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Review on Light Weight Concrete

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ABSTRACT: This review aims to study further sustainability to the low self- weight concrete by replacing its natural gravel coarse aggregate by an fly ash aggregate and some other natural and artificial aggregates. The compressive strength was evaluated by measuring the maximum acceptable load using compression testing equipment. Compressive strength portion. The compressive strength of light weight concrete with fly ash aggregate substitution was higher compared to normal concrete with gravel aggregate. This investigation work encourages the use of fly ash aggregate in concrete with its easy availability and low cost, if not free.

KEYWORDS:: Lytag, Flyash aggregate, Lightweightaggregateconcrete, Lightweightaggregateconcrete, Lightweightconcrete, Concrete strength..

I. INTRODUCTION

Concrete is a widely used material around planet. Large quantities of different types of concrete are used due to its structural advantages and strength. The enhanced properties of the concrete in freshly prepared and hardened states, durability and its environmental impact are very remarkable topics for analysis. Due to its higher self weight and low tensile stress carrying capacity, the application of plain cement concrete gets limited. Themainadvantagesofusingtheflyashaggregateinconcretearereductionindeadloadandreuseofwastematerial.Artificialflyashaggregatescan be manufactured from flyash through various processeslike sintering, hydrothermal treatment and coldbonding.Lytag,Pollytagaresomeofthecommerciallyavailablelightweightflyashaggregatesaroundtheworld.Themainobjective of this paper is to present a review on the previousworkscarriedout by usingflyashaggregatesinconcrete.

II. LITERATURE REVIEW

ErgulYasar, Cengiz Duran Atis, AlaettinKilic, Hasan Gulsen (FEB 2003)-This paper presents a part of the results of an ongoing laboratory work carried out to design a structural lightweight concrete (SLWC) made with basaltic pumice (scoria) as aggregate and fly ash as mineral admixtures. A control lightweight concrete mixture made with lightweight basaltic pumice (scoria) containing only normal Portland cement (NPC), and with fly ash lightweight concrete mixture containing 20% of fly ash as a replacement of the cement in weight basis was prepared. Fly ash is used for economical and environmental concern. The concrete samples were cured at 65% relative humidity at 20 jC temperature. The compressive and flexural tensile strengths of hardened concrete, the properties of fresh concrete includingdensity, and slump workability were measured. Laboratory compressive and tensile strength tests results showed that SLWC can be produced by the use of scoria.

B.A. Herki, J.M. Khatib and E.M. Negim (SEP 2013) –This paper presents results of an experimental work on the effects of waste Expanded Polystyrene (EPS) based light weight aggregate called Stabilised Polystyrene (SPS) and fly ash in concrete. The composite aggregate was formed with 70% waste polystyrene which was shredded to coarse and sand sizes, 10% of a natural material to improve the resistance to segregation of eps and port land EPS and 20% Portland cement. Nine different mixtures with water to binder ratio (W/B) of 0.8 with varying SPS content ratios of 0, 60 and 100% as partial replacement of natural fine aggregate by equivalent volume at the fly ash replacement levels of 0, 20 and 40%with Portland cement were prepared and tested.

KhampheeJitchaiyaphuma, TheerawatSinsiria, PrinyaChindaprasirt(2011) – The porosity of cellular lightweight concrete or CLC, which is pre-formed foam method made from port land cement blended with foaming agent and pozzoloan materials. Uses of fly ash replace cement in the proportions 10, 20 and 30 percent by weight ofbinder. Constant water to binder ratio of 0.5 and unit weight of 800 kg/m3 compared compressive strength .

Düzce University, Technical Education Faculty, Department of Construction Education, Konuralp, Düzce 81620, Turkey.(MAR 2009) – The effect of using fly ash in high strength lightweight aggregate concrete produced withexpanded clay aggregate on physical and mechanical properties of the concrete was investigated. For this purpose, lightweight concrete mixtures with 350, 400 and 450 kg/m3 cement content were prepared using expanded clay aggregate. Besides, concretes with 0, 10, 20 and 30% fly ash replacement were produced out of the mixtures with different cement contents. Concrete density, porosity, ultrasonic pulse velocity, compressive and split tensile strength experiments were performed on the prepared samples. As a result, it was seen that it is possible to produce high strength lightweight concrete using expanded clay aggregate; the cement content with 450 kg/m3 among concrete mixtures had the highest strength values; mechanical properties of concrete could be enhanced by using 10% fly ash; thus a saving in cement amount could be achieved.

Manu S. Nadesan, P. Dinakar(SEP 2017) - A mix design methodology for light weight concrete was proposed. Different specimens were casted using light weight aggregates and varying water/cement ratio of 0.25, 0.35, 0.45, 0.55, 0.65 and 0.75. It was observed that the plastic densities of LWCs varied between 1940 and 2040 kg/m^3, whereas the plastic densities of normal concrete usually varied between 2200 and 2600 kg/m^3. It can be seen that a density reduction of approximately 20% can be achieved when coarse aggregates in normal concretes were completely replaced with sintered fly ash aggregates. The superplasticizer dosage required to develop a workable high strength concrete using LWA was minimal. The reason for the lesser demand of superplasticizer might be due to the spherical shape of the aggregates, which might have helped the concrete to exhibit more workability. The tensile strength characteristics of LWAC were almost similar to that of the normal weight concrete (NWC). It is evident from the results that the splitting tensile strength increased with the decrease in w/c.

M. Abdullahi, H.M.A. Al-Mattarneh, B.S. Mohammed(2009) - Equations for mix design of structural lightweight concrete are presented. Conventionally, mix design of concrete is conducted using the tabular data and charts in standards. This requires extra efforts of understanding the data in the code and interpolations are often required when intermediate values are needed. The process is also liable to human error as data may be erroneously taken by the mix designer. The tabular data and graphs in ACI 211.2-98 are converted to equations. Various models were tried and the best model that adequately represents the data was chosen based on the regression coefficient and its predictive capability. The equations were used to solve some mix design problems from reputable textural sources. The developed equations are capable of giving material constituents for the first trial batch of structural lightweight concrete. These equations can be used in place of the data in the code and would reduce the effort, time and energy expended in the manual process of mix design of structural lightweight concrete. The equations are also useful for mixture proportioning adjustment.

PayamShafigh, MohdZaminJumaat and HilmiMahmud(OCT 2010) –Equations for mix design of structural lightweight concrete are presented.

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NallaiahgariSivanagi Reddy, CH.Vema Reddy (Apr 2017) - The manufacturing process of cement and the methods involved in production of fly ash aggregates (Sintering, Autoclaving, Cold bonding and Pelletisation) were discussed briefly. The aggregates were experimented for Aggregate Crushing Value, Aggregate Impact Value, and Aggregate Abrasion Value as per the IS 2386 (Part IV) – 1963. Also Specific gravity, water absorption, bulk density and void ratio of aggregates were calculated as per IS 2386 (Part III) - 1963. Both natural and flyash aggregates showed crushing and impact value within the limit of 45%, fly ash aggregateshowed 31.8% lower value than the natural aggregate for crushing and 26.4% higher impact value. But abrasion was nearly equal for both cases. The mix design for concrete was made for M40 grade as per IS 10262– 2009. The water absorption of fly ash aggregate is 9 times higher than that of natural gravel. Two mixes were produced in which one was conventional concrete and the other was Flyash concrete in which the coarse aggregates are replaced by Flyash Aggregates. It was observed that the concrete with flyash aggregates offered better workability than conventional concrete. The density flyash based concrete was also found to be 15% lesser than conventional concrete

S.Azzaruddin, K.Tanuja, N.Vasu Deva Naidu (2016) – The materials used were OPC 53 cement, Class F Flyash, River Sand, Flyash Fine aggregate (FAFA), Hard Broken Granite Stone (HBGS) and Flyash Coarse Aggregate (FACA). Three mixes were obtained with 100% Hard Broken Granite Stone, HBGS replaced with 40% FACA and HBGS replaced with 50% FACA. Compression test, Split tensile strength and flexural strength were carried out on 7^{th} day, 14^{th} day and 28^{th} day of casting of concrete specimens. It was observed that the weight of fly ash Aggregate concrete was reduced by 27.5% than conventional concrete.

T. Saikishore Chandra and M.Srinivasula Reddy (Sep 2019) - The concrete mix design was obtained for M25, M35 and M45 grades using conventional aggregates and lightweight aggregates. Density, Compressive strength, Split tensile strength and water absorption were determined using specimens casted for each design mixes. The compressive strength of Mix design with SLWCs exhibit results on par with mix design with standard aggregates. The split tensile strength of SLWCs is less compared to standard aggregate concrete. However, split tensile strength of SLWCs is satisfying the requirements of structural applications according to ASTM C330.

Dr. M.VijayaSekhar Reddy, Dr. M.C. Nataraja, K.Sindhu, V.Harani and K.Madhuralalasa (2016) – The concrete grade opted for experimentation is M40 using conventional aggregates and flyash aggregates. Slump test was carried out and it was observed that flyash aggregate concrete gave better workability. The compressive strength of normal concrete was 48% greater than the fly ash pellet concrete in the first day, which was reduced to 12% in 28 days.

C.Venkata Siva Rama Prasad (Mar 2017) – Two mixes corresponding to M20 grade concrete was obtained in which the Hard Broken Granite Stone aggregate is replaced by 40% and 50% Fly ash aggregates. Compression test, Split tensile strength and Flexural strength were carried out on 7^{th} day, 14^{th} day and 28^{th} day of curing. The strength of fly ash aggregate concrete was less than the strength of conventional concrete yet it can be used as structural concrete.

Faculty of Civil Engineering, Cracow University of Technology (2020)- this study present the problem of durability of structural lightweight Concrete made of a sintered fly ash aggregate. The issue of durability was researched for 12 concrete series in terms of their water absorption, water permeability, and freeze-thaw resistance. Additionally, the microstructure of several concretes was analyzed with a scanning electron microscope (SEM).In the durability research, the influences of the following parameters were taken into consideration: The initial moisture content of sintered fly ash (mc = 0, 17–18, and 24–25%); the aggregate grading (4/8and 6/12 mm); and the water-cement ratio (w/c = 0.55 and 0.37). As a result of various compositions, the concretes revealed di_erent properties. The density ranged from 1470 to 1920 kg/m3, and the corresponding strength ranged from 25.0 to 83.5 MPa. The durability research results of tested lightweight concretes showed that, despite considerably higher water absorption, a comparable water permeability and comparable or better freeze-thaw resistance in relation to normal-weight concrete may be present. Nevertheless, the fundamental requirement of lightweight concrete to achieve good durability requires the aggregate's initial moisture content to be limited and a suffciently tight cement matrix to be selected. The volume share of the cement matrix and aggregate, the cement content, and even the concrete strength are of secondary importance.

Karl-Christian Thienel , Timo Haller and Nancy Beuntner (2020)- This review starts with a retrospective that gives an idea of the wide range of applications covered by lightweight concrete during the last century. Although lightweight concrete is well known and has proven its technical potential in a wide range of applications over the past decades, there are still hesitations and uncertainties in practice. For that reason, lightweight aggregate properties and the various types of lightweight concrete are discussed in detail with a special focus on current standards. The review is based on a background of 25 years of practical and theoreticalexperience in this field. One of the main challenges in designing lightweight concrete is to adapt most of design, production and execution rules since they often deviate from normal weightconcrete. Therefore, aspects are highlighted that often are the cause of misunderstandings, such as nomenclature or the informational value of certain tests. Frequently occurring problems regarding the mix design and production of lightweight concrete are addressed and the unintended consequencesare described. A critical view is provided on some information given in existing European concrete standards regarding the mechanical properties of structural lightweight concrete. Finally, the latest stage of development of very light lightweight concretes is presented. Infra-lightweight concrete isintroduced as an innovative approach for further extending the range of applications of lightweight concrete by providing background knowledge and experiences from case records**.**

P C Chiadighikaobi (2019)- The percentages, lengths and diameters of chopped basalt fiber in concrete mixture have high influence on concrete strength. On the other hand, expanded clay contributes mostly in the weight reduction of the concrete hereby, giving what is called lightweight concrete. The collapse of concrete structures can be blamed to the effect of cracks that are born in the weak concrete structures. This paper shows how expanded clay with chopped basalt fiber of length 20mm, diameter 1.5μm affected the maximum load that the concrete samples bear and how the existence expanded clay and basalt fibers affect the concrete in terms of resistance to cracks seen through the bending (flexural) and strength on compressive of the concrete samples. The purpose of this research paper is to investigate the effect of chopped basalt fiber with expanded clay in strengthening the mechanical behaviour of concrete. Concrete specimens were mixed with chopped basalt fiber and casted, the strength checked on 7th, 14th and 28th day and evaluated based on flexural strength, compression strength. The addition of basalt fiber in the specimens showed significant effect where the compressive strength decreased while the flexural strength increased.

Table -1: Propertiesofflyashaggregates

S No	**Authors**	**Typeof aggregate**	**SpecificGravity**	**BulkDensity (kg/m^3)**	**Water absorption(%)**
1	A.Arokiaprakash,V. Thenarasan	CA	1.72	917	13
2	Priyadharshini.P,Mohan Ganesh.G,Santhi.AS	CA	2.12	1247	13.23
3	S.Viveka,R.Renuka	CA	1.727	924.8	11.84
		FA	1.74	1067	9.54
4	Kayali.O	CA	1.72	831 (dry)	8.5
		CA	1.69	848 (dry)	3.4

*CA–CoarseAggregate,FA–FineAggregate

III. CONCLUSIONS

Asaresultofreviewingtheliterature,followingobservationswere identified:

- Thedensityofflyashaggregateconcretewaslessertha nthedensity ofconventionalconcrete.
- Theworkabilityoftheconcretewasunaffectedwhenflyashcoarseaggregateswasused.
- Theuseofflyashaggregatesresultedinconsiderablelossofstrength ofconcrete.
- Theconcretemadeupofflyashaggregatespossessedlowermodulusofelasticitywhencompared withconventionalconcrete.
- The moisture content of fly ash aggregates affect thedurabilityoftheconcrete.Theconcretemadeup ofdry fly ash aggregate was more durable than theconcretemadeupofpresaturatedflyashaggregates.
- Theuseoffineaggregatesofflyashmustbeavoided as it increased the water penetration anddepth of carbonationinconcrete.
- The use of fly ash aggregate in concrete would be aneffectivewaytopreservenaturalresourcesthatarebeingused astheingredientsofconcrete.

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