IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

IJARSCT
Impact Factor: 6.252

Volume 2, Issue 1, July 2022

Influence of Amount of Light Weight Aggregate on Properties of Self Compacting Concrete

Sabyath Shetty and Ashish Shetty
Department of Civil Engineering
N.M.A.M. Institute of Technology, Nitte, Karnataka, India
shettysabyath@nitte.edu.in and ashish.shetty919@gmail.com

Abstract: *Concrete with low density is termed lightweight concrete. The unit weight of such concretes is about two-thirds of normal concrete. Most structural lightweight concretes weigh between 1600 and 1760 kg/m3. Design strengths between 20 to 35 MPa are common. The lightweight nature of these concretes is usually obtained either by using lightweight cellular aggregates. LWC can be produced by using lightweight materials like Lightweight Expanded Clay Aggregate, Pumice stone, expanded shale, Perlite etc. Structural lightweight aggregate can be produced naturally or from environmental waste. use of these aggregates can reduce the density of concrete, the self-weight of the structure and it helps to construct larger precast unit. Lightweight concrete (LWC) is an exceptional solution in terms of decreasing the dead weight of the structure, while self-compacting concrete (SCC) eases the pouring and eliminates construction difficulties. Investigations are also reported the literature on the performance of micro silica in SCC wall panels. The Self-Compacting Concrete made by partially varying coarse aggregate with the lightweight pumice aggregate is described in the paper. This paper presents the fresh and hardened properties of low strength grade and standard grade, self-compacting concrete partially incorporating pumice as coarse aggregate with different replacements. This experimental study also compares the fresh and hardened concrete properties of conventional self-compacting concrete and Light weight self-compacting concrete. The fresh concrete test properties were examined using the slump flow, T500, and J-ring tests. Hardened concrete test properties incorporate 7-, 28- and 56-days compressive strength tests. From the test results it is found that Lightweight self-compacting concrete exhibits better flow property than conventional self-compacting concrete.*

Keywords: Light weight concrete, Self-compacting concrete, Pumice aggregate, Design strength, Compressive strength

I. INTRODUCTION

Lightweight concrete can be defined as a type of concrete which includes an expanding agent in that it increases the volume of the mixture while giving additional qualities such as workability and lessened the dead weight. It is lighter than the conventional concrete. The use of lightweight concrete has been widely spread across countries such as USA, United Kingdom and Sweden. The main specialties of lightweight concrete are its low density and thermal conductivity. Its advantages are that there is a reduction of dead load, faster building rates in construction and lower haulage and handling costs. Lightweight concrete maintains its large voids and not forming laitance layers or cement films when placed on the wall. This research was based on the performance of aerated lightweight concrete. However, sufficient water cement ratio is vital to produce adequate cohesion between cement and water. Insufficient water can cause lack of cohesion between particles, thus loss in strength of concrete. Likewise, too much water can cause cement to run off aggregate to form laitance layers, subsequently weakens in strength. Nowadays lightweight concrete is commonly used in precast and prestressed components. Light weight concrete offers design flexibility and substantial cost savings by providing less dead load, improves seismic structural response, better fire rating, decreased storey height, smaller size structural members, lower foundation cost, and less reinforcing steel. The highly porous microstructure of light weight aggregate gives it low density and better insulation and make that the concrete made with light weight concrete exhibit lower thermal conductivity than that of normal weight concrete. Therefore, light weight concrete provides more efficient fire protection than dense aggregate as it is less liable to spalling and has a higher thermal insulation.

The word “concrete” itself represents a very large segment to the total load of the structure which is playing a vital role in the present versatile construction industry. it is having high probable strength gaining capacity from many years because of its sustainable hardening capacity which helps in making the structure very strong. One of the ways to reduce the weight of a structure is the use of lightweight aggregate concrete (LWAC). In recent years, more awareness has been paid to the development of lightweight aggregate concrete. In this study, the replacement of usual aggregate by light weight aggregate concrete and the method of using pozzolanic material is studied. Light weight aggregate is of natural origin mostly volcanic tuff which acts as active pozzolonas when used as aggregates. Natural light weight aggregate as a pozzolonic material in light weight concrete has grown as much that it became an essential ingredient in concrete, particularly for making high strength & high-performance concrete. An active pozzolona is an alumino siliceous material in finely divided form which chemically reacts with calcium hydroxide by forming calcium silicate hydrate and other cementitious compounds. For the reduction of cost in the construction purpose mineral admixture are widely used in concrete for reducing the amount of cement required. Moreover, pozzolans will act as byproduct materials in saving energy consumption and weight reduction.

The effect of pozzolonic material in light weight aggregate concrete improves workability, increases water tightness, lower heat of hydration and reduce alkali-aggregate reaction. At present more awareness has been made to the development of light weight aggregate concrete which is the most probable way in reducing the weight of structure and acts as a relatively new material where weight saving is an important factor. Light weight concrete is a type of concrete material that is lighter than the conventional concrete because of varying material composition. It maintains good durability in satisfying the required demands by making the concrete as a high-performance material. When an light weight aggregate is made for the same crushing strength the density of concrete obtained will be 35% lower when compared to the normal weight concrete Light weight concrete is having an oven dried density of not less than 800 kg/m3 and not even more than 2000 kg/m3 when compared to normal weight concrete. The major benefit in adopting the light weight concrete mixes is of reducing the self-weight of the structure up to 15% or more. When there is less unit weight of aggregate then comparatively the unit weight of concrete will also be low and it is done by replacing the normal weight aggregate to the lightweight materials. The materials which will occur naturally are pumice stone, volcanic tuff, porous limestone, foamed lava. Among these aggregates pumice stone which is of natural light weight aggregate is being chosen as a best material for the partial replacement to coarse aggregate. it gives good strength when compared to the other materials More research work is being carried out because of its low density, porous in nature and high-volume occupancy. It includes an enlarging agent which increases the volume of the mixture. It is having low-density by preserving large voids and when placed on the wall it forms cement films.

The effect of aggregate composition, the maximum particle size of light weight aggregate, mineral admixture and the volume percentage of sand on high strength semi light-weight concrete is investigated. The effects on compressive strength, splitting tensile strength, modulus of elasticity and dry apparent specific gravity are reported. Test results show that aggregate composition affects both physical and mechanical properties of semi-lightweight concrete. Reducing the maximum particle size of lightweight aggregate or introducing mineral admixture can improve its compressive strength and splitting tensile strength but these changes have negligible effect on its dry apparent specific gravity. The Indian standard code (ISC) defines silica fume as "very fine non-crystalline silica produced in electric arc furnaces as a by-product of the production of elemental silicon or alloys containing silicon". The use of silica fume (SF) for production of high-performance concretes is very common. Many extensive experiments were carried out by many researches around the world indicated that the usage of silica fume in concrete increases the concrete strengths, modulus of elasticity, chemical and abrasion resistance, in addition to enhancing durability, corrosion protection and mechanical properties. But there is not a clear, unique conclusion regarding the optimum silica fume replacement percentages, although some of the researchers have reported different replacement levels. No replacement materials were designed with a 28-days compressive strength of 50 N/mm2. Most of normal weight aggregate of normal weight concrete is natural stone such as limestone and granite. With the increasing amount of concrete used, natural environment and resources are excessively exploited. Synthetic lightweight aggregate produced from environmental waste, like fly ash, is a viable new source of structural aggregate material. The use of light weight concrete permits greater design flexibility and substantial cost savings, reducing dead load, improved cyclic loading structural response, longer spans, better fire ratings, thinner sections, smaller size structural members, less reinforcing steel, and lower foundations costs. Weight of lightweight concrete is typically 25% to 35% lighter but its strengths is comparable to normal weight concrete. The conventional cement concrete is a heavy material having a density of 2400kg/m3, and high thermal conductivity. The dead weight of the structure made up of this concrete is large compared to the imposed load to be carried, and a relatively small reduction in dead weight, particularly for members in flexure e.g., in high rise buildings, can save money and manpower in construction. Based on a microstructure model predicted, a procedure for the diffusivity of high strength concrete by considering water-to-binder ratio, silica fume replacement ratio, and degree of hydration as major influencing factors. They concluded that diffusivity of concrete can be reduced by adding silica fume which makes the microstructure of concrete denser. The properties evaluated were development of compressive strength, secant modulus of elasticity, strain due to creep, shrinkage, swelling and moisture movement. Other researchers studied the effect of high temperature on the performance of lightweight concrete with silica fume in terms of compressive and splitting tensile strengths, weight loss and mechanical properties.

II. IMPORTANCE

1. Light weight aggregates are used for making high strength & high-performance concrete.
2. Light weight aggregate concrete improves workability, increases water tightness, lower heat of hydration and reduce alkali-aggregate reaction.
3. At present more awareness has been made to the development of light weight aggregate concrete which is the most probable way in reducing the weight of structure and acts as a relatively new material where weight saving is an important factor.

III. LITERATURE REVIEW

T.Z.H. Ting et al.,[1] has presented a paper on Recent development and perspective of lightweight aggregates based self-compacting concrete. The utilization of natural and artificial lightweight aggregates in lightweight self-compacting concrete (LWSCC) is gaining popularity in research field. Extensive research has been carried out in the past decade all over the world to utilize lightweight aggregates (LWA) in self-compacting concrete (SCC). LWSCC, which uses renewable aggregates, has great potential to become an alternative material to conventional concrete. The paper is aimed to review the more recent research of physical properties of lightweight aggregates used in developing mix design of lightweight self-compacting concrete. In design, the mix proportion of LWSCC is a crucial factor to achieve the desired fresh and hardened concrete properties. The methods to develop LWSCC mix design with anticipated fresh and hardened concrete are reviewed. Research shows that the mix design LWSCC is preferably proportioned by aggregates packing concept. In addition, discussion on the fresh and hardened concrete properties is made and summarized in thispaper. Studies indicate that there is a promising future for the use of lightweight aggregates in SCC as
it shows satisfactory filling ability, passing ability, segregation resistance and compressive strength. Research gaps recommendations are then identified through this review to further discover lightweight self-compacting concrete in several aspects, particularly in term of sustainability.

P. Sundar Kumar et al.,[2] presented a paper on Experimental Study on Lightweight Aggregate Concrete. Lightweight concrete (LWC) has been successfully used since the ancient Roman times and it has gained its popularity due to its lower density and superior thermal insulation properties. Compared with normal weight concrete (NWC), LWC can significantly reduce the dead load of structural elements, which makes it especially attractive in multi-storey buildings. However, most studies on LWC concern “semi-lightweight “concretes, i.e., concrete made with lightweight coarse aggregate and natural sand to manufacture the “total lightweight” concrete, more environmental and economic benefits can be achieved if waste materials can be used to replace the fine lightweight aggregate. With increasing concern over the excessive exploitation of natural aggregates, synthetic lightweight aggregate produced from environmental waste is a viable new source of structural aggregate material. The uses of structural grade lightweight concrete reduced considerably the self-load of a structure and permit larger pre-cast units to be handled. The mechanical properties of a structural grade lightweight aggregate made with fly ash and clay will be presented. It is well known that in general fly ash (FA) and silica fume (SF) increases the compressive strength, splitting tensile strength and flexural strength of concrete. In our study it was found that 10% replacement of fly ash and S.F will increase the compressive strength, tensile and flexural strength. When FA & SF was increased to 20% the compressive strength, flexural splitting tensile will be decreased. However, if the FA addition to the concrete is too high the pacts effect of FA weakens because of positive inference and the secondary hydration reaction is delayed. The SF used in our test has high specific surface, high amorphous siO2 and small particle size only with such chemical and physical characteristics.

T. Divya Bhavana et al.,[3] has presented a paper on Study of Lightweight concrete. The present-day world is witnessing construction of very challenging and difficult civil engineering structures. In this study comparison has been made between plain cement concrete and light weight concrete having different proportion of aggregates and admixtures. i.e., Expanded Clay Aggregates: 0%, 25%, 50%, 75% and 100% with coarse aggregate, silica fumes 10% and PVA (Poly Vinyl Alcohol) 1.6% of constant replacement with cement and water respectively. It helps to increase the volume of concrete and hence reduce the weight.

P. O. Awoyera et al.,[4] has carried a paper on a Lightweight Self-Compacting Concrete Incorporating Industrial Rejects and Mineral Admixtures: Strength and Durability Assessment. By the recent global research developments, a lot of natural and artificial materials that are normally discarded and landfilled, are continually investigated for potential construction applications. In this study, the mechanical and durability properties of lightweight self-compacting concrete produced using pumice, ground granulated blast furnace slag (GGBS), rice husk ash (RHA) and precipitated silica, was investigated. A detailed experimental design was performed, which entailed reducing the water powder ratio, and use of viscosity modifying admixture, for enhancing the fresh SCC quality. The experimental process involved assessment of mechanical and durability properties of concrete mixtures. The results have shown that compressive and flexural strength of SCC made with lightweight aggregate are improved using mineral blended cement. Also, same mix, but with pumice as coarse aggregate gave higher split-tensile strength than other mixtures. This study deduced that pozzolanic reactivity and filler action of supplementary cementitious materials used, enhanced the resistance of the mixtures to deterioration when exposed to aggressive environment.

B. Devi Pravallika et al.,[5] has presented a paper on The Study on Strength Properties of Light Weight Concrete using Light Weight Aggregate. In this paper, Concrete is widely noted to be most expensive constituents in the entire construction industry. Many research works have been carried out on concrete mixes which had encouraged the development of material with partial replacement of natural aggregate like pumice stone, thermocol beads, saw dust. For the construction of structures, the new sources that is produced from environmental waste is Natural aggregate which reduces the self-weight and helps in constructing of larger precast units. light weight concrete plays a prominent role in reducing the density of concrete structures where reduction of self-weight is an important factor which may increases thermal insulation by relating of structural response & serviceability. Light weight aggregate is of natural origin mostly volcanic tuff which acts as active pozzolonas when used as aggregates. In this study the strength and durability properties of M40 concrete by partial replacement of coarse aggregate with natural light weight aggregate pumice stone will be studied. The properties of conventional M40 concrete are compared with properties of concrete with light weight aggregate, produced by replacing coarse aggregate with pumice stone by 0%,10%,20%,30%,40% and 50%. The physical and mechanical properties of natural aggregate are evaluated. An optimum control mix is designed based on structural light weight concrete M40 using the light weight aggregate pumice stone as a partial replacement to coarse aggregate. For this purpose, 6 sets were prepared in which each set comprises of 15 cubes, 3 cylinders and 3 beams. Slump test were carried out for each mix in the fresh state. The compressive strength of cubes (150mmX150mmX150mm), split tensile strength for cylinders (150mm diaX300mm height), flexural strength for (beams 500X100X100mm) tests will be carried out to determine the strength of concrete at 7and 28 days which were performed in the hardened state.

IV. OBJECTIVES

1. To study the effect of light weight aggregates on fresh properties of self-compacting concrete.
2. To evaluate the influence of light weight aggregates on mechanical properties of self-compacting concrete.

V. METHODOLOGY

5.1 Testing Program of Lightweight Concrete

In order to study the behaviour of lightweight concrete, normal concrete testing was done to determine the material and structural properties of each type of lightweight concrete and how will these properties differ according to a different type of mixture and its composition. Once concrete has hardened it can be subjected to a wide range of tests to prove its ability to perform as planned or to discover its characteristics. For new concrete this usually involves casting specimens from fresh concrete and testing them for various properties as the concrete matures.

5.2 Compressive Strength

Compressive strength is the primary physical property of concrete (others are generally defined from it), and is the one most used in design. It is one of the fundamental properties used for quality control for lightweight concrete. Compressive strength may be defined as the measured maximum resistance of a concrete specimen to axial loading. It is found by measuring the highest compression stress that a test cylinder or cube will support.There are three type of test that can be used to determine compressive strength; cube, cylinder, or prism test. The ‘concrete cube test' is the most familiar test and is used as the standard method of measuring compressive strength for quality control purposes (Neville, 1994).

5.3 Water Absorption

These properties are particularly important in concrete, as well as being important for durability. (J.H Bungey, 1996). It can be used to predict concrete durability to resist corrosion. Absorption capacity is a measure of the porosity of an aggregate; it is also used as a correlation factor in determination of free moisture by oven-drying method. The absorption capacity is determined by finding the weight of surface-dry sample after it has been soaked for 24 hr and again finding the weight after the sample has been dried in an oven; the difference in weight, expressed as a percentage of the dry sample weight, is the absorption capacity (G.E Troxell, 1956). Absorption capacity can be determine using BS absorption test. The test is intended as a durability quality control check and the specified age is 28-32 days (S.G Millard). Test procedure has been described by BS 1881: Part 122 is as listed in the appendix 2.

5.4 Density

The density of both fresh and hardened concrete is of interest to the parties involved for numerous reasons including its effect on durability, strength and resistance to permeability. Hardened concrete density is determined either by simple dimensional checks, followed by weighing and calculation or by weight in air/water buoyancy methods (ELE International, 1993). To determine the density of lightweight concrete sample, the simple method is preferred.

5.5 Tests on Materials

5.5.1 Cement Tests

Expt. No: 1 Normal Consistency of Cement

Aim: To determine the quantity of water required to produce a cement paste of standard consistency.

Apparatus:

- Vicat’s apparatus conforming to IS:5513-1976
- Weighing balance
- Gauging Trowel
- Stop Watch

Reference Code:

- IS: 4031(Part 4)-1998 methods of physical test for hydraulic cement
- IS: 5513-1996 for specification for Vicat’s apparatus

Theory:

The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the vicat mould. For finding out initial setting time, final setting time, soundness of cement and compressive strength of cement, it is necessary to fix the quantity of water to be mixed in cement in each case.

Observation and Calculation

- Type of cement = 53 grade OPC
- Brand of cement = Ultra tech
- Time of test = 35 minutes
- Room temperature

Table 5.1 Normal Consistency of Cement

Trail no	Weight of the cement	% Of water of dry cement	Amount of water	Penetration
1	300	26%	78ml	14
2	300	28%	84ml	29

Result

Normal consistency for the given sample of cement is 30%

Expt. No: 2: Determination of Setting Time of Standard Cement Paste

Aim: To determine the initial and final setting time of a given sample of cement.

Apparatus:

- Vicat's apparatus conforming to IS: 5513-1976
- Weighing balance
- Glass plate
- Gauging trowel
- Stop watch

Reference Code

- IS: 4031(part 4) -1988 methods of physical test for hydraulic cement.
- IS: 5513-1996 for specification for Vicat's apparatus.

Theory

Initial setting time is regarded as the time elapsed between the moments that the water is added to the cement to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the moment the water is added to the cement and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain definite pressure.

Observation

- Type of cement = 53 grade OPC
- Brand of cement = Ultratech cement
- Weight of given sample of cement = 300gms
- The normal consistency of a given sample of cement is = 30%
- Volume of water added for preparation of test block = 90ml

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 1, July 2022
IJARSCT
Impact Factor: 6.252

Result

- The initial setting time of the cement sample is found to be 45 minutes.
- The final setting time of the cement sample is found to be 366 minutes.

Expt. No 3: Specific Gravity of Cement

Aim: To determine the specific gravity of given sample of cement.

Apparatus

- Weighing balance
- Specific gravity bottle (50 ml capacity)
- Kerosene
- Funnel

Theory

Specific gravity is defined as the ratio between weight of a given volume of material and weight of an equal volume of water. To determine the specific gravity of cement, kerosene is used which does not react with cement.

Observations

- Initial Reading = 0.5ml
- Final reading = 20.7 ml
- Volume displaced by cement = final reading – initial reading
  = 20.7 - 0.5 = 20.2 ml
- Specific gravity of cement = weight of cement in grams / displaced volume in ml
  = 64/ 20.2 = 3.15

Results

Specific gravity of given Cement = 3.15 %

Expt. No: 4: Fineness Test of Cement by Sieve Analysis

Aim: To determine the fineness of the cement of the given sample by sieve analysis.

Apparatus:

- IS: 9µ test sieve
- Bottom pan
- Weighing balance
- Brush

Reference Code:

IS 4031(PART 1): 1988, IS 460(PART 1): 1985

Theory:

The degree of fineness of cement is a measure of the mean size of the grains. The finer cement has quicker action with water and grains early strength without change in the ultimate strength. Finer cement is susceptible to shrinkage and cracking.

Observation:

Weight of cement taken = 100 gms

Weight of cement retained after sieving = 96 gms

DOI: 10.48175/IJARSCT-5640

Type of cement = 53 grade OPC
Brand of cement= Ultratech cement
Percentage weight of Residue=Weight of sample left on the sieve
Total weight of sample = 96/100 = 0.96

Result
Fineness of the given sample is **0.96**

5.5.2 Fine Aggregate Tests
Expt. No 1: Determination of Specific Gravity of Fine Aggregate

Aim: to determine specific gravity of a given sample of fine aggregate.

Apparatus:
- Pycnometer bottle
- Taping rod
- Funnel

Observation and Calculations:
- Weight of empty bottle (W1 g) = 608.5g
- Weight of empty bottle + coarse aggregate (W2 g) = 1088.5g
- Weight of empty bottle + water+ coarse aggregate (W3 g) = 1814.5g
- Weight of empty bottle + water (W4 g) = 1517.5g
- Specific gravity of fine aggregate = (W2-W1)/ (W4-W1)-(W3-W2)
  = (1088.5-608.5)/(1517.5-608.5)-(1814.5-1088.5) = 2.62

Result:
Specific gravity of fine aggregate = 2.62 %

Expt. No 2: Test on Sieve Analysis of Fine Aggregate

Aim: To determine particle size distribution of fine aggregate

Apparatus: IS sieve size of 4IS sieve size of 4.75mm, 2.36mm, 1.18mm, 600micron, 300micron, 150micron, pan, sieve shaker.

Theory:
Sieve analysis is conducted to determine are particle size distribution in a sample of aggregation. Properly graded aggregate produces dense concrete and needs smaller quanties of fine aggregates. The fineness modulus of sample of aggregate is proportional to average of particle in aggregate. It is computed by adding one cumulative percentage of materials coarses than each of following sieves and dividing the sieves by 100.

Observations and Calculations

Table 5.2 Sieve Analysis of Fine Aggregate

IS sieve	Weight retained in IS sieve	Cumulative % Weight	Cumulative % passed
4.75	7.5	7.5	0.75
2.36	22.6	30	3

1.18	12.6	156	15.6
600	179.5	335.5	33.5
300	571.5	907	90.7
150	47.15	954.15	95.41
pan	42.5	996.65	99.6

Fineness modulus = Cumulative % Retained
100
= 338.62/100
= 3.38 %

Expt.No:3
Test for Determination of Bulk Density of Fine Aggregate

Aim: To determine the bulk density of fine aggregate.

Apparatus:
- Weighing balance
- Brush

Theory:
Bulk density is the weight of material in a given volume. It is normally expressed in kg per liter. A Cylindrical measure preferably machined to accurate internal dimensions is used for measuring bulk density. The size of the container for measuring bulk density for fine aggregate is 3 litres.

Observation and Calculations
- Weight of the empty cylinder W1= 2.70kg
- Weight of loose aggregate + weight of the cylinder W2 = 6.990kg
- Weight of the loose aggregate Wl = W2-W1 = 6.990-2.700 = 4.29 kg
- Weight of the compacted aggregates W3= 7.480kg
- Wc= W3-W1 = 7.480-2.710 = 4.77kg
- oose bulk density = Wl/3 =4.29/3 = 1.43kg/l
- Compacted bulk density = Wc/3 = 4.77/3 = 1.59kg/l

5.5.3 Coarse Aggregate Tests
Expt. No. 1:
Determination of Specific Gravity of Coarse Aggregate

Aim: to determine specific gravity of a given sample of coarse aggregate

Apparatus:
- Pycnometer bottle
- Taping rod
- Funnel

Observation and Calculations:

- Weight of empty bottle (W1 g) = 608.5g
- Weight of empty bottle + coarse aggregate (W2 g) = 1088.5g
- Weight of empty bottle + water+ coarse aggregate(W3 g) = 1814.5g
- Weight of empty bottle + water(W4 g) = 1517.5g
- Specific gravity of fine aggregate = (W2-W1)/ (W4-W1)-(W3-W2)
  = (1088.5-608.5)/(1517.5-608.5)-(1814.5-1088.5) = 2.62

Result:
Specific gravity of fine aggregate = 2.62 %

Expt. No 2: Test on Sieve Analysis of Coarse Aggregate
Aim: To determine particle size distribution of coarse aggregate

Apparatus: IS sieve size of 4IS sieve size of 4.75mm, 2.36mm, pan, sieve shaker.

Theory:
Sieve analysis is conducted to determine are particle size distribution in a sample of aggregation. Properly graded aggregate produces dense concrete and needs smaller quantities of coarse aggregates. The fineness modulus of sample of aggregate is proportional to average of particle in aggregate. It is computed by adding one cumulative percentage of materials coarses than each of following sieves and dividing the sieves by 100.

Observations and Calculations

Table 5.3 Sieve Analysis of Coarse Aggregate

IS sieve	Weight retained in IS sieve	Cumulative % Weight	Cumulative % PAASED
4.75	7.5	7.5	0.75
2.36	22.6	30	3
1.18	12.6	156	15.6
600	179.5	335.5	33.5
300	571.5	907	90.7
150	47.15	954.15	95.41
pan	42.5	996.65	99.6

Fineness modulus = Cumulative % Retained
100
= 338.62/100
= 3.38

Result:
Fineness modulus of coarse aggregate is 3.38

Expt. No 3: Test for Determination of Bulk Density of Coarse Aggregate

Aim: To determine the bulk density of coarse aggregate
Apparatus
Theory:
Bulk density is the weight of material in a given volume. It is normally expressed in kg per litre. A Cylindrical measure preferably machined to accurate internal dimensions is used for measuring bulk density. The size of the container for measuring bulk density for coarse aggregate is15litres.

DOI: 10.48175/IJARSCT-5640

Observation and Calculations

- Weight of the empty cylinder W1= 9.640kg
- Weight of loose aggregate + weight of the cylinder W2 = 28.650kg
- Weight of the loose aggregate Wl = W2-W1 = 28.650-9.64 = 19.01 kg
- Weight of the compacted aggregates W3= 30.700kg
- Wc= W3-W1 = 30.700-9.640 = 21.06kg
- Loose bulk density = Wl/15 =19.01/15 = 1.267kg/l
- Compacted bulk density = Wc/3 = 21.06/15 = 1.404kg/l

5.5.4 Foundry Sand Tests

Expt. No. 1: Determination of Specific Gravity of Light Weight Aggregate

Aim: To determine specific gravity of a given sample of light weight aggregate.

Apparatus:

- Pycnometer bottle
- Taping rod
- Funnel

Observation and Calculations:

- Weight of empty bottle (W1 g) = 610g
- Weight of empty bottle + light weight aggregate (W2 g) = 740g
- Weight of empty bottle + water+ light weight aggregate (W3 g) = 1460g

Weight of empty bottle + water (W4 g) = 1500g

Specific gravity of light weight aggregate = (W2-W1)/(W4-W1) -(W3-W2)

= (740-610)/ (1500-610) -(1460-740) = 0.764%

Expt. No2: Test on Sieve Analysis of Light Weight Aggregate

Aim: To determine particle size distribution of light weight aggregate

Apparatus: IS sieve size of 4IS sieve size of12.5mm, 10mm, 4.75mm, pan, sieve shaker.

Theory:

Sieve analysis is conducted to determine are particle size distribution in a sample of aggregation. Properly graded aggregate produces dense concrete and needs smaller quantities of coarse aggregates. The fineness modulus of sample of aggregate is proportional to average of particle in aggregate. It is computed by adding one cumulative percentage of materials coarses than each of following sieves and dividing the sieves by 100.

Observations and Calculations

Table 5.4 Sieve Analysis of Light Weight Aggregate

IS sieve	Weight retained in IS sieve	Cumulative % Weight	Cumulative % PAASED
12.5	0	0	0
10	20	20	2
4.75	690	710	71
pan	90	800	80

Fineness modulus = Cumulative % Retained

100

= 153/100 = 1.53

Result: Fineness modulus of coarse aggregate is 1.53

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
IJARSCT
Impact Factor: 6.252
Volume 2, Issue 1, July 2022

5.5.5 Water Absorption for the Light Weight Aggregate

Some of the aggregates are porous and absorptive. Porosity and absorption of aggregate will affect the water cement ratio and hence the workability of concrete. The porosity of aggregate will also affect the durability of concrete when the concrete is subjected to freezing and thawing and also when the concrete is subjected to chemically aggressive liquids.
Water absorption of coarse aggregate = 1.83

VI. EXPERIMENTAL APPROACH

- Mix Design
- Flow ability test
- Slump test
- Casting of moulds
- Curing

6.1 Mix Design

1. Grade designation : M50
2. Type of cement : OPC 53 grade
3. Maximum nominal size of aggregate: 12 mm
4. Type of aggregate : Crushed angular aggregate
5. Chemical admixture type : Super plasticizer (Polycarboxylate ether based)
6. Specific gravity of cement : 3.15
7. Specific gravity of fine aggregate : 2.62
8. Specific gravity of coarse aggregate : 2.66
9. Specific gravity of Pumice : 0.95
10. Specific gravity of super plasticizer : 1.2
11. Specific gravity of mineral admixture : 2.89
12. Specific gravity of water : 1

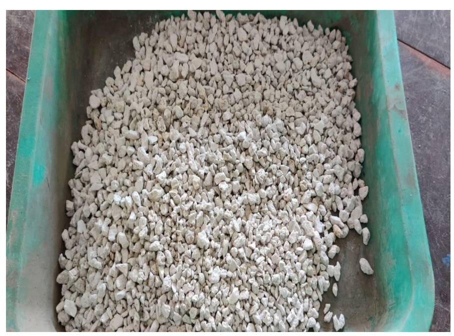

Fig 6.1 Aggregate mix

Table 6.1 Concrete Mix Proportion

NO	INGREDIENTS	SCC P = 0%	SCC P =10%	SCC P =20%	SCC P = 30%	SCC P = 40%
1	Cement (kg\m^3)	417.26	417.26	417.26	417.26	417.26
2	GGBS (kg\m^3)	278.17	278.17	278.17	278.17	278.17
3	Chemical Admixture	0.65	0.65	0.65	0.65	0.65
4	Water – cement Ratio	0.34	0.34	0.34	0.34	0.34
5	Coarse aggregate (kg\m^3)	790.54	713.49	634.21	554.93	475.65

6	Fine aggregate (kg\m^3)	586.47	586.47	586.47	586.47	586.47
7	Pumice (kg\m^3)	0	22.85	45.71	68.56	91.42

C: FA: CA= 1: 1.37: 1.89

6.2 Slump Test

It is used to evaluate the horizontal flow of SCC in the absence of obstructions. It was first developed in Japan for use in assessment of underwater concrete. The test method is based on the test method for determining the slump. The diameter of the concrete circle is a measure for the filling ability of the concrete.

Fig 6.2 Slump Cone Test

Fig 6.3 Slump Cone Test

Workability Tests Results for SCC

Table 6.2 Workability Test Results

Sl.NO	Method	Unit	SCC P = 0	SCC P = 10%	SCC P = 20%	SCC P = 30%	SCC P = 40%
1	Slump Flow	mm	650	650	650	650	650
2	T50 Slump Flow	sec	4	5	6	7	7

6.3 Casting of Moulds

The moulds will be prepared and well-oiled to ease for removal of moulds after hardened state, the prepared mix was taken and poured in the mould. Hence this is self-compacting concrete no vibrators are used to fill the moulds.

Fig 6.4 Casting of Mould

6.4 Curing of Moulds

The specimens were de-moulded after 24 hours of casting and placed in water for curing. The water used for curing should maintain room temperature. The specimens must be cured properly to obtain accurate results. The hydration of cement is not a momentary action but a process continuing for long time.

Fig 6.5 Curing Process

Fig 6.6 Curing Process

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252

Volume 2, Issue 1, July 2022

VII. SAMPLE PREPARATION AND TESTING

7.1 Sample Preparation

After mixing the concrete, workabilityproperties of the LWSCC mixes were determined byslump flow, J-ring, L-box, V-funnel tests. Slump flow test was done to determine the free flowability and deformability of light weight self-compacting concrete. A slump flow cone of height 300 mm, base diameter 200 mm and top diameter 100 mm was used for thetest. The J-ring test was conducted to determine thepassing ability of concrete. The equipment consists of an open steel ring, drilled vertically with holes to accept threaded sections of reinforcement bar. Thedimension of the ring vertical bar 300 mm diameter and height 100 mm. After pouring of concrete, the difference in concrete between the concrete inside and that just outside the J-ring was measured. V- Funnel Flow Time Test was done to determine the deformity through restricted area. The concrete freshmix was filled with a trap door. After filling, the trap door is opened and the time taken to flow of concrete was measured. Lastly, L-Box test was done to assess the effect of reinforcement on free flow of concrete constrained by form work. The flowability, blocking and segregation of the concretewere measured for the concrete mixes. Thus, concrete samples were cast for compression. The hardened concrete was tested in alignment. After placing concrete in the moulds, it was left for 24hrs to properly set, before the samples were demoulded and were cured in water for 7, 28 and 56days period. This procedure allows the samples to be partially hardened before curing process begins. Compressive strength, split-tensilestrength and flexural strength of the samples were determined after 7, 28 and 56days curing period.

7.2 Test Conducted

7.2.1 Compressive Strength

Concrete cubes are casted in the moulds of size 150mm x 150mm x 150mm. The moulds are initially oiled before casting of concrete for smooth handling and easy de moulding of concrete cubes. Later cured and tested for 7days, 28days and 56 days in compression testing machine of 200-ton capacity. Concrete cubes were casted for all the mixes. Three cubes for each of 7day, 28day and 56 days were casted for each mix.

Fig 7.1 Compressive Testing

Fig 7.2 Compressive Testing

7.2.2 Ultrasonic Pulse Velocity

Ultrasonic pulse velocity (UPV) in concrete is an important parameter in evaluating concrete's properties [44]. UPV testing measures the ultrasonic wave speed when it penetrates through materials in order to predict the strength of the materials, find any changes in condition of the materials, and find any internal flaws, and the travelling distance has a full report on the correlation between the compressive strength. First, one transducer was placed against one end of the test sample. The other transducer was placed at the other end of the test sample. The distance between the two transducers was measured as L. After the excitation measurement, the first Vaseline was applied between the transducer and the concrete surface, and the pressure wave was received. UPV test equipment consists of three parts: the ultrasonic pulser, the receive amplifier, and the time measurement device that indicates that the time of ultrasonic wave travel through the medium and the receiving transducer receives the signal. The measurement data are displayed and recorded in the control host.

To determine the velocity of ultrasonic pulse wave, two quantities are measured: the transmission distance and the duration ultrasonic pulses transmitted. The UPV Test measures the time of travel of an ultrasonic pulse passing through the cobncrete. The high UPV Test and lower time of travel indicate good quality of concrete in terms of density, uniformity, homogeneity, etc.

As per IS 516 (Part 5 section 1) the permissible limit of ultrasonic pulse velocity and it shows the different limitation value of UPV which is mentioned in the code

Table 7.1 Velocity Criterions for Concrete Quality Grading

SR. No.	Pulse Velocity by Cross Probing (Km / Sec)	Concrete Quality Grading
1.	Above 4.5	Excellent
2.	3.5 to 4.5	Good
3.	3.0 to 3.5	Medium
4.	Below 3.0	Doubtful

VIII. RESULTS

The first phase of investigations was carried out to develop different percentage replacement of pumice in the concrete and to study its fresh and hardened properties.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
IJARSCT
Impact Factor: 6.252
Volume 2, Issue 1, July 2022

Table 8.1 Compressive strength of 7 days Concrete

Pumice replacement in %	Load (KN)	Compressive strength (N/mm^2)	Compressive strength for 7 days (N/mm^2)	Weight (KG)
0	800	35.55	33.33	8.01
	700	31.11		8.11
	750	33.33		8.12
10	850	37.78	40.75	8.02
	950	42.23		7.76
	950	42.23		7.8
20	800	35.55	35.40	8.12
	790	35.11		8.01
	800	35.55		8.06
30	450	20	25.04	7.54
	570	25.33		7.60
	670	29.78		7.42
40	600	26.67	26.37	7.30
	620	27.56		7.45
	560	24.89		7.51

Table 8.2 Compressive strength of 28 days Concrete

Pumice replacement in %	Load (KN)	Compressive strength (N/mm^2)	Compressive strength for 28 days (N/mm^2)	Weight (KG)
0	1220	54.22	51.85	8.12
	1190	52.89		8.13
	1090	48.44		8.09
10	900	40	39.29	8.04
	950	42.23		7.80
	800	35.56		7.82
20	1030	45.78	41.18	8.14
	900	40		8.05
	850	37.78		8.09
30	750	33.34	37.34	7.58
	920	40.89		7.63
	800	35.56		7.45
40	780	34.67	34.07	7.32
	750	33.34		7.47
	770	34.22		7.53

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

IJARSCT
Impact Factor: 6.252

Volume 2, Issue 1, July 2022

Table 8.3 Compressive strength of 56 days Concrete

Pumice replacement in %	Load (KN)	Compressive strength (N/mm^2)	Compressive strength for 56 days (N/mm^2)	Weight (KG)
0	1090	48.45	51.11	8.12
	1100	48.89		8.13
	1260	56		8.09
10	950	42.22	49.34	8.06
	1200	53.34		7.20
	1180	52.44		7.9
20	1130	50.22	40.74	8.23
	700	31.11		8.15
	920	40.89		8.08
30	1100	48.89	43.11	7.84
	900	40		7.56
	910	40.44		7.46
40	820	36.44	41.77	7.83
	900	40		7.67
	1110	48.89		7.54

Fig 8.1 Compressive strength Test Conduction

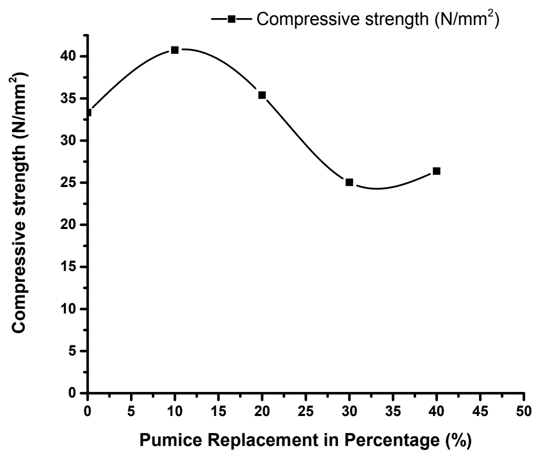

Fig 8.2 Compressive strength of 7 days Concrete

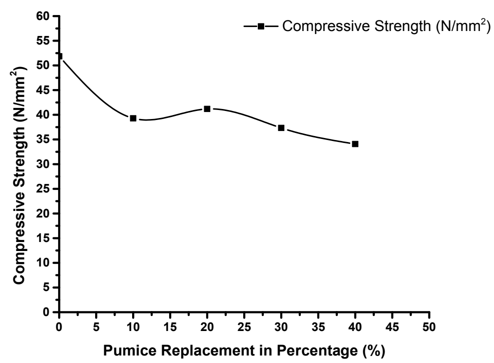

Fig 8.3 Compressive strength of 28 days Concrete

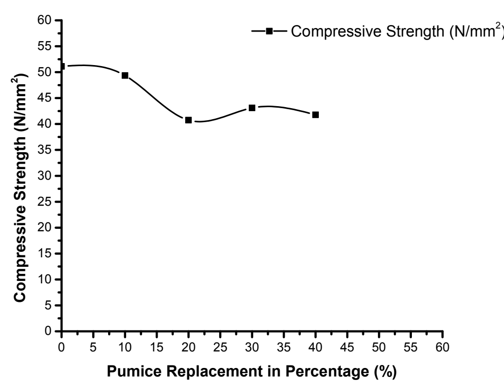

Fig 8.4 Compressive strength of 56 days Concrete

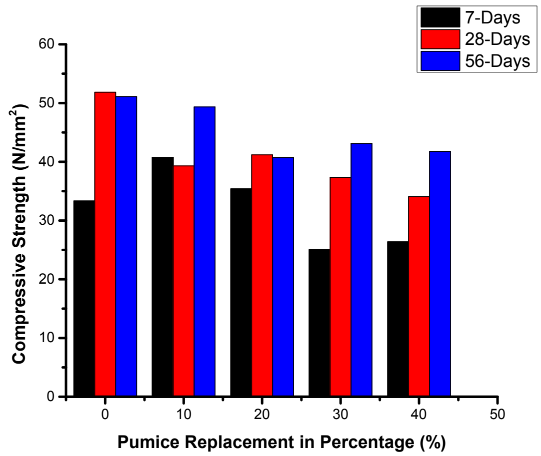

Fig 8.5 Overall Compressive Strength

8.1 Ultrasonic Pulse Velocity Test

Ultrasonic pulse velocity (UPV) test is a nondestructive popular test used to examine the homogeneity, quality, cracks, cavities, and defects in concrete. The ultrasonic pulse velocities were measured using direct and indirect approach on plain concrete surface. In this approach UPV was computed as the ratio of wavepath length between the transmitting and receiving transducer to the time of flight**.**

8.2 Equipment

There is the following equipment used in ultrasonic pulse velocity test such as;

- It includes a pulse generation circuit consisting of an electronic circuit for generating pulses.
- A transducer for transforming electronic pulse into mechanical pulse which has an oscillation frequency in the range of 40 kHz to 50 kHz.
- For receiving the signal, it includes a pulse reception circuit.

8.3 Procedure:

- Check the instrument zero, a reference bar is provided and on it, the pulse time for the bar is engraved. Before placing it on the opposite ends of the bar apply a smear of grease to the transducer faces.
- It is recommended that the 0.1-microsecond range should be selected for path length up to 400mm for maximum accuracy.
- Make careful measurement of the path length 'L' and to the surfaces of the transducers apply couplant and onto the surface of the material press it hard.
- While reading is being taken do not move the transducers because in measurements this can generate noise signals and errors. Until a consistent reading appears on the display which is the time in microsecond for the ultrasonic pulse to travel the distance 'L', continue holding the transducers onto the surface of the material.
- To prevent the two transducer leads from coming into close contact with each other when the transit time measurements are being taken it is suitable.
- If this is not done the receiver lead might pick-up unwanted signals from the transmitter lead and an incorrect display of the transit time occurs.

DOI: 10.48175/IJARSCT-5640

Fig 8.6 Ultrasonic Pulse Velocity Test Conduction

Table 8.4 Ultrasonic Pulse Velocity Test

Pumice replacement in %	Direct Test (m/s)	Indirect Test (m/s)
10	4792	5579
20	4808	5638
30	4491	5248
40	4399	4930

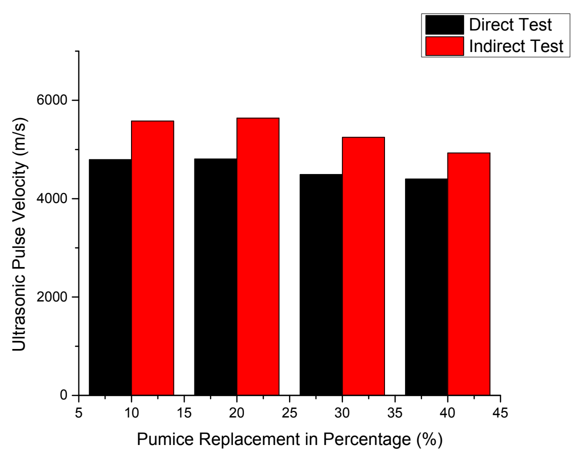

Fig 8.7 Variation Ultrasonic Pulse Velocity

IX. CONCLUSION

- The workability of all the light weight concrete mix considered were within the specified standard limits and an indication that the use of mineral admixtures in addition to superplasticizer also enhance the workability of light weight concrete. Thus, this concrete technology will reduce the noise pollution from vibrators used for compaction of normal weight concrete.
- It has been observed that between 30-40% pumice replacement of coarse aggregate significantly reduces the density of concrete and overall contribute to the making of a durable light weight concrete.
- It is very evident that pumice stone, even though are slightly weaker in compression can be used for structure purpose in addition with other pozzolanic material. For any admixture concerned with the durability factor, the predefined proportion provides better durability andstructural strength.
- Thus, a proper choice of aggregates has significant influence on the fresh and hardened properties of SCC and moreover, it leads to a betterconcrete and an efficient constructionprocess. Therefore, meaning that a successful

development of SCC ensures a good balance between deformability and stability.

- The indirect ultrasonic pulse velocity is statistically similar to direct ultrasonic pulse velocity and there are uniform properties including moisture gradient along the surface and along the depth.

REFERENCES

[1]. Kayali, O.A. and Haque, M.N. "A new generation of structural lightweight concrete," ACI, SP-171, 1997, pp. 569-588

[2]. Serkan suba March (2009) "The effects of using fly ash on high strength lightweight concrete produced with expanded clay aggregate" volume 4, pp.275 – 288.

[3]. P. Sundar Kumar "Experimental Study on Lightweight Aggregate Concrete" International Journal of Civil Engineering Research Volume 1, Number 1 (2010), pp. 65–74© Research India Publications http://www.irphouse.com/ijcer.htm

[4]. I.B. Topcu, T. Uygunog˘lu, Effect of aggregate type on properties of hardened self-consolidating lightweight concrete (SCLC), Constr. Build. Mater. 24 (7) (2010) 1286–1295, https://doi.org/10.1016/j.conbuildmat.2009.12.007.

[5]. Y.J. Kim, Y.W. Choi, M. Lachemi, Characteristics of self-consolidating concrete using two types of lightweight coarse aggregates, Constr. Build. Mater. 24 (1) (2010) 11–16, https://doi.org/10.1016/j.conbuildmat.2009.08.004.

[6]. Ranjbar M, Beygi M, Nikbin I et al (2011) Evaluation of the strength variation of normal and lightweight self-compacting concrete in full scale walls. Mater Tehnol / Mater Technol 45:571–577

[7]. P. priyadharshini, g. mohan ganesh and a. s. santhi june (2012) **"**A Review on Artificial Aggregates" issn 0974-5904, volume 05, No. 03(01), pp. 540 – 546.

[8]. N. Sivalinga Rao, Y.Radha Ratna Kumari, V. Bhaskar Desai, B.L.P. Swami (2013) **"**study on Fibre Reinforced Light Weight Aggregate (Natural Pumice Stone) Concrete."

[9]. Slamet Widodo, "Experimental Study on The Potential Use of Pumice Breccia as Coarse Aggregate In Structural Lightweight Concrete", Vol 5, No 1, 2014. [6] Lakshmi Kumar Minapu1,et.al , "Experimental Study on Light Weight Aggregate Concrete with Pumice Stone, Silica Fume and Fly Ash as a Partial Replacement of Coarse Aggregate, Vol. 3, Issue 12, December 2014.

[10]. Mang,uriu Geoffrey N,et.al, "Properties of Pumice Lightweight "Vol 2, No.10, 2012

[11]. B. Devi Pravallika "The Study on Strength Properties of Light Weight Concrete using Light Weight Aggregate" International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

[12]. N.Venkata Ramana , "Behaviour of Pumice Light Weight Concrete." International Journal of Advance Research In Science And Engineering IJARSE, Vol. No.4, Special Issue (01), April 2015.

[13]. Rajeswari S**, "**Experimental Study of Light Weight Concrete by Partial Replacement of Coarse Aggregate Using Pumice Aggregate" International Journal of Scientific Engineering and Research (IJSER) www.ijser.in ISSN (Online): 2347-3878, Impact Factor (2015): 3.791

[14]. Syed Mudabir Altaf, Mir Mohammad Shoaib Mauloodi, HOD Zubair Ahmad Bhat, Raja Minad Ajaz Mrch (2015) "Study of Effect of Light Weight Aggregate Containing Fly Ash on Properties of Concrete", volume 2, issue 3, pp.197 – 202.

[15]. T.M. Grabois, G.C. Cordeiro, R.D. Toledo Filho, Fresh and hardened-state properties of self-compacting lightweight concrete reinforced with steel fibers, Constr. Build. Mater. 104 (2016) 284–292, https://doi.org/10.1016/j.conbuildmat.2015.12.060

[16]. B. Vakhshouri, S. Nejadi, Mix design of light-weight self-compacting concrete, Case Stud. Constr. Mater. 4 (2016) 1–14, https://doi.org/10.1016/j.cscm.2015.10.002.

[17]. B. Vakhshouri, S. Nejadi, Mix design of light-weight self-compacting concrete, Case Stud. Constr. Mater. 4 (2016) 1–14, https://doi.org/10.1016/j.cscm.2015.10.002.

[18]. T. Divya Bhavana "STUDY OF LIGHT WEIGHT CONCRETE**"**International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 4, April 2017, pp. 1223–1230 Article ID: IJCIET_08_04_137.ISSN

Print: 0976-6308 and ISSN Online: 0976-6316

[19]. Zarnaghi VN, Fouroghi-Asl A, Nourani V, Ma H (2018) On thepore structures of lightweight self-compacting concrete containing silica fume. Construction Build Mater 193:557–564. https://doi.org/10.1016/j.conbuildmat.2018.09.080.

[20]. Ting TZH, Rahman ME, Lau HH, Ting MZY (2019) Recent development and perspective of lightweight aggregates based self-compacting concrete. Construction Build Mater 201:763–777. https://doi.org/10.1016/j.conbuildmat.2018.12.128

[21]. Karthika V, Awoyera PO, Akinwumi II et al (2018) Structural properties of lightweight self-compacting concrete made with pumice stone and mineral admixtures. Rev Rom Mater Rom J Mater 48.