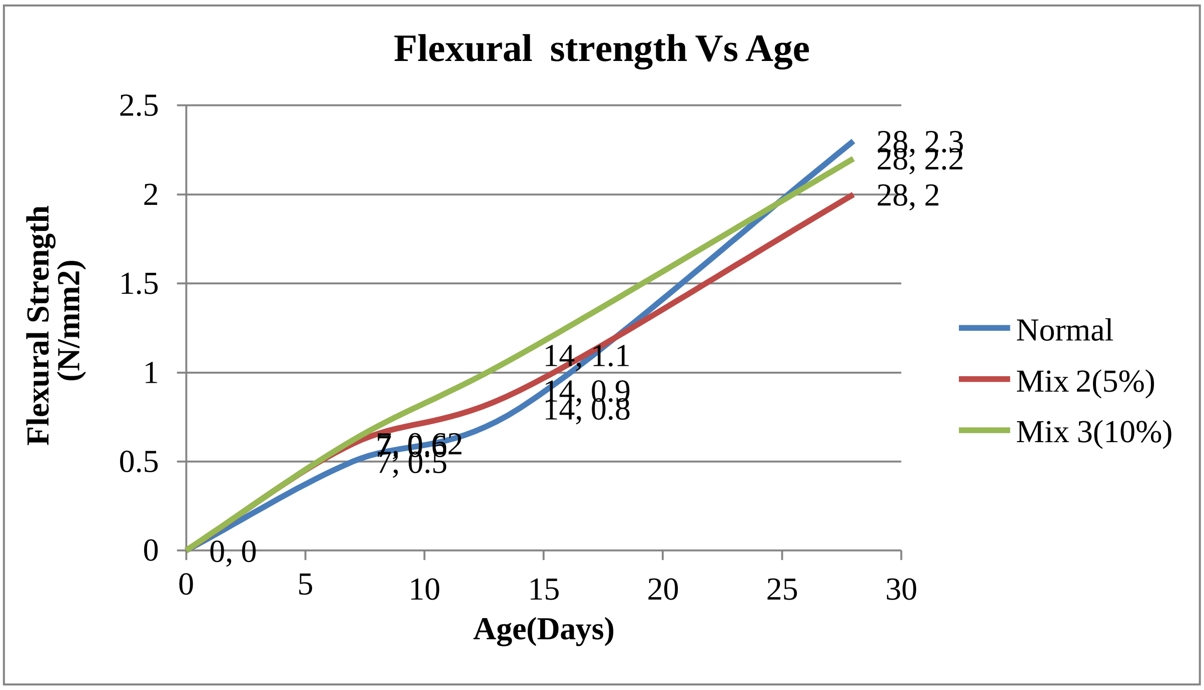

Figure 12: Flexural strengthTable 20: Flexural Strength

		Flexural Strength (N/mm^2)	
Days	Normal (Mix 1)	Mix 2	Mix 3
7	1.5	1.8	2.1
14	3.9	4.3	4.7
28	7	6.1	6.8

Percentage of weight Reduction

The main important factors which define Lightweight concrete is its dead weight or self weight. The volume of concrete increases due to presence of aluminium powder, which reduced the self-weight of concrete and relatively the use of brick ballast as lightweight aggregate has massive impact on the self-weight of concrete.

Figure 13: Self-Weight of Normal Concrete (Cylinder & Beam)

Figure 14: Self-weight of normal cube

Figure 15: Self-weight of Lightweight concrete

Figure 16: Self-weight of LW beam

The 3% and 5% of aluminium powder are added to mix 2 and mix 3 respectively. It is found that 30.9%, 33.92% and 39.79% reduction of self-weight of lightweight concrete as compared to normal or conventional concrete mix.

Table 21: Weight Reduction

Mould	**Weight (kg)**		**Reduced Weight (%)**	
For Cube				
Mix 1	Mix 2(3%)	Mix 3(5%)	Mix 2	Mix 3
7.7	5.5	4.9	28.57	36.36
8.7	6.15	5.1	29.31	41.38
8.9	5.8	5.2	34.83	41.57
		Average Reduction	30.90	39.77
For Cylinder				
12.7	8.02	7.3	36.85	42.52
13.1	9.47	7.8	27.71	40.46
12.9	8.1	7.1	37.21	44.96
		Average Reduction	33.92	42.65
For Beam				
11.59	7.85	7.1	32.27	38.74
12.5	8.93	7.3	28.56	41.60
12.3	8.79	6.9	28.54	43.90
		Average Reduction	29.79	41.41

DISCUSSION :

After the analysis of result, the adding of 3% and 5% of aluminium powder to cement, aggregates massively increases the volume of concrete mix and produces gases in the mixtures which later on escaped and formation of small pores in concrete. It result in reduced the self- weight of concrete and reduced the quantity of other materials which is economic factor.

Replacing the natural aggregates by brick ballast (50%) contributes to developing of lightweight concrete. Brick ballast is a material with porous nature which absorbs water during mixing and dries after sufficient curing.

The compressive strength and flexural strength of Lightweight concrete are relatively lowered than the normal concrete or conventional concrete. It is due to the over expansion of concrete and unwell strength of brick ballast but it lowered the economic factor which are mostimportant in construction management.

Table 22: Water Absorption for Cube specimen

S No.	**Weight of Fresh MixConcrete (kg)**				**Dry Weight (After 28Days) in Kg**			**Water Absorption of normal mould (%)**	
	Mix 1	**Mix 2**	**Mix 3**	**Mix 1**	**Mix 2**	**Mix 3**	**Mix 1**	**Mix 2**	**Mix 3**
1.	17.44	11.21	9.5	7.7	5.5	4.9			
2.	18.34	12.32	10.8	8.7	6.15	5.1			
3.	18.61	12.37	10.31	8.9	5.8	5.2	53.48	51.39	50.34
Average	18.13	11.97	10.20	8.43	5.82	5.07			

The absorption of water percentage is more in normal mixes or conventional concrete mix i.e Mix 1, thus it increases the dead weight of concrete. The Mix 2 and Mix 3 has contain less water thus light in weight.

Conclusion :

Lightweight Concrete is generally lighter than conventional concrete. It is developed by replacing natural aggregate with 50% brick ballast and adding 3% and 5% of aluminium powder to the cement. As silica fume and cow dung ash are adding 5% and 10% of cement weight respectively, the total admixtures adding for Mix 2 is 10% and Mix 3 is 20% of cement weight respectively. So, the Mix 2 results in low initial setting time, fast gaining of compressive strength, more permeability and good workability as compared to Mix 3, because the percentage of admixtures adding to the cement is more and both silica fume and cow dung ash are accelerating admixtures.

Aluminium powder added in the mixtures form gas and escape after setting which lead to the formation of empty voids filled by air thus it is good for soundness effect. It also can absorb the thermal effect. The compressive strength and flexural strength of Lightweight concrete are relatively lowered than the normal concrete or conventional concrete. It is due to the over expansion of concrete and unwell strength of brick ballast but it lowered the economic factor which are most important in construction management.

Thus the developing of lightweight concrete can lead to next generation building materials. The using of silica fume and cow dung ash minimize the cement requirement, it also improve the various concrete properties. The lightweight concrete has following properties:

i. 25% to 40% lighter than conventional concrete.
ii. Relatively good compressive strength as compared to conventional concrete.
iii. Using of silica fume and cow dung ash give better workability.
iv. Flexural strength varies between 0.5 to 3 N/mm^2.
v. Good sound resistance.
vi. Give better surface finishing.
vii. Ease of handling, placing and transportation.
viii. Less in self-weight or dead weight.

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