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An Experimental Investigation of Lightweight Self Compacting Concrete with Replacement of Coarse Aggregate as Pumice Stone- A Review

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Abstract. Due to its unique properties as compared to ordinary concrete, lightweight concrete play a major role in construction sector. Here, this research explain the development of lightweight self-compact concrete by replacing the coarse aggregate together the pumice stone, which is used as a lightweight material in various proportions. An investigation on the effect of coarse aggregate on the partially replaced with pumice stone in lightweight self-compact concrete is carried out. The fresh and hard property of this lightweight self-compacting concrete have been studied and compared with the results of normal concrete. Pumice stone is used due to its special property such as unit weight, heat insulation property, resistance against fire when we combined with the coating substance the properties of this concrete has been improved. Several properties of lightweight self-compacting concretes such as unit weight, flow diameter, flow diameter after an hour, V-funnel and L-box tests, 28 days split- tensile strength, dry unit test, water absorption 7- and 28-day compressive strength, and ultrasonic pulse velocity test was investigated. According to the study, lightweight self-compacting concrete properties include flow strength, segregation resistance, and filling capability of fresh concrete. Pumice stone is used by replacing with natural coarse aggregate, at the levels of 20%, 40%, 60%, 80% by volume with fly ash and blast furnace slag minerals at the constant rate of 40%. 28 days compressive strength, dry unit weights, thermal conductivity in addition to ultra-sonic velocity of self-compacting concrete were obtained. The compression, flexural, and split tensile strengths of cubes, cylinders, along with prisms are tested for 7, 14, and 28 days. Results shows that pumice stone met the requirements for structural applications.

Introduction

General

Concrete is a heterogeneous substance that is made by mixing cement, sand and aggregate with water. In most cases, cement is used as a binder and sand is used to fill the gaps between the aggregates. Aggregate is the most common material in concrete, accounting for more than 70% to 80% of the total volume and providing the concrete with strength. The high demand for concrete in construction is raised due to population growth, resulting in increased demand for different construction materials. So, it is essential to develop or materials that can be used substitute for sand and aggregate in concrete. As aggregate is the most common material in concrete, it is obtained by grinding stones in stone quarries, which requires a large amount of manpower and mechanical equipment. When stones are crushed, very small dust particles with low density are

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produced, which easily mix with air and have a negative impact on the environment as well as the workers' health. In order to overcome this issue, various lightweight aggregates are used. Pumice stone is one of the many lightweight aggregates used in concrete to minimise self-weight and dead load, as well as to develop the mechanical and durability property of concrete, resulting in environmental and economic benefits.

Properties of concrete

Concrete has three main characteristics. They are workability, strength, and durability. Hardened concrete is supposed to have higher strength and durability, whereas fresh concrete is thought to have higher workability. Mix design and fresh properties can both be attributed to hardened properties. [3]. It is critical to evaluate the characteristics of hardened concrete at earlier. The issue is due to consistency and mechanical property does not improve after the hardening process. Concrete's structural behaviour is determined by the mixed proportions and material properties of composite system, which does not alter after the process of hardening. Workability, and fundamental rheological properties, reversible and non-reversible evolution, thixotropy, slump loss, setting time, bleeding, segregation and practical issues related to formwork filling is the fresh properties [4]. Compressive strength, tensile strength, elastic properties, shrinkage, cracking resistance, electrical, thermal, creep, transport and few properties comes under the properties of hard concrete [4].

Properties of pumice

Pumice has numerous potential features for lightweight aggregate, including limited density, strong thermal insulation, excellent resistance of fire and non-combustibility, adequate compressive strength, appropriate elasticity, a structure has pores with low permeability. Pumice stone as coarse aggregate has a specific gravity of 0.82. Pumice exists in a range of colours, ranging from brown to black and white to gold. This is largely determined by the pumice's chemical composition. Pumice ore primarily contains low amounts of $TiO2$ and $SO3$, as well as CaO (1–2%), $Fe2O3$ (1–3%), $Na2O$-$K2O$ (7–8%), $Al2O3$ (13–17%), and $SiO2$ (60–75%). Heat insulation, reduced alkali-silica reaction (ASR) expansion, heat resistance, freeze/thaw resistance, chemical resistance, and lightweight matrix are all benefits of pumice in concrete and mortar. The addition of pumice stone to the matrix, on other hand, decreased the mechanical strength, drying shrinkage, water absorption and workability.

Self Compacting Concrete (SCC)

Self-compacting concrete (SCC) is a distinctive category of concrete, which is also called self-consolidating concrete that could be placed and compacted without the need of vibrations. Due to their excellent deformability and cohesiveness which allowed it to be treated without segregation or bleeding [1]. The properties of Self-compacting concrete are used to fill in the gaps, passing ability and immune to separate [1]. For the last few years, usage in concrete that compacts itself has increased. When processing SCC, the use of chemical admixtures is often needed to improve workability and minimise segregation [9]. Two types of admixtures are used. They are mineral and chemical admixture. water-reducing chemical admixture such as superplasticizer, used in SCC [3].

Lightweight concrete (LWC)

Lightweight concrete which utilizes the lightweight aggregates that can help to reduce the density of concrete and to reduce dead load acting over the structure [3]. The significant issue is concrete's density when controlling the dead load of concrete structure, in reality it's troublesome throughout the construction of tall structures [2]. Consequently, lightweight concrete have replaced the standard concrete in several contemporary buildings. Generally, a concrete is often regarded to as lightweight if the density in range of 1440–1840 kg/m3 [2]. In the preparation of lightweight concrete, lightweight aggregates for instance enlarged clay shale, paper waste, vermiculite, rice husk, perlite, pumice stone, stuff, scoria, and cinders were utilised [2]. Lightweight aggregate concrete with outstanding durability with superior advantages such as the use of natural materials, lightness, and ease of workability [11].

Lightweight Self Compacting Concrete (LWSCC)

Several investigations in development of Lightweight self-compacting concrete, LWSCC have been conducted in recent decades with the aim of combining the advantages of both self-compacting concrete (SCC) and Lightweight concrete (LWC) [3]. Lightweight self-compacting concrete (LWSCC), a type of high-performance concrete which get established through self-compacting concrete (SCC) [3]. According to studies, usage of various mineral admixtures enhances the concretes workability , which additionally enhances the qualities of fresh and hardened concrete [4]. Also, it gives better mechanical efficiency and advantage such as thermal properties, economic viability is also improved. Another benefit is that LWSCC effectively decreases the structures self-weight and acoustic rate also its possible to use it for repairs and upkeep [1]. According to research, the compressive strength of Lightweight Self Compacting Concrete is affected because of aggregate type, w/b ratio proportion. Packing density theory which is a concrete mixture design method which has been utilised victoriously in lightweight self compacting concrete to assess ideal mortar to aggregates packing voids ratio [3]. Key procedures in this process for achieving the LWSCC mix design are: (1) reducing void volumes associated with coarse aggregate, (2) lowering the water/cement ratio, (3) increasing the density of cementitious materials, (4) improving the discharge ability and necessities of fresh concrete [3]. Self-compacting lightweight concrete research and assessment processes are familiar to which used by SCC. Extensive research on the practicability of SCC has been conducted in North America and Europe. The L-box, U-box, and J-ring tests have been stated to be useful in evaluating SCC passing capacity and, to a lesser extent, deformability and resistance to segregation [1]. The L-box test is ideal for on-site SCC quality control when compared with slump flow test. For estimating resistance of SCC to segregation, the visual stability index, wet sieve segregation test, and penetration test are commonly used [1]. Parhizkar et al. (2011) made research regarding few characteristics of pumice as lightweight aggregates in concretes and concluded that Pumice in lightweight concrete meets the requirements structural lightweight concrete specifications [5]. On the basis of the above-mentioned information, an analysis was studied and reported.

Literature Assessment

This literature study reveals that pumice stone is replaced with natural coarse aggregate. It is a new style of concrete which have the advantages of both lightweight and self-compacting concrete. The lightweight concrete is to decrease the dead load acting over the structure and also to remove the construction issues. If a concrete density is lies between 1440 and 1840 kg/m^3 then it is considered as a lightweight aggregate [2]. The main aim is to arrive mix design to test the workability of the concrete. Shear flow velocity increases as the binder content increases [1]. While

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adding different mineral admixtures to the concrete it increases the workability and also improving its properties [3]. When we replaced as coarse aggregate it does not affect the properties of concrete and thereby it increases the mechanical properties. From this study, lightweight and mineral aggregate cause a reduction in 14% of the concrete specific weight. While replacing 30 to 40% of the coarse aggregate with pumice, it increases its density, compressive strength, split tensile strength and also flexural strength in LWSCC that is lightweight self-compacting concrete [6]. It is studied that pumice stone absorbs more water than the natural course aggregate, in order to solve this issue various superplasticizers or coating materials or polymers are used. When we replace normal aggregate completely the compressive strength of the concrete is reduced. So, we can replace the pumice stone with the percentage of 50 to gain the compressive strength [9]. Usually, 60 to 100% replacement of the pumice stone can be done only for the -structural purposes. Pumice Stone in concrete mix, the workability of the self-compacting concrete is get improved slightly. Polycarboxylic ether-based superplasticizer used in this study [9]. Lightweight self-compacting concrete containing pumice stone had shown the better flow property [9]. Lightweight aggregate has promising future in self-compacting concrete is observed from the study because they have good passing ability, segregation, compressive strength and filling capacity [9]. Fly ash is a complementary material used in this concrete to increase the compressive strength. LWSCC, lightweight self-compacting concrete is less labour-intensive solution that can be implemented quickly. When Mixture containing 30% pumice stone has the high compressive strength is also assessed during the study. When determining the effectiveness of internal curing the volume of water observed by pumice is an important factor to consider. When the mix containing pumice shows specific increasing in durability of the concrete after 90 days. Usage of pumice indicates that decrease in global warming potential and it seems to be an environmentally sustainable concrete. So, it is aimed to replace the pumice as partial replacement with coarse aggregate with coating of cement paste in that aggregate to reduce water absorption into SCC, to enhance the fresh and hard property of SCC using lightweight aggregate.

Materials

In this study, Portland pozzolana cement (PPC) is used. M-Sand is used as fine aggregate. It has to pass through sieve of size 4.75 millimetre and has a specific gravity of 2.6. The modulus of fineness is 2.94 [9]. The coarse aggregate with size of maximum 12.5 mm is preferred also it is replaced by pumice stone with varying percentages. It has the specific gravity range of 0.69-1.89 [11]. Pumice is a volcanic rock, is widely used to make lightweight concrete and insulate low-density cinder blocks. The usage of pumice stone in lightweight self-compacting concrete are reducing. The major reason for this its increasing water absorption rate. So, we came up with the idea of coating the pumice stone with any one of the polymers or cement paste in order to decrease the rate. The coarse aggregate's modulus of elasticity is one of its properties. A concrete with a higher aggregate modulus would have a higher modulus. Fly ash has a specific gravity of 2.20. Particles vary in size from 10 to 100 microns. It is a thin grey powder with spherical glassy fragments that float in the flue gases. When water and cement are mixed, a paste is formed that binds the concrete together. It causes concrete to harden and this mechanism is called as hydration. As a result, provide workability during mixing and placing. It is often assumed that water suitable for drinking is often necessary for the development of concrete. PCE (polycarboxylate super plasticizer), also known as polycarboxylate ether super plasticizer, is a new type of advanced world-level environment friendly concrete admixture. PCE water reducer is a liquid super plasticizer that is ready to use. It is light yellow colour in appearance. It may even be fully submerged in water. PCE concrete admixture has a water removal potential of up to 25%.

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Mix Proportion of LWSCC

The LWSCC mix proportion is critical in the application since they may affect the necessary characteristics in fresh and hard states. ,Hence for satisfying the self-compacting requirement, LWSCC, as SCC, must achieve the necessary new characteristics such as filling ability, passing ability, and segregation resistance. [11]. The proportion mix were obtained using the EFNARC (European Federation of National Associations Representing Concrete) guidelines [9]. Thus the consistency was perhaps critical aspect in ensuring the created mixtures easy handling for practical deployment. The goal is to attain superior workability which would result in self-flowing concrete that did not require compaction. Another crucial component was to keep the mixture simple by employing only a few common materials and ordinary equipment [28].

Behnam Vakhshouri et al. Method

When it comes to the mechanical properties of hard concrete, mixed design and new concrete characteristics are the very important factors for consideration. Because LWSCC is extremely affective to change the mix component characteristics and proportions, it demands more quality control. The optimum mortar to aggregates packing voids ratio was determined using packing density theory, a technique of concrete mix design which have been victoriously used in LWSCC. In this approach, the key phases to achieve the LWSCC mix design are: (a) limiting void volumes linked to coarse aggregate (b) minimising water to cement ratio, (c) maximising the density of cementitious materials, and (d) optimising the discharge ability and necessities of fresh concrete. Limit the fine aggregate content and water to powder ratio, as well as using super plasticizer, viscosity modifying, and air entraining agents in the mix design, prepares the required fluidity and viscosity of mortar in LWSCC, similar to mix design of SCC [3].

T.Z.H. Ting et al. Method

When creating LWSCC mix design, there are a few common challenges to consider. Furthermore, no set of guidelines or guideline for developing LWSCC mix design has been provided. As a result, identifying the appropriate aggregate size distribution is crucial for designing a LWSCC mix. The physical characteristics of the LWA included have a huge effect on mix proportions of LWSCC and also with the performance in both fresh and hard states. Specific gravity, size gradation, form, texture, and water absorbing ability are all properties of LWA that can dramatically affect the quantity of material needed in mix design. The most of the existing LWSCC mix design approaches in the literature is based on close aggregate packing. Number of researcher utilise the trial-and-error technique to build the LWSCC mix design because most of the suggested methods aren't suitable for usage after the application's demands change. The mix is suited for areas that require a great deal of early strength [11].

S.P. Sangeetha et al. Method

M30 concrete was employed, with a nominal mix according to IS 456-2000 and IS 10262:2009. The specimens are casted by replacing coarse aggregates with pumice aggregates in various percentages, such as 0%, 10%, 20%, 30%, 40%, 50%, 60%, 80%, and 100%, respectively. The higher the replacement of pumice stone, the lighter the mix and the greater the water absorption [5].

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Remarks

To minimise segregation and retain strength, Mazaheripour et al. proposed using a high-performing concrete mix design technique for LWSCC. However, the method cannot generate the optimal LWSCC mixture portion in the views of new and hard characteristics. The majority of proposed methods for portioning LWSCC mix design is dependent on the close aggregate packing principle, as shown by the studies discussed above. The aggregate packing concept is used to select the aggregates with the least void to reduce the void created by LWA and to decide the right coarse to fine aggregates ratio for making the lowest density LWSCC. For simplifying and developing performance based LWSCC mix design technique, further statistical data analysis is required. The coarse to fine aggregate ratio employed is normally in the range of 0.5 to 0.6, and most researchers recommend the ratio of 0.6 because it is majorly cost effective. [11]. LWA is commonly found in an angular and flaky form, most studies have set the maximum coarse aggregate size at 12.5 or 16 mm [6].

Fresh Properties of LWSCC

Fresh concrete is a form of concrete that may be moulded and is still in a plastic state.

Workability criteria

This chapter discusses the fresh concrete test. In a fresh concrete test, the workability is a crucial consideration.For better evaluation the work ability of SCLC, the two dynamic and static stability tests were used.Static stability is concerned with characteristics of SCLC throughout time from casting to initial set, whereas dynamic stability is very much related to the characteristics of SCLC on the occasion of the activity of mixing, transportation, and casting [1]. LWSCC should be examined on filling capacity, passing capacity, and segregation resistance. These factors are utilised for determining practicability of LWSCC [11]. The main property of fresh concrete are consistency, workability, settlement and bleeding, plastic shrinkage and loss of consistency. Slump flow, V-funnel test are the methods used for determining filling ability [10]. It is the most standard test for SCC to determine its consistency. The capacity of SCC to pass through boundaries and into narrow places is also shown by its passing ability. Its stability against segregation allows concrete to retain the consistency of aggregates and mortar [10]. L- box, U-box and J-ring testsare made for evaluating the passing capacity. These tests also called as dynamic stability tests. Segregation resistance is also assessed through various tests.

Review of dynamic tests

LWSCC characteristics such as both fresh and hardened properties were studied in both review and research papers and listed below.

Slump flow test-Zhimin Wu et al. [1] studied that the slump test is unsuitable for determining the fluidity of SCLC, the slump flow test is used instead. Flowability or deformability of concrete mix was tested using a slump flow test. A normal slump cone and a steel plate with dimensions of 900 mm x 900 mm composes the testing apparatus. The mean of greatest diameter (D1) of spread concrete and the diameter (D2) of spread concrete at a right angle to the largest diameter were used to calculate the slump flow. During slump flow test, the segregation and bleeding of SCLC mixtures were visually examined. SCLC blends with slump flows in the range of 550–850 mm was found to be adequate. T.Z.H. Ting et al. [11] studied the impact of steel fibres over the properties of LWSCC in both the fresh and hardened states. In their study, they used expanded clay as aggregates. The addition of steel fibres to LWSCC increased the slump flow spread slightly.

The viscosity of fresh concrete and the quantity of superplasticizer necessitated for producing appropriate slump flow are both enlarged by enhancing the replace level of additives from 10% to 15% [18].Fariborz Hedayatinia et al. [10] studied according to Eurocode, slump flow range is 650 to 800 mm, and the T_{50} cm range is 2–5 seconds. Fig.1 shows the slump flow tests,

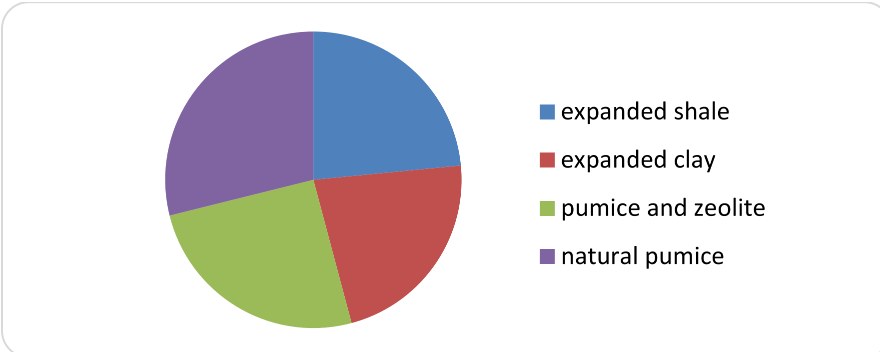

Figure.1. Slump flow tests

V-funnel test-Murat Kurt et al. [5] observed SCC has high passing ability, based on EFNARC, when the ratio of h2 to h1 is more than 0.8. it is used to assess the self-levelling and the capacity to pass the fresh SCLC. Zhimin Wu et al. [1] evaluated SCC T_V, in class 1 is less than 8 seconds, whereas SCC T_V in class 2 is 9–25 seconds. When polypropylene fibres are used, the V-funnel test time is increased [51]. In the control sample and the additives-containing specimens, the V-funnel flow times were 13 s and 8.8–12.8 s, respectively. The addition of pumice reduced the flow time, indicating increased workability [8]. Because of obstruction of steel fibres inside the V-funnel limited region, the V-funnel flow time reduced because of the increment in steel fibres [11]. Fig.2 shows the V-funnel tests,

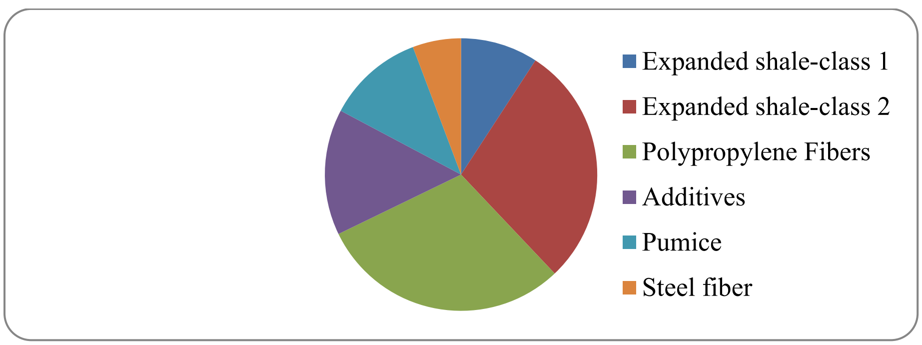

Figure.2. V-funnel tests

L-box test-L-box tests were carried out based on the EFNARC Committee's recommendations. Zhimin Wu et al. [1] studied the height of concrete in the chimney, h1, the height of concrete in the channel section, h2 and the time it takes for SCLC to reach 400 mm from three steel bars, T_{400}.For normal SCC, the L-box ratio is suggested within 0.7 - 0.9 [8].Obstructions are more significant in determining the L-box test. For the control mix and additive-containing specimens, the L-box (h2=h1) test ratios were 0.87 and 0.86–0.94, respectively [8]. L-box flow times improved more when Portland cement (PC) was replaced with fine aggregate (FA) than when ground granulated blast furnace slag(S) was used, which was better than binary FA + S [38].In an extremely fluid substance, the L-box (h2/h1) ratio equals 1. According to the EFNARC Committee report, if this ratio is less than 0.8, the aggregate may be blocked [6]. Fig.3 shows the L-box tests,

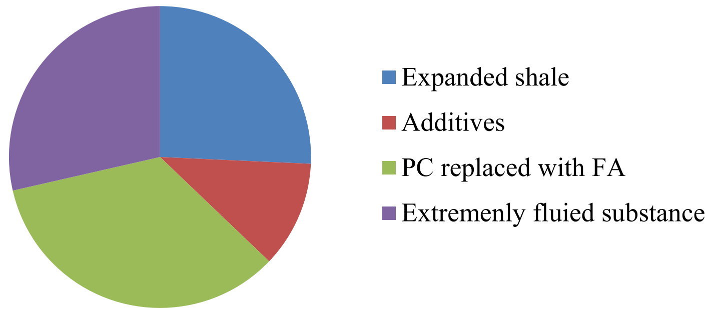

Figure.3. L-box tests

U-box test- Zhimin Wu et al. [1] observed the difference of height in concrete between the two boxes Δh, is the main parameter to be measured. In U-box test, increasing the volume % of polypropylene fibres in LWSCC decreases the filling height [51]. The H2-H1 value in the U box test must be less than 30 cm [13].

5.3 Remarks

The investigations described so far in this indicates the work ability of LWSCC is very much reliant on packing density, void volume of the aggregates. As SCC, the water - binder ratio, super plasticizer dose, and total binder content all of these has a significant impact on LWSCC workability in terms of filling capacity, passing capacity, and segregation resistance. Application of a thin cementations crust to pumice aggregates appears to improve pumice aggregate self-compacting concrete (PASCC) workability retention. Different types of additional resources are included, has a variety of effects on the LWSCC's workability Additionally, while including fibres such as steel and synthetic fibres might increase filling ability, it has a detrimental impact on passing ability. As the binder content increased, so did the necessity for super plasticizer in order to maintain the same filling ability. Incorporating fly ash in replace to binary or ternary blend can increase entire 3 new characteristics while it also lowers the quantity of SP necessitated. [11].

Hardened properties of LWSCC

Hardened concrete is a type of concrete that must be able to endure the structural and service loads that will be applied to it, as well as the environmental exposure for which it was intended.

Tests on hardened concrete

This chapter discusses the hardened concrete test which includes compressive strength test, flexural strength test, split tensile test and ultrasonic pulse velocity test. Generally the properties of hardened concrete are strength of concrete ,concrete creep, shrinkage, modulus of elasticity, water tightness, rate.

Tests criteria

Compressive strength test

The compressive strength of any fresh material is the most crucial component. Concrete's compressive strength has a significant impact on its structural performance [11]. Zhimin Wu et al. [1] used expanded shale as the replacement material and observed SCLC1 had a compressive strength of 42.6 MPa and a density of 1879 kg/m3 after 28 days, whereas SCLC2 had a compressive strength of 50.1 MPa and a density of 1920 kg/m3. Revathy.S [50] observed the 7-day and 28-day compressive strengths of concrete are seen to rise initially as the replacement percentage of pumice powder increases, reaching at around 15% and then decreasing. It is clear that after 15% replacement, there is a decrease in strength. As the amount of aluminium powder is increased, the compressive strength decreases [50]. Despite their high pozzolanicity, zeolite-containing SCCs have a poor compressive strength when compared to control SCCs. Pumice-containing mixes have a higher compressive strength than control mixtures. The compressive strength of concrete containing 10% metakaolin (MK) was higher than that of plain concrete [8].The process of inclusion of synthetic fibres in LWSCC with expanded clay as the aggregates and recycled concrete aggregate as the partial replacement enhances the strength by addition of silica fume [11]. Fig.4 shows the compressive strength tests,

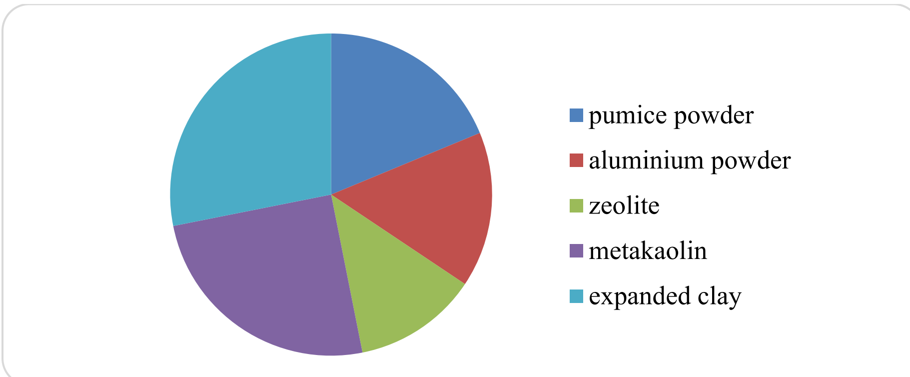

Figure.4. Compressive strength tests

Flexural strength test

An essential criteria for determining tensile strength of concrete is flexural strength [11]. With the inclusion of synthetic fibres, there was no substantial increase in the flexural strength of LWSCC [11]. For maximum volume percentage of the fibres, flexural strength is increased by 8.7% and 10.7%, respectively (0.3 %) [51]. When the volume percentage of polypropylene fibres in LWSCC is raised, flexural strength improves [51]. Among those 3 categories of aggregates, LWSCC along with furnace slag as aggregates had highest flexural strength, but LWSCC with enlarged clay as aggregates had low strength [11]. Fig.5 shows the flexural strength tests,

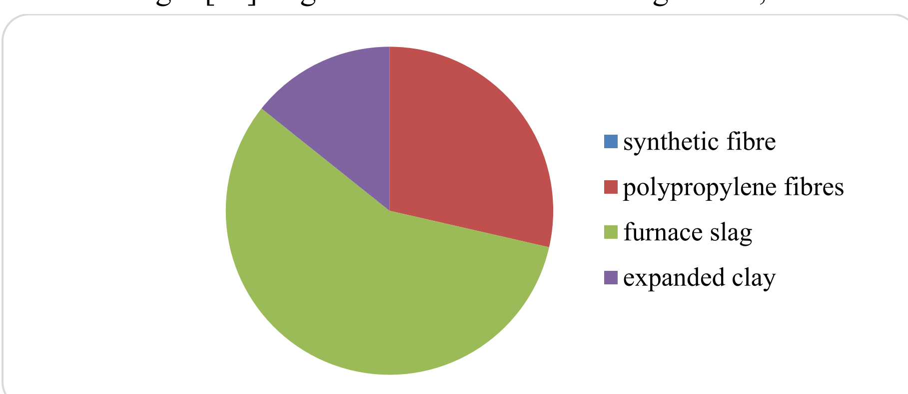

Figure.5. Flexural strength tests

Split tensile test

Concrete is usually weak under tensile action. Under flexural loading, the tensile strength of concrete is usually used for estimating the load which causes cracking in member [11]. As the proportion of polypropylene fibres in LWSCC increases, the splitting tensile strength increases [51].The inclusion of synthetic fibre did not improve the tensile strength of LWSCC.But, additional research into LWSCC's tensile strength is required before it can be used to completely replace conventional concrete in any structure. [11]. Fig.6 shows the split tensile tests,

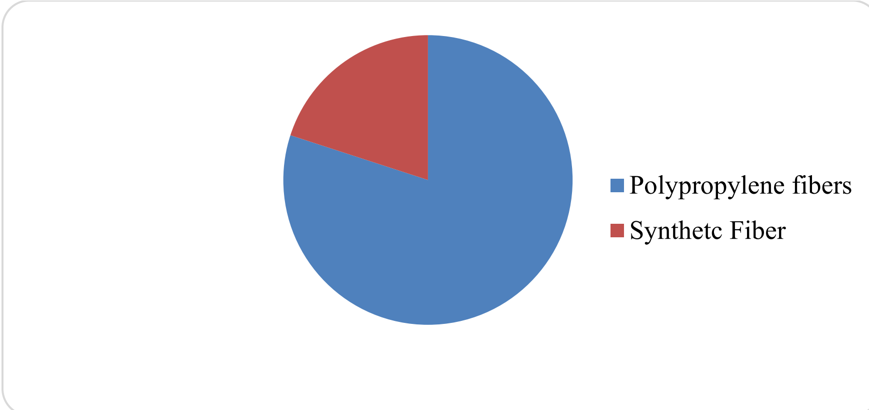

Figure.6. Split tensile tests

Ultrasonic pulse velocity test

Non-destructive concrete testing uses ultrasonic pulse velocity to assess the homogeneity, quality, void structure, damage mechanism, and compressive strength of concrete mixes [20]. Nominal frequency of the transducer pair was 54 kHz. Send a wave pulse into concrete then monitor time it takes for the pulse to propagate through the samples is how ultrasonic pulse velocities are measured. Murat Kurt et al. [6]**,** Pumice stone is used to assess the properties and evaluated that in the 1st and 2nd groups of tests, the ultrasonic pulse velocities of SCLC were determined to be between 2611 and 2884 m/s and 3022–4770 m/s, accordingly. Ultrasonic pulse velocity was affected by the variables that affected compressive strength. As a result, the ultrasonic pulse velocities increases linearly with compressive strength [6]. Fig.7 shows the ultrasonic pulse velocity tests,

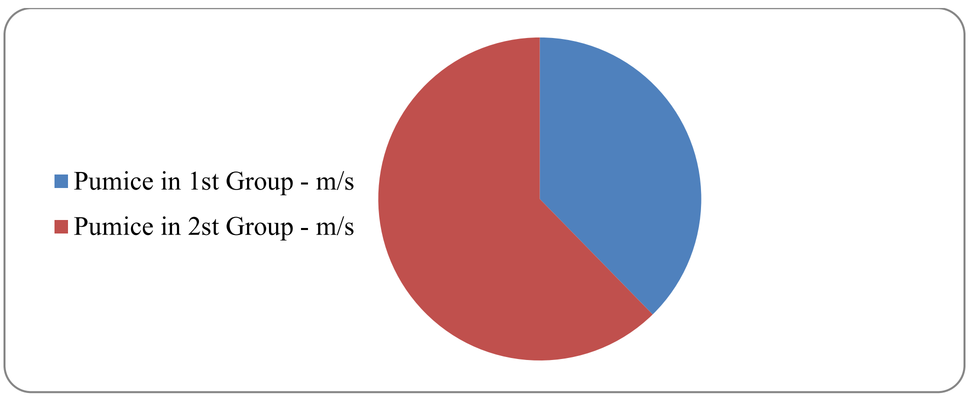

Figure.7. Ultrasonic pulse velocity tests

Remarks

The homogeneity of the batch concrete determines compressive strength of LWSCC. The mixing period, methodology determine the uniformity and homogeneity of LWSCC.The strength variability of LWSCC can be linked to the distribution of their aggregates, and it is a function of segregation resistance. Changes in mix component properties and proportions, such as water to binder ratio, binder content, and the incorporation to supplemental cementitious materials, affect the compressive strength of LWSCC. The strength of LWA have a significant effect on compressive strength of LWSCC. [11].The unit weight, thermal conductivity, and ultrasonic pulse velocity values of concrete samples reduced as a result of using pumice and natural aggregate combined in SCLC, but compressive strengths and water absorption ratios increases[6].

Advantages, Limitations and Applications of LWSCC

The benefits are decrease in structure's self-weight, lowering the dead weight of the parts and making building easier, thermal properties have been improved, fire resistance has been improved, on-site transportation and storage of precast units was reduced, formwork and propping are being reduced [52]. Also, reduction in dead load saves money on foundations and reinforcement. It also has high durability, cost effectiveness, and site productivity. Few applications are listed below. LWSCC are used to construct the high-rise structures, partition walls, Residential and non – residential buildings in seismic areas. As thermal insulation, cellular lightweight aggregate is used in the form of safety laws for non-loading flat roofs. For old sewage pipes, wells, unused cellars and basements, storage tanks, tunnels, and subways, bulk feeling is achieved by using very low strength material. Development of light-weight heat-insulating wall panels. Maintain concrete's acoustic balance. Produce light plates made of cement and plaster. Use in the bridge to prevent it from freezing. Lightweight concrete is used in the building of roof slabs and small houses with load bearing walls because of its low strength. It's also used in the design of staircases, windows, and garden walls. This is also used in the design of partition walls in large buildings. Inside the structure, these are formed into slabs and used as thermal insulators. Thus, LWSCC are employed in these areas [6]. In developing LWSCC mix design, there are numerous common problems [11]. Because of the porosity and angularity of the aggregate, it is more difficult to place and finish. The dry grains absorb water quickly and can disturbs the mixture's workability [11]. It also slows the drying time. The main disadvantage is water absorption. Flooring contractors would have to delay their work for a prolonged period of time. The mixing period is longer than conventional concrete to ensure optimal mixing. It shows that they are resistant to lightweight concrete or porous concrete.

Conclusion

The focus of the research is to evaluate fresh and hard characteristics of self-compacting concrete (SCC) made with pumice stone as a coarse aggregate replacement with cement paste coating. The following hypotheses can be taken from the study:

We can understand the characteristics of the LWSCC. And we know about the importance of fly ash and polycarboxylate ether-based super plasticisers added in the mix and also the coating of aggregate. The literature study provided experimental result in performance of pumice aggregate in SCC in the fresh and hardened properties. Pumice concrete has a lower thermal conductivity, which indicates it provides less heat. Pumice aggregate coating using a thin cementations crust (though difficult in practice) seems to add the workability retention of (LWSCC). Due of its low density and high porosity, adding pumice the parts of aggregate reduced workability, unit weight, and mechanical strength. Replacement of 30% pumice yields the best performance of hardened and fresh test results. The practicability of entire LWSCC mixes are studied and within the specified standard limits, indicating that the addition of mineral admixtures to the superplasticizer improves LWSCC workability. As a result, noise emissions from vibrators used for normal weight concrete compaction can be reduced by this concrete technology. It is clear that pumice stone, while being slightly weak in compression, can be used in combination with other pozzolanic materials such as GGBS and RHA for construction purposes. According to the results, when using GGBS, RHA, less than 30-40% substitution of coarse aggregate by pumice stone is preferred for better density and strength. To get the expected results of the desired flowability, fresh and hardened properties, various types and range of mineral and chemical ad-mixtures (super plasticizer, air entraining agent, and viscosity modifying agent) are applied in mix.

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