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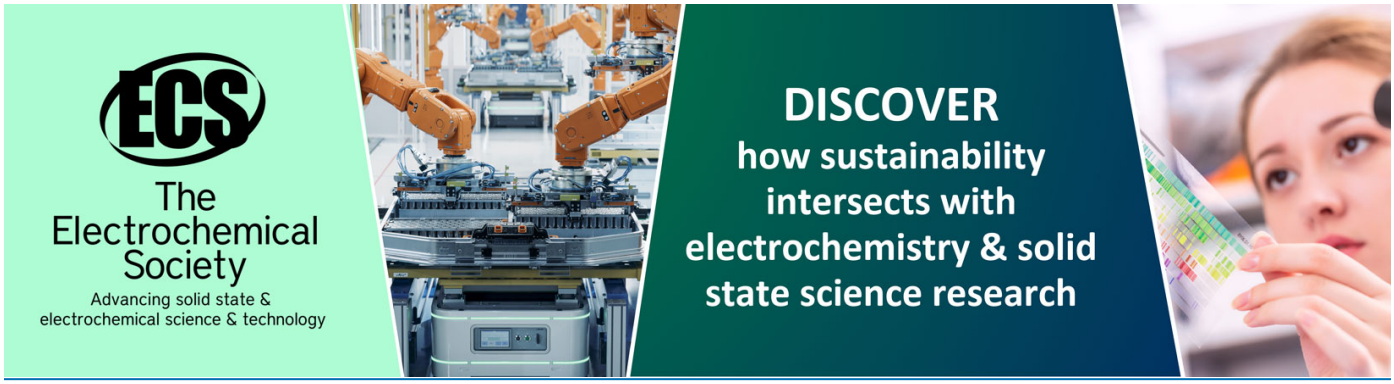

Natural aggregates used for Light weight concrete – A Review

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Abstract. Lightweight concrete is comparatively lower weight than conventional concrete which helps to reduce the dead load in structure and act as an insulation against sound and heat however the strength of lightweight concrete is low compared with normal concrete, but it will be highly used for such requirement where the concrete is not expected to bear more loads. This paper provides more information about natural aggregates used for lightweight concrete furthermore it gives an insight of aggregates such as vermiculite, rice husk, volcanic cinder, saw dust, scoria, pumice and diatomite. This article also gives some of the research ideas for future approach in this area.

Keywords: vermiculite, rice husk, volcanic cinder, saw dust, scoria, pumice, diatomite, lightweight concrete

1. Introduction

In the present scenario, the construction industry needs more advancement in materials to reduce self-weight as well as adequate performance, so lightweight concrete has been demonstrated and basic approach to developing lightweight concrete is inducing air in concrete hence, it could be achieved by replacing conventional aggregates by natural aggregates therefore in this article few natural aggregates such as vermiculite, rice husk, volcanic cinder, sawdust, scoria, pumice and diatomite have been discussed.

Adilson et al. (2014) discussed the differentiation between the thermal and mechanical composition and their properties of concrete aggregates, light in weight like EPS, and vermiculite through the air-entraining substance. So, as a result, come out like EPS, lightweight concrete is having higher thermal conductivity than vermiculite, and it has had more strength than vermiculite. Lightweight concrete too containing 55% content is more reliable than any other lightweight aggregate [1]. Blessen et al. (2018) concluded the utilization and advantages of the ash made of Rice husk as a concrete material which more sustainable and eco-friendly because Rice husk can be only made use of in this way as it is not that much useful in another usage like animal feeding, using as dispose of.If we set fire to it, the produced ash can be more hazardous for locality and environment. Besides, some RHA amounts in concrete may prevent erosion by chemical actions, porosity, chemical attacks, fracture development, and RHA having higher parameters in strength. Substantial to sulfate, chloride, and carbonation and lower in permeability and depreciation [2].

Celik et al. (2014) investigated an analysis of laboratory which presents about the improvement of workability strength and stability of self-compacting concrete by substitution of Portland cement instead of high volumetric natural volcanic pozzolan and limestone powder. Furthermore, the NP in the concrete examined with scanning electron microscopy & petrographic Tests [3]. Vinita et al. (2018) presented that to promote solid waste treatment to

cut down the disposal rate of waste material. Replacement of cement and aggregates with different disposal materials. To restrict co2 emission and environmental pollution, a green concrete mix is required by implementing nanotechnology greenhouse gases impacts can be resolved. People can produce revenues by trading disposal materials for building industries and can stop global warming [4]

Alexandre et al. (2017) this presentation designate about non-structural lightweight concrete (NSLWC) with scoria aggregates. NSWLC with scoria can show at least identical suppressible & expansible strength. It also had less compression, higher punching strength & better conduct at high temperatures. In whatever, if presented oversize solidity & narrowly higher thermal conductivity [5]. Kaizhi et al. (2019) presented autogenous compression & microstructure optimization for UHPC rooted in porous pumice is addressed perfect composition of pumice rooted UHPC system is produced. To describe the UHPC ITZ poly analytical techniques are used, poly assessment of pore structure for the growth of UHPC is finished. The inner remedy impression originates from pumice material is investigated [6].

Mustafa et al. (2020) examined a study about characters of CDP improved HSMS of mechanical and microstructural at extensive and rising temperatures. The supreme mechanical character at extensive and rising temperatures demonstrate the HSM improved with 15% CDP. The intensities of the XRD vertex of the Ca(OH)2 are the leanest hydration products of cement. The worth of Uw reduced with increasing the CDP contents applied in the HSMS no serious changes & cracks were executed in the cement matrix, and sand of HSMS by PLM check out [7].

2. Vermiculite

Okyoung et al. (2015) emphasized that the thermal composition can be changed or varied due to the vacuum impregnation process of based on n.octadecane composite phase change materials and according to the result of TCI n-octdecane based composites are preferable for thermal conductivity. Heat bearing capacity during the changes in temperature and their workability. In this study, some of the methods were used to found out the characteristics like TGA, DSC, SEM, and FT-IR analysis [8]. Alaa M.Rashad (2016) represented that how EV is generally used in a different way in civil engineering works as great constructional material, and the EV proved that it performs as a bound resistor and to improve the compressive strength, porosity, water absorption capacity, ASR mitigation of the construction. Due to the uses of this, it will decrease the mechanical strength of the structure, but it can be prevented by increasing additives in the EV properties [9].

Figure 1: Raw form of vermiculite materials [9]

K.Naveen Kumar et al. (2020) discussed regarding mechanical properties of vermiculite concrete blocks based on the classification according to their grades of concrete and laboratory tests using the trial mix ratio proportion of concrete (coarse cement aggregate: vermiculite). The lightweight concrete is most cost-effective and helpful to decreasing the self-weight of masonry work during the construction work, and it is more conservationist with nature [10].Figure 1 shows raw form of vermiculate materials before using for construction activities.

Fuat et al. (2020) examined the thermal and physic inherent characteristics of foam concrete during the high-temperature conditions, and these types of concrete carrying similar auspicious execution like vermiculite and can vary within the dry and fresh weights moreover. Silica fume satisfied the modifications caused by vermiculite of instinctive in a negative manner, and it has high compressive strength [11].

3. Rick husk

Anhad et al. (2017) pointed out that how the utilization of self-compacting concrete is mostly beneficial to achieve the toughness and microstructural agents during compression in a company with rice husk ash and metakaolin. The mixture of these two properties enhances the soundness composition and microstructure of self-compacting concrete. And also, the individual performances are helping to boost the compressive strength of the concrete [12]. Sung-Hoon et al. (2019) reported about the enforcement of concrete with no use of thermal treatment to enhance the mechanical component, which was based on Rice husk Ash responsive filler. The strength of the structure by substituting the amount of QP or SF along WRHA we are of ash sets a limit to decreasing the capillary pores. According to the consumption of the ash in the constructional field is eco-friendly it should be taken more concern regarding agricultural consumption and can be useful as a versatile material for the improvement work of the concrete [13].

Figure 2: Rice husk[13]

Shaswat Kumar et al. (2020) expressed this theory for future work regarding the application geo-polymer concrete. To note down the action of fly ash blast furnace slag based concrete same developed technologies were taken like FESEM, FTIR, PSA, XRD, & XRF for analysis of mechanical and chemical properties of the concrete and effect on the workability process. Additional, there is a great opportunity for Rice Husk Ash to be a greener concrete material along with geo polymerization procedure [14]. Figure depicts image of original rice husk

Anhad Singh Gill et al. (2018) conducted an experiment on the stability and microscopic components of self-compacting concrete, which is constructed with Rice Husk Ash and metakaolin. According to the light-weighted concrete material, the MK and RHA were used instead of cement in three distinct proportions of mix. Also, to confirm the performance of the SCC, the sample was tested like Rapid chloride permeability Test, hardness Test and also for the micro-structural properties XRD and SEM tests are managed for better result of toughness [15].

4. Volcanic cinders

Liguang et al. (2017) treated basalt fiber with silica powder and sodium silicate after manufacturing of heavy-handed and etching consideration along with sodium hydroxide and found with the trial and error consequence that the new light-weighted aggregate concrete based on basalt fiber volcanic slag exhibited the improved level of flexural strength, durability, and compressive strength when differentiating to non-fiber. Apart from these, the mechanical components of the plastic cracking properties also enhanced[16].

Marai M. et al. (2009), counting on the advantages of neural network procedure, found the compressive power of LWC (Light Weight Concrete) with the help of those statistical modules and similar for complex action. The compressive strength was tested in successive days with the help of two modules, namely BP (Back Propagation) and CC (Cascade Correlation). They were examined under light grounds and discovered the CC model to be more promising with quick learning and accuracy, hence proving neural network system effective non the less, cost-effective, and time-saving [17].

Figure 3: volcanic ashes [16]

Rafat Siddique (2012) discussed the composition of the concrete material of Volcanic Ash, which is created thought out the volcanic explosion and according to the standard specification, the VA is deliberated as Natural Pozzolan, and more reliable for cement concrete materials as well as the use of VA fulfills all the required mechanical & chemical properties of the concrete and can be substituted with concrete masonry units like pestle & mortar [18]. Figure 3 depicts volcanic ashes from volcanic eruption.

Rafat Siddique (2011) represented that the constructed volcanic ash in the meanwhile of volcanic detonation having adequately inflated in silica. So it can be usable with the preference of ASTM C618-93 for the standard specification of Portland cement concrete properties. Moreover, VA also used as the liquid in stone or brick binding work instead of mortar and cement and also improved the impact of thermal and chemical properties of the manufacturing of concrete [19].

5. Saw dust

Huiwen et al. (2018) discussed that Norel autoclaved aerated concrete (AAC) could be made by dealing with the stone-sawing mud. The stone-sawing mud is very supportive of creating C-S-H gel in the AAC. Stone sawing mud had good porosity and thermal conductivity characteristic with the help of AAC. It can reduce a lot of drying and grinding power expenditure. The formation of stone-sawing mud, principally quartz, contains little amount of sodium & potassium feldspar [20]. Siddique et al. (2020) examined that this trial exploitation of sawdust produced by the wood industry has been discovered. Various percentages of water & sodium silicate handled sawdust as a substitute for sand. In the manufacture of concrete, saw dust feasible component to be used—consolidation of silica fume as replacement of cement factor decrease in a slump of concrete inclusive sawdust. The summation of either water or sodium silicate handle sawdust enhancement of capillary water soaking & water ingress in concrete. Inclusion of silica fume in concrete inclusive water handled sawdust also factor of decrease chloride porous [21].

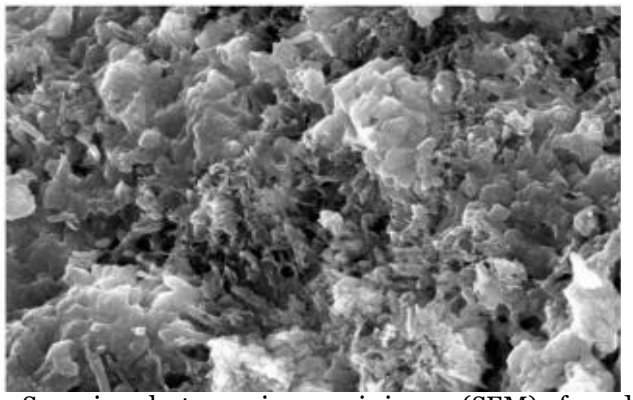

Figure 4: Scanning electron microscopic image (SEM) of sawdust [21]

Hanuseaca et al. (2020) studied the mechanical characteristics & environmental staging of floaty concrete made by replacement of sand in various percentages with chopped PET/wood disposal. Disposal could be used as a replacement for cement, and for collections, this research launches new types of building components that use recycled components, giving to the spherical economy. It is very advantageous to evaluate the eco-mechanical index for both mechanical and environmental staging of building components, essence, and framework [22]. Figure 4 shows SEM image of saw dust

Tausif et al. (2020) presented the research to estimate the conveniences of simple, achievable saw dust Ash along with cement for the manufacture of fair CSEBs with coarse-grained soil. Sawdust ash is conveniences for making power and lasting CSEBs. The quality optimal saw dust ash (SDA)content is established within 4-8% SDA relying on the cement content. The inclusion of optimal SDA with cement is dominant in the tenacious mix in repaired the shear experience. The expected tenability criteria of various codes and standards with cement indulge are associability of optimal SDA [23].

6. Scoria

Min-Gyu lee et al. (2018) reported that artificial zeolite was synthesized from scoria by using the hydrothermal method. The artificial zeolite crystals have a tine particle size of about 1.0 or less. When alkali content increased in size, the artificial zeolite tends to decrease in particle size. From original materials supplies an efficient application, the crystallinity of artificial zeolite commercially successively increases with the ratio of scoria [24]. Gunduz (2007) emphasized that by using 22 different mixture batches with CHLM blocks were cast into a mold Vibro compacting, de-moulded instantly & translocate to a storehouse for remedy up to 96 days in normal air condition. CHLM blocks presented by perlitic pumice, scoria, fly ash & cement could be practiced for hollow concrete blocks in the building industry. It is reviewed that CHLM blocks have sufficient strength & much convenient water soaking for their use in the regular building industry. The subsequence shows that the higher amount of fly ash in the mixture, the minor the arid density of CHLM blocks [25].

Figure 5: Scoria aggregate [5]

Mohseni et al. (2019) studied that lightweight structural concrete with concernment of indoor temperature was evolved. The coating system of TESA concrete diminished water soaking & dried shrinkage. The thermal durability & credibility of PCM were scrutinized by the TGA & DSC test. The macro-encapsulated technique was applied to incorporate the PCM into the LWA [26]. Mohseni et al. (2019) discussed that the physical & mechanical character of polypropylene fiber floaty geopolymer concretes are estimated. Geopolymer concretes synthesized using rice house ash & nano alumina. PP fibers developed the mechanical character considerably flexural strength for structural application floaty geopolymer concrete were appropriate [27].Figure 5 depicts scoria aggregates .

7. Pumice

Hatice (2018) discussed former concrete with acidic pumice aggregate was presented. It has published that the result of PCS incorporating pumice had superior water vulnerability & surface abrasion resistance with the change of cement dosage of two concrete zones were produced. The strength of concretes diminished by the substitution of crushed stone with acidic pumice. The water vulnerability increased the co-efficient of pc by accelerating [28]. Ozlem

(2016) studied that by dealing with coated aggregates, floaty concrete was produced. Pumice aggregates were coated with the help of cement & CL mixture. To interrupt concrete from power deficit should using of colemanite coated aggregates expands with the help of unit weight of concrete under rising temperature there is a chance of loss of concrete weight with coated aggregates [29].

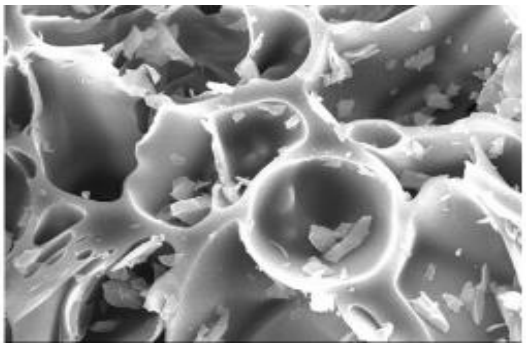

Figure 6: SEM images of pumice stone [6]

Chaabane et al. (2017) presented that with the help of dune sand, a floaty concrete can be manufactured. It also studies the character of lightweight of mechanical & thermal concrete, the function of thermal and concrete density changes by done sand with the replacement of alluvial sand. There raises a thought regarding its formation, as compared to ordinary concrete character done sand have poor significances of removal properties of concrete [30]. Armin et al. (2020) proposed a study to decrease city & industrial runoff pollution by the betterment of its ability and physical character of pc by the impact of zeolite & pumice us cementitious materials. It also decreases pollution parameters by dealing pumice enhances the filterability of idle water types; the physical character of porous concrete does not deteriorate using pumice material, and zeolite, the compressive power of GPC by pumice, had no minus impact [31].Figure 6 shows Scanning electron microscopic image (SEM) of pumice stone

8. Diatomite

Luan et al. (2019) discussed that Diatomite was included in the system to resolve the case of short reaction time and kinship between power and porosity. Diatomite/magnesium phosphate porous composite material (DM-MPPCM) was improved with Diatomite by pre-foaming mode. DM-MPPCM had an identical pore size dispensation of Diatomite as an extender power strapping setting time. DM-MPPCM exhibit with a compressive power of 1.104 MPa can be the porosity of 90.70% [32]. Patcharapol et al. (2013) studied that inclusive calcined diatomite aggregate the characteristic oblate lightweight concrete. AT 10000c contributed to the high power of coarse aggregate diatomite. For the production oblate lightweight concrete blocks, calcined diatomite is a preferable lightweight aggregate. Concretes with a unit weight of 1000-1200 kg/m3 were acquired. To get 28-day suppressible strengths of 7-12 MPa oblate lightweight concrete required the porosity and water soaking of concrete with different calcined temperatures were the same [33].

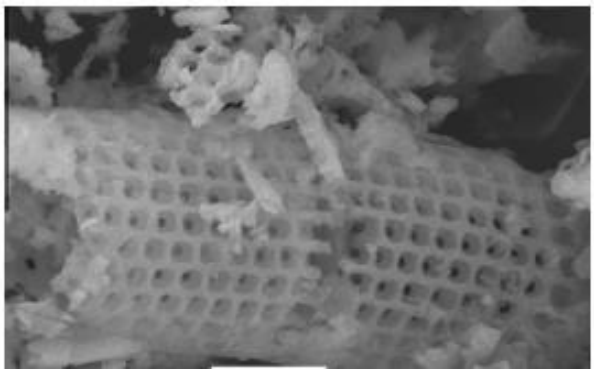

Figure 7: SEM image of diatomite [33]

Behnam et al. (2018) presented the ultimate principle in studying the size impact of fracture mechanics. This study uses various shapes and sizes of test specimens. It estimated the experimental values of compressive and splitting tensile power. The impact of shape and size of test specimens on EPS-LWC characteristic are modeled. In compressive & splitting, the tensile power of EPC-LWC is introduced to age reason. Current models of size impact of LWC traditional concrete are investigated [34]. Figure 6 shows Scanning electron microscopic image (SEM) of diatomite.

Miliozzi et al. (2019) founded that this work connected to the evolution of innovative cement mortars acquired by mixing a base mortar with various types of materials. The practical investigation of rising temperature thermal deposit concrete materials to concrete to rise strength density no phase variation material rises with thermal & mechanical properties. The acquired results show that the inclusion of the little amount of phase variation material in a cement mortar can guide to a positive impact on thermal and mechanical properties[35].

9. Future studies and recommendations

Lightweight concrete is one of the advanced and trending research areas in civil engineering which is expected to create more impact in future hence some of the future areas to be improved are given below [22][24]

- In general, Lightweight concrete is low in self-weight so that it can be used as a partition wall in high rise buildings
- Advanced methodology and research are necessary to make lightweight concrete as better heat insulation
- Lightweight concrete is can also use for load-bearing structure since self-weight is low
- Advanced equipment is necessary for mixing of lightweight concrete since it is taking more time

10. Conclusion

The paper presents a detailed review of lightweight concrete using natural aggregate, and the future recommendation has been discussed. In this approach, few natural aggregates have been taken in to account such as vermiculite, rice husk, volcanic cinder, sawdust, scoria, pumice and diatomite have been discussed and related to discuss few points have been highlighted below

- This article provides more information about lightweight concrete and its improvement in construction industry
- Discussion includes both advantages and disadvantage of the lightweight concrete for all the building structural elements.
- This paper also discussed practical application of lightweight concrete in construction industry
- Reliability and safety of using lightweight concrete have been discussed

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