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Mechanical Properties of Self-Compacting Paste System Using Wood Saw Dust- an Eco-Friendly Application

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Abstract

An attempt is made in the field of high performance self-compacting cementitious system to have an eco-friendly construction material utilizing raw materials, in this case wood waste sawdust. Two different types of wood sawdust (SD) namely, kikar (Vachellia Nilotica) sawdust (KSD) and partal (Abies pindrow) sawdust (PSD) were used with neat Portland cement paste system in replacement mode. The replacement of SD was 3%, 5% and 7% in each case. results showed a consistency in the slight decrease of compressive strengths, the reduction in shrinkage with samples having sawdust (SD) were highly significant. the effect of water and air curing along with the water absorption capacity of sawdust in powder form and the comparison of water uptake of self-compacting paste samples with and without sawdust at different days during wet curing showed that sawdust has the potential to serve as an internal curing agent in self-compacting cementitious system.

Keywords: Self-compacting Paste System; Melflux; Kikar Sawdust; Partal Sawdust; Internal Curing Agent

Introduction

Self-consolidating concrete or sometimes called as self-compacting concrete (SCC) is a special type of concrete which can be placed and consolidated under its own weight without any vibration effort due to its brilliant deformability, and which at the same time is cohesive enough to be handled without segregation or bleeding. As per ACI committee 237R-07 [1] self-compacting concrete (SCC) is a highly flow able, non-segregating concrete that can spread into place, fill formwork, and encapsulate the reinforcement without any mechanical consolidation. Its inception roots back to 1980 were in Japan, Asia where thereafter in no time it quickly worked its attractiveness over the whole Europe and the research community all over the world was not able to resist exploring it more to its limits. A similar attempt is made here in this research. It has also been suggested as per European Guidelines that it has the same engineering behavior as that of conventional concrete which is externally vibrated uniformly and carefully. The significant controlling factor in the behavior of concrete and its characteristics goes to its comprising paste portion system [2]. Hence self-compacting paste systems serve as not only an important demonstrative but a major representative sample for the self-compacting mortar (SCM) and self-compacting concrete (SCC) systems having a vital effect on the properties of overall system. Addition of different admixtures, internal curing agents and SRM's to a paste system are some of the many techniques used to obtain a paste of required properties in a system.

State of the art

Sawdust is a by-product of the wood industry and is composed of small wood particles that are created during the process of sawing, milling, or sanding. There is a significant body of literature on the properties and applications of sawdust in various fields, including agriculture, construction, and energy production. Sawdust is a versatile material that has numerous potential applications and continues to be the subject of research and development in various fields. It is unsurprising that preventive measures to matters related to depletion of resource and global pollution are the key aspects if not the main objectives of most of the research works being carried out in any field [3]. Overall, sawdust is a versatile material with many potential uses, but its use must be carefully managed to ensure its safe and sustainable disposal and to minimize its environmental impact. As such, there continues to be ongoing research and development focused on finding new and innovative ways to utilize sawdust and to minimize its waste. The construction industry is no exclusion to that and has a direct significant impact on environment and its localities, the need of the hour is to go for an environment friendly material which utilizes easily available raw and waste materials to not only benefit the environment but also keeping the material quality and its standards intact [4]. In the same spirit, an attempt has been made in the field of self-compacting cementitious system using wood wastes. Wood is one of the vital construction and adaptable material, hence generation of continuous large quantities of wood waste in sawmills and farms is inevitable. Hence, wood waste particularly in the form of sawdust is accumulated all over the world and has severe environmental and health issues [5].

Table 1 shows the annual wood waste data in major regions around the world. The storage of sawdust in large piles and their consequent decomposition at rapid rate could also worsen the green-house effect [6]. Earlier wood sawdust being used in conventional concrete as lightweight aggregate and reduction in compressive strength was prominent [7]. Valeria [5] highlighted the fact of wood sawdust in mortar and suggested a better output of mortar with fine sawdust rather than using coarse size. Bouguerra et al. [8] used wood waste as light weight aggregate in cement clay mix and noted an increase in porosity along with reduction in water absorption of the system, revealed the effect that better thermal and insulation properties are achieved when wood waste used in cement and clay mix. Adebaku et al. [9] incorporated sawdust in hollow concrete sand blocks and proved that at 10% replacement sawdust with sand in mortar, the overall cost and weight can be reduced by 3% and 10% respectively. Bederina et al. [10-12] explained that by coating wood waste with cement paste before to its addition in the system improved the thermal conductivity and compressive strength of the system. Also, it was seen that densities got reduced when sawdust was used. Turgut et al. [13,14] executed experimental work and insisted the potential use of sawdust with limestone bricks to have lightweight and cost effective bricks.

Table 1: Wood waste data in some important regions.

Country/Region	Total Wood Waste (tones/year)	Non-Recycled Wood Waste (tones/year)
United States of America	64,047,240	25,764,050
United Kingdom	4,600,000	1,840,000
Germany	8,800,000	3,520,000
Australia	4,508,136	1,741,000
Pakistan	1,730,948	1,384,758

Rojas et al. [15] recommended that better acoustic and thermal characteristics were achieved with false ceiling plates when wood sawdust shaving were used in the mix as compared to conventional plaster mixes. Morales et al. [16] investigated the physical and mechanical behavior of wood-gypsum composites by using wood waste as an additive. It was noted that the addition of wood in the system lessened the hardness and thermal conductivity of the composites, whereas the compressive strengths were also decreased of the composites. Coatanlem et al. [17] used wood chippings in the concrete system and studied its durability, it was suggested that better results were achieved due to an improved bonding between chippings and cement paste when wood chippings were saturated with sodium silicate solution before its use.

Keeping in view the earlier work done on sawdust in cementitious system, there exists a gap as no comparison has been done between response of hard wood saw dust and soft wood saw dust and no one proposed about how to recover the reduced strength when saw dust is used in SCP. In this study emphasize was on the use wood sawdust in replacement mode in self-compacting cementitious system and comparison of two different types of sawdust response w.r.t control formulations. The soft wood saw dust chosen for study was partal and hard wood saw dust of kikar was used.

Research Significance

To reduce the burden on the environment, the usage of the wastes and reduction in depletion of natural resources are our top priorities. In the literature, little work is presented on the use of sawdust as a lightweight aggregate or thermal insulator in self-compacting paste systems. The previous works of authors could not consider the effect of different types of sawdust. The effect of hard and soft type of sawdust on the samples having different proportions of sawdust in the self-compacting paste system was also studied to check the change in mechanical properties.

Material Characterization & Experimental Methods

Cement

Ordinary Portland cement type 1 of grade 53 meeting the requirements/specifications of ASTM C150-07 [14] was used. It is manufactured by Best-way Industries Pakistan and is locally/easily available in Lahore, Pakistan. For chemical composition X-ray Fluorescence analysis was done and the results are shown in the Table 2.

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Table 2: Chemical analysis of cement.

Sample	LOI (%)	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)	MgO (%)	K_2O (%)	Na_2O (%)	SO_3 (%)	Cl (%)
OPC	-	19.76	4.65	3.38	62.79	2.31	0.65	0.25	2.72	0.005

Sawdust

The sawdust procured were ordered especially to be naturally produced during saw work and of the independent sources to avoid mixing/impurity issues in their consequent usage and comparison. The source trees were kikar and partal, two preferred woods by consumers for their furniture and wood construction due to their durability, availability, and smooth finishing qualities. Two different types of sawdust were utilized, as shown previously. Particle size analysis has been shown in Figure 1 & 2.

- Partal Sawdust (PSD), 0-400 microns
- Kikar Sawdust (KSD), 0-250 microns

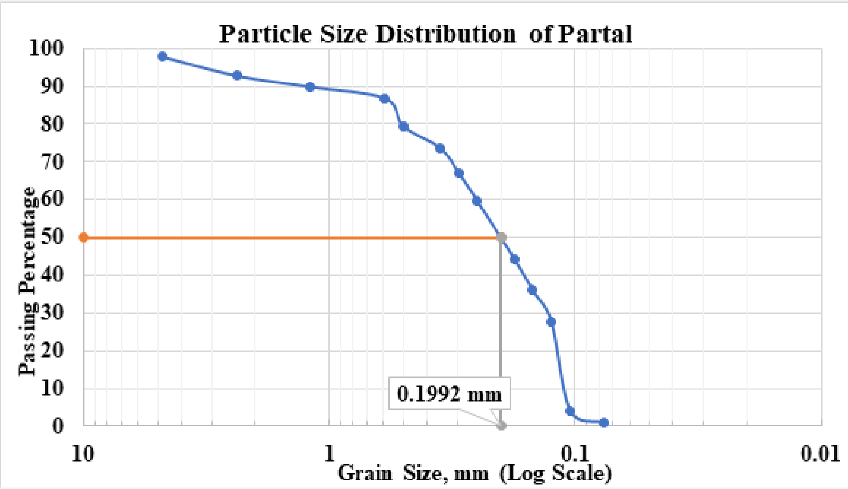

Figure 1: Particle size distribution of partal wood saw dust.

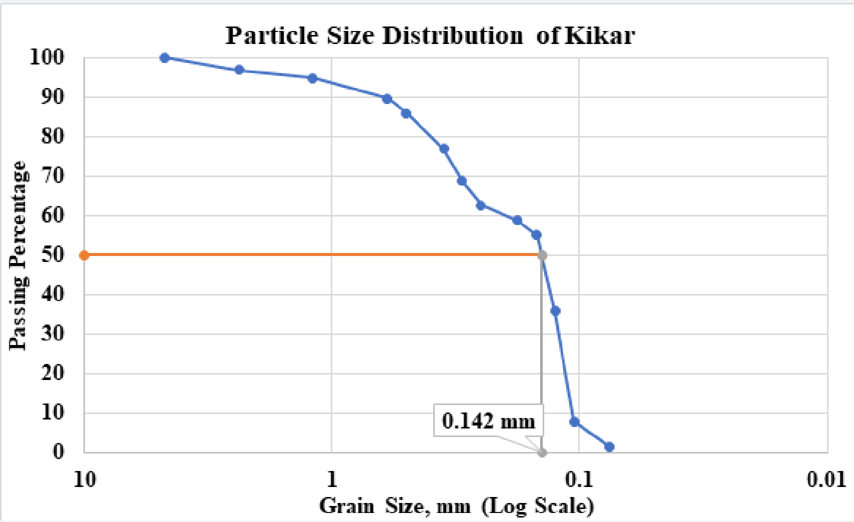

Figure 2: Particle size distribution of kikar wood saw dust.

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Superplasticizer

To create paste specimens, a highly effective water reducer called Melflux 2651F was used. This super-plasticizer belongs to the third generation of poly-carboxylate ether (PCE) and was imported from BASF industries in Germany. By being part of the PCE family, Melflux 2651F effectively reduces the amount of water needed and helps prevent segregation and bleeding. The manufacturer recommends a dosage of 0.05 to 1.00% for optimal results. The origin of third generation PCE Super plasticizers was from Japan and Germany in late seventies [18].

Formulations

The sawdust was used in cement replacement modes and the replacement levels were 3%, 5% and 7% of the total weight of cement used. Making a total of 7 formulations, 3 for PSD replacement, 3 for KSD replacement and one control formulation having no replacement at all as shown Table 3.

Table 3: List of formulations with partal and kikar sawdust.

Sr. No	Cement	PSD %	KSD %	SP Demand %	W/C %	Formulation ID
1	C1	0	0	0.19	27.0	S-0-0
2	C1	3	0	0.320	33.0	S-3-0
3	C1	5	0	0.655	34.5	S-5-0
4	C1	7	0	1.215	38.5	S-7-0
5	C1	0	3	0.315	31.0	S-0-3
6	C1	0	5	0.465	33.5	S-0-5
7	C1	0	7	1.02	37.5	S-0-7

Mixing Regime

The mixing regime followed was to add total mixing water in the system then slow (145 rpm) mixing of 30 seconds followed cleaning and then fast (285 rpm) mixing for about 2.5 minutes (150 seconds). So the total mixing time of 3 minutes (180 seconds). Flow Measurements for a target flow of 30±1cm, trials on SP content were made using Hagerman's mini cone apparatus with dimensions 10 x 7 x 6 cm^3.

Mechanical and Compressive strength

The strength tests for compression on 4x4x16cm^3 prisms were carried out. The tests were conducted at 1, 7 and 28 days for each formulation having three samples in flexure first. To obtain precise compressive strength average of 5 tests was considered for each formulation at 1, 7 and 28 days and average of 5 samples was taken for compressive strength.

Shrinkage Strains

Volume changes or shrinkage was determined using German Schwindrine apparatus as shown under having channel size of 4 x 6 x 25 cm^3. The early responses were recorded for the first 24 hours for each formulation. The relative humidity and temperature of the laboratory were 55% and 28°C respectively.

Thermal Conductivity

Thermal conductivity was performed in accordance with ASTM standard C518. Guarded hot plate apparatus (thermal conductive tester) was used for this which follows hot plate method.

Chemical Tests

Chemical tests were also conducted on the materials to perceive its chemical composition and elements/compounds involved. The tests which were performed are namely FTIR, XRD, TGA and SEM.

Water Absorption

The water absorption capacity of sawdust was calculated by two methods.

- The Sieve method
- The Teabag method

Sieve Method

In this method sawdust was poured in a beaker reasonably filled with water and left it submerged for 24 hours. After 24 hours, the sample was passed through a sieve No. 200 for water removal. The sawdust quantity was kept at room temperature for about 15 minutes so that the water which accumulated at the surface may evaporate to achieve SSD condition. By knowing the amount of saturated sawdust, the sample was placed in oven for 24 hours at 120 ºC. After 24 hours, oven dried condition is achieved. Weights were taken at every step and the results are listed below. This gave water absorption of saw dusts.

Tea Bag Method

Both empty and wet weights of a tea bag are noted before a known amount of fully dry weighted material was poured and the teabag was sealed. The sealed tea bag was then placed in a beaker

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of water for 24 hours so that the material may absorb the water to its capacity. The weight of the wet teabag is subtracted from the total weight of saturated sample in a teabag. The difference between the dry poured sample and fully saturated sample in the teabag after it was kept submerged in water for 24 hours, gives the idea about its absorption capacity. It was also noted that the absorption rate of sawdust (SD) is not immediate when it was added to water, it takes several hours for SD to absorb the water and reach its saturation capacity and settling down. The results are given below in Table 4.

Table 4: Water absorption capacity of PSD and KSD.

Sample	Methodology		Average Water Absorption Capacity (g/g)
	Teabag method (grams/gram)	Sieve method (grams/gram)	
Partal sawdust (PSD)	6.2	7.2	6.7
Kikar sawdust (KSD)	3.8	4.2	4.0s

Results, Discussions & Analysis

Physical Properties of Wood Saw Dust

Particle size distribution of both partal saw dust (PSD) and kikar saw dust (KSD) was conducted using sieve analysis. The graphs are shown in Figure 2 & 3. The Dv50 which is called the median particle size that was calculated for each wood sawdust and that is 192 and 142 Micron for PSD and KSD respectively. Which indicates that PSD is slightly coarser as compared to KSD.

Composition of Materials

The FTIR, XRD was done for sawdust to understand its chemical nature and XRF was performed for cement.

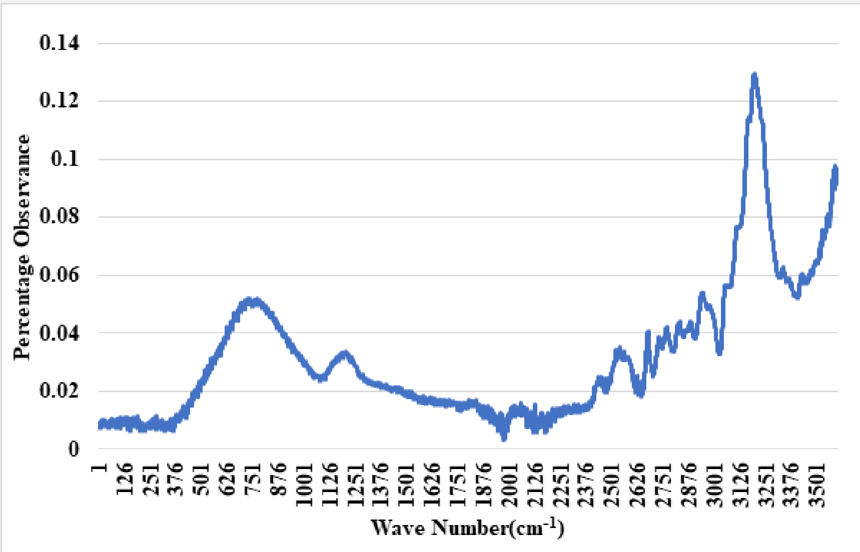

Figure 3: FTIR analysis of Partal saw dust.

FTIR of Sawdust

FTIR analysis is carried out to detect organic, polymeric, and inorganic materials in some cases. In this test infrared light beam is used to examine test samples and observe chemical properties. The FTIR of Sawdust test result had a scanning range of 500 - 4000cm^{-1}. The results are shown in Figure 3 & 4. From FTIR spectrograph, peak is obtained between the ranges of 3000-3400 which are then compared with FTIR spectroscopy ranges to analyze the functional group. The peaks were mostly from 3000 to 3400 range sparingly distributed. Pulses in FTIR graph were compared with FTIR chart, the result showed strength of Alkyl halide groups and cellulose. The analyses showed the high presence of Alkyl halide functional groups having strong bonds with carbon. Alkyl Halide general formula is RX where R is alkyl and X is halogen. RX is an electrophile that is why it makes strong bond with Carbon.

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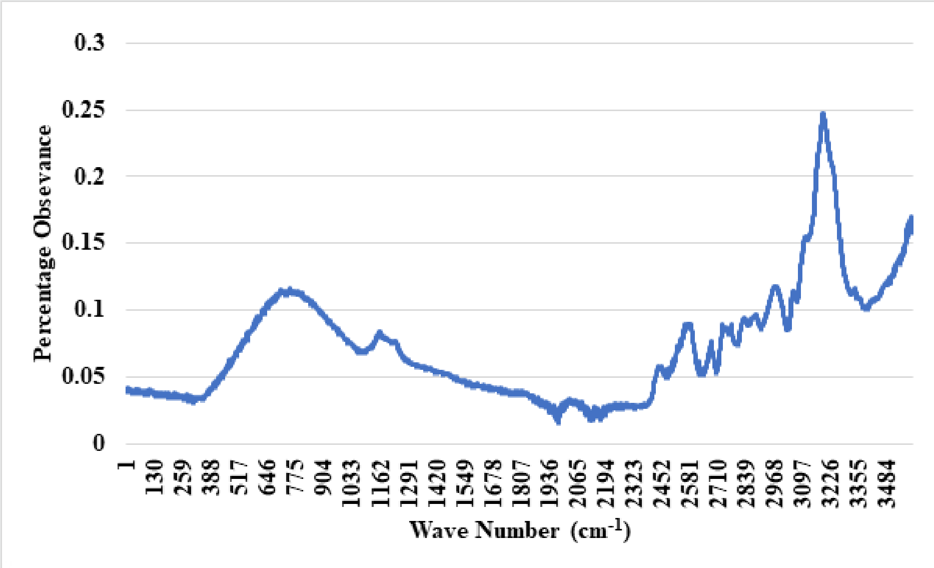

Figure 4: FTIR analysis of Kikar saw dust.

X-Ray Diffraction (XRD) of Sawdust

The XRD test of sawdust was performed as shown in Figure 5. Three major pulses were obtained and can be clearly seen in the Figure. The results were observed with respect to their quality using MATCH software and phases were checked globally with available data base to find out the pattern. The most suitable and required discovered compounds are shown in Table 5.

Table 5: Data from XRD analysis of powdered saw dust.

Sample	OCH3 %	Cellulose (C6H10O5) %
Wood sawdust	10.8	76.7

Thermal Conductivity Results

Thermal conductivity of SCP samples was decreased with respect to increase in percentage replacement of waste material as shown in Figure 6.

Thermal Gravimetric Analysis (TGA) of Sawdust

The thermal gravimetric analysis (TGA) was performed of the Diyar sawdust. Four major weight loss sequences were clearly visible with the details as shown in Figure 7. The first interval of Diyar Sawdust graph starting at 27ºC and ending at 215ºC. First interval is due to extraction of internal moisture and soaked in the water with a weight loss of 10.72%. Second and third interval starting and ending at 215ºC, 380ºC and 380ºC and 500ºC respectively. During these intervals the depolymerization of hemi-cellulose occurs and the total weight loss is 93.27%. The fourth interval starting at 500ºC and ending at 800ºC. At this interval the degradation of cellulose and lignin occurs with weight. Results show that by replacement of 3.0%, 5% & 7% of KSD thermal conductivity decreased as compared to control by 5.8%, 16.3%, 23.3% respectively, while PSD showed reduction as compared to control by 4.7%, 15%, 22% respectively. By comparing the results, kikar is more insulator than partal.

Thermal Gravimetric Analysis (TGA) of Kikar Sawdust

The thermal gravimetric analysis (TGA) was performed of the partal sawdust. Four primary weight loss intervals were prominent with the details as shown in Figure 8. The first interval starting at 27ºC and ending at 215ºC. First interval is due to extraction of internal moisture and adsorbed water with a weight loss of 10.47%. Second and third interval starting and ending at 215ºC, 370ºC and 370ºC and 500ºC respectively. During these intervals the depolymerization of hemi-cellulose and lignin occurs and the total weight loss is 87.56%. The fourth interval starting at 500ºC and ending at 800ºC. At this interval the degradation of cellulose and lignin occurs with weight.

Water Demand

The Vicat's water demand for each SCP formulation was separately calculated by making different trials. The water to cement ratio was kept the same at their respective water demands

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for each formulation. The results are shown in Figure 9. It was found that water demand of the system was proportional to the percent of cement replaced by saw dust (SD). That is because of the fact that the initially added water in sawdust was being absorbed during the mixing process which led to more demand of water. Also, as compared to KSD, PSD showed more requirement. This is because of its high absorption capacity and soft nature.

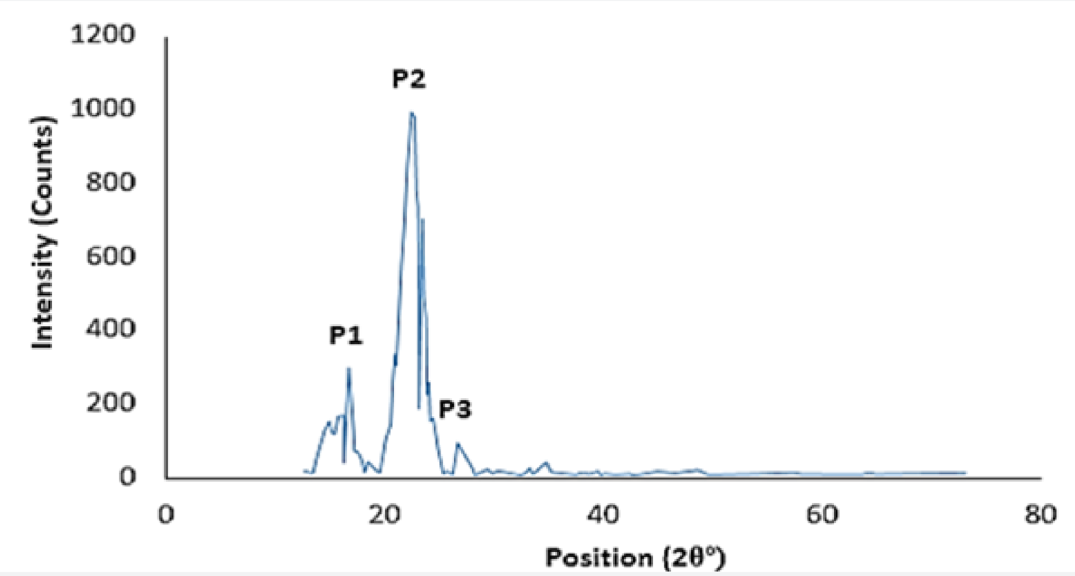

Figure 5: XRD analysis of powdered saw dust.

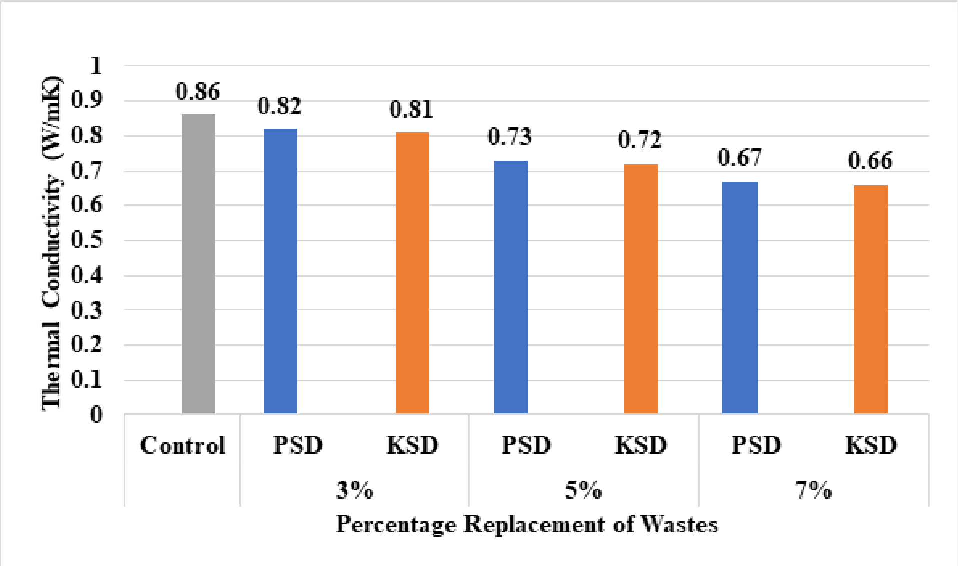

Figure 6: Thermal conductivity of thermally SCP.

Super Plasticizer (SP) Demand

The SP Demand for all the formulations was carried out by making trials for each formulation using the Hagerman's mini cone apparatus with cone dimensions 10 x 7 x 6 cm^3 for the targeted flow of 30±1 cm. It is vital to observe here that the water to cement ratio was kept the same as their respective water demands previously calculated. The results are shown below in Figure 10. It is clear that if SD content is increased, the SP demand also increases with the same effect.

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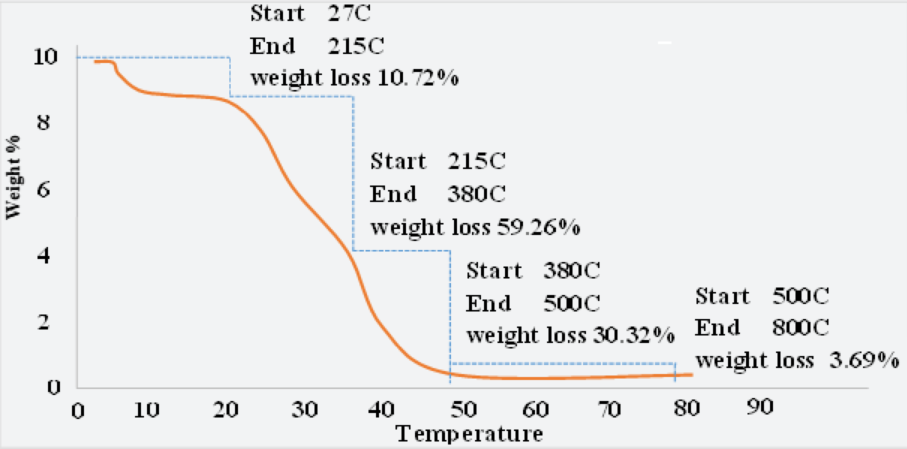

Figure 7: TGA curve for Partal saw dust with intervals.

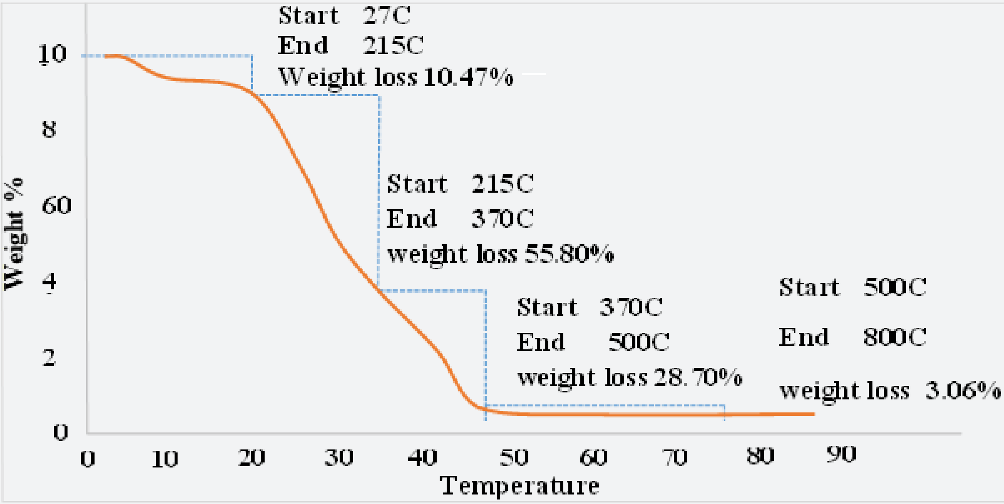

Figure 8: TGA curve for Kikar saw dust with intervals.

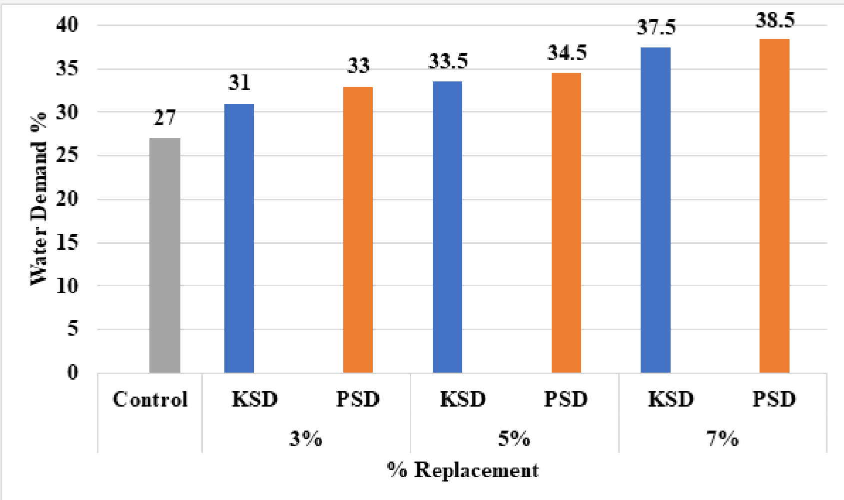

Figure 9: Water demands of the corresponding formulations.

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Setting Times of SCP Systems

The initial and final Vicat setting times were calculated for all formulations as shown in Figure 11. For samples having SD, initial and final setting time goes up proportionally to their replacement percentages in comparison with control specimen. The delay in setting times can be due to the fact that the sawdust on the top of being a highly inert material which makes it difficult to react with cement and water, with time tends to absorb and physically uptake water which is available to cement matrix for its hydration process, hence making the effective water content below the required water content level in the respective sawdust specimens. Moreover, the high dose of super-plasticizer also contributes to the delaying process in the system.

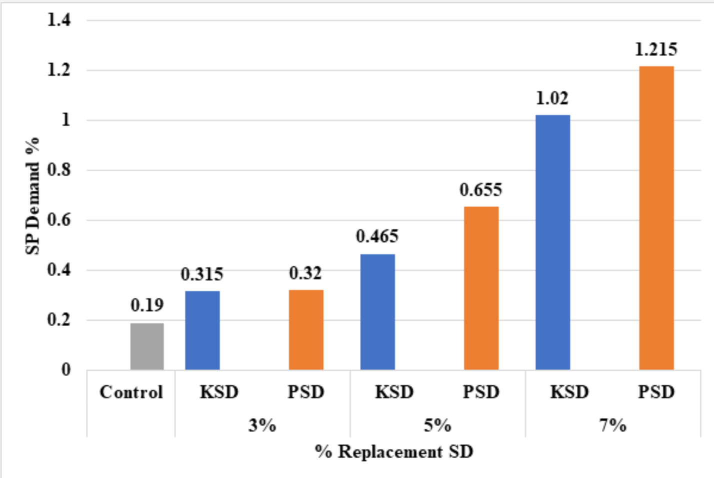

Figure 10: Super plasticizer demand of the corresponding formulations.

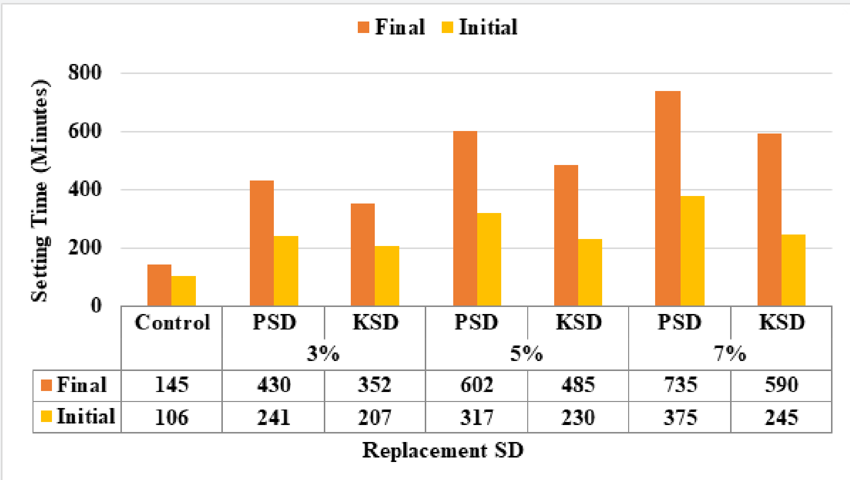

Figure 11: Initial & Final Vicat setting times of the SCP formulations having wood saw dust.

The flow time which reaches 25cm of target on Hagerman's apparatus is called the T25cm time and similarly for a target of 30cm the time is called T30cm time. The T25cm and T30cm was recorded for each formulation as shown in Figure 12. T25cm is the indication of viscosity of the system while T30cm is the indication of the yield stress of the flow system. It was observed that viscosity and yield stress both increased by adding sawdust to the system.

Compressive Strength

The compressive strength of SCP systems containing wood saw dust was determined at 1, 7 and 28 days. One frame (3 prisms of 4x4x16 cm^3-DIN 196) for each formulation, 3 tests

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were performed on each formulation. The standard conditions at the laboratory were temperature 25 ± 1 º C, relative humidity 55 % and mixing water temperature was 26 ºC. The compressive strength development of SCP formulations having wood saw dust is shown in Figure 13.

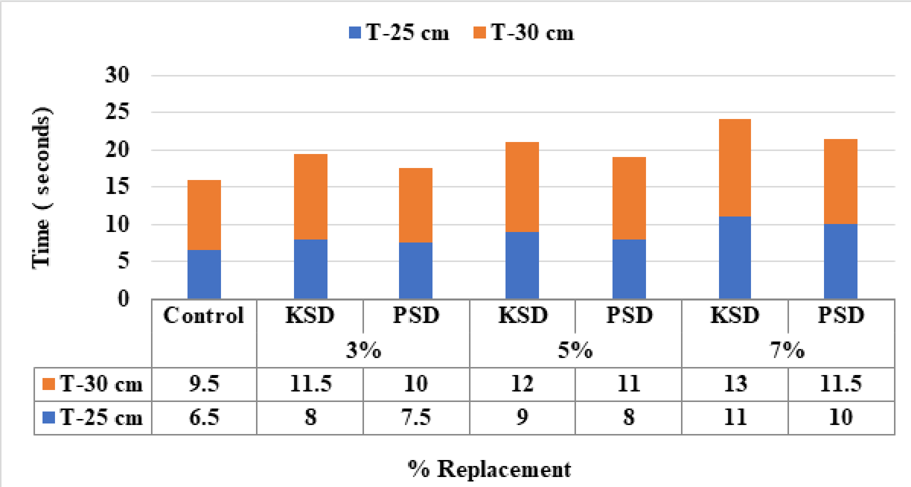

Figure 12: T25cm and T30cm time for each SCP formulation having wood saw dust.

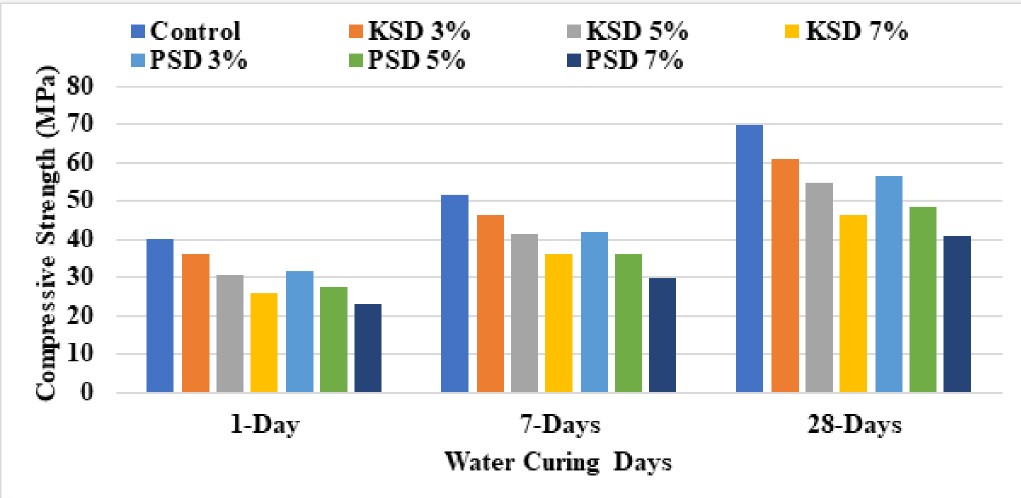

Figure 13: Progressive compressive strength at corresponding wet curing days.

In comparison to control at same ages, compressive strength of samples tends to decrease with percentage sawdust. This reduction is strength of samples completely depends upon the addition of sawdust particles which accelerate the presence of air content leading on to overall weakness of the internal microstructure, also the nature of sawdust (soft, hard) effects the compressive strength of SCP. The over-all average strength reduction for specimens having KSD was observed to be 7%, 17% and 28% with sawdust in replacement mode of 3%, 5% and 7% percent respectively at 28 days. Moreover, PSD was observed to be 12%, 24%, 37% with sawdust in replacement mode of 3%, 5% and 7% percent respectively at 28 days.

Water Absorption of SCP Formulations having Wood Saw Dust

The water absorption of all the samples after 28 days of curing was calculated. After setting the steel molds were demoded and the samples were removed before they were weighed and placed in a water curing tank in the laboratory. The standard conditions at the laboratory were, temperature 25 ± 1 ºC, relative humidity 55 %. After 28 days difference in weights were noted to calculate the percentage of water absorbed in saturated surface dry

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conditions. Here the 28 days water absorption of the samples in percent are reported in Figure 14. It was observed that samples having sawdust replacement, absorbed considerable amount of water during its curing time in water tank as compared to control sample. The highest amount of water was absorbed by the sample having 7% sawdust in PSD sample.

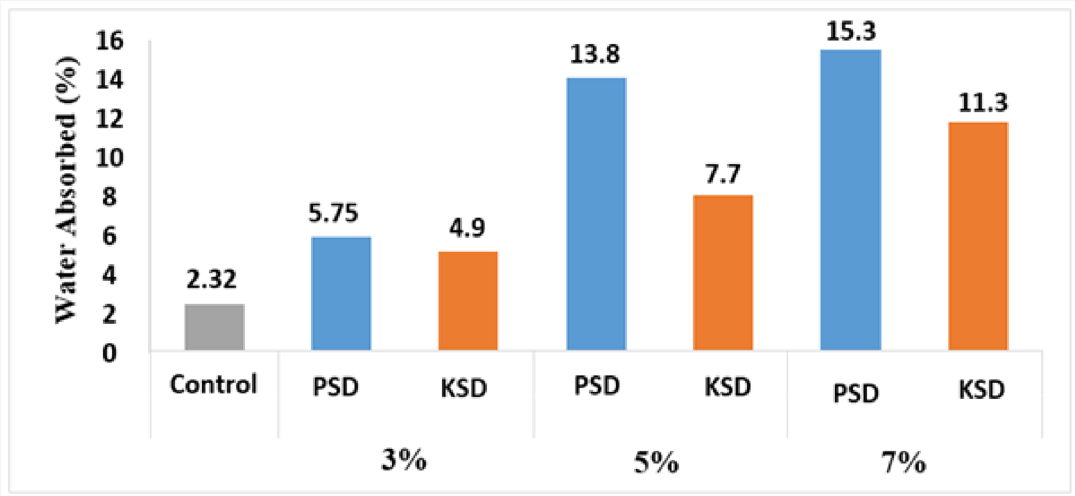

Figure 14: Water absorption after 28 days of wet curing.

Shrinkage of SCP Samples

Modified German shrinkage channel apparatus (Schwindrine) having channel dimensions of 4 x 6 x 25 cm^3 was used to observe the linear shrinkage of all the formations. Results are shown in Figure 15 below. The early shrinkage changes of all the formulations were observed for 24 hours each and the results are reported. A prominent reduction in shrinkage of samples with wood sawdust can clearly be seen in the results. This reduction in shrinkage further increases by increasing sawdust percent replacement. For 3 percent of PSD sawdust change, the shrinkage is cut down to half as compared to control (formulation 1) and with 5 percent change the reduction is almost 70%.

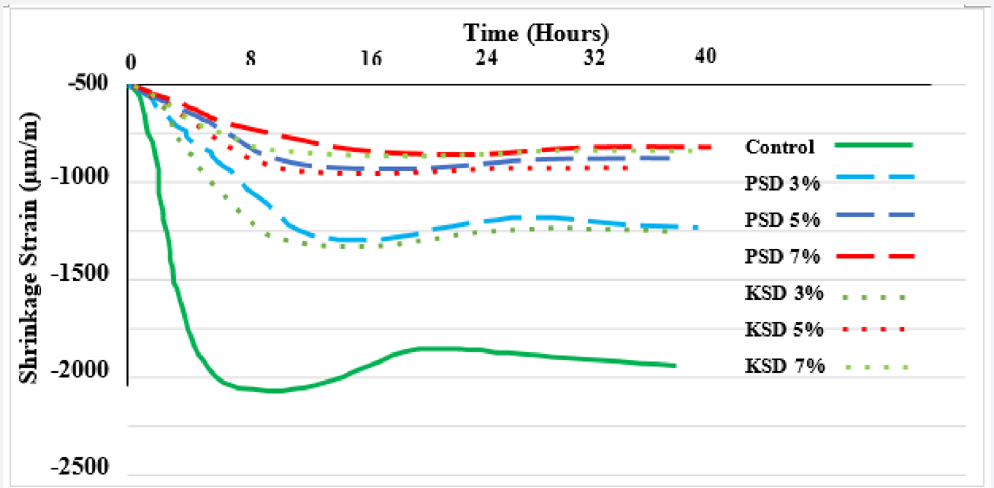

Figure 15: Shrinkage response of SCPs with and without saw dust.

Calorimeter on SCP with and without Sawdust

Hydration kinetics analyses was performed through calorimeter, in this test 750g of SCP for each formulation was kept in to the meter and results were observed for up to 48 hours. Results are shown in Figure 16. Analyses shows that for a particular formation in hydration, after the addition of SD there was a prominent delay in time. Data shows that addition of SD is SCPs

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in inverses the peak heat of hydration, i.e. higher the SD quantity, lower the peak heat of hydration, also happening simultaneously, hence retardation time increases with SD count. In Figure 16 it is clear that the SCP system with 7% of PSD particles shows that there was a slight pulse in curve initially, but eventually resulted in to straight line and continuity.

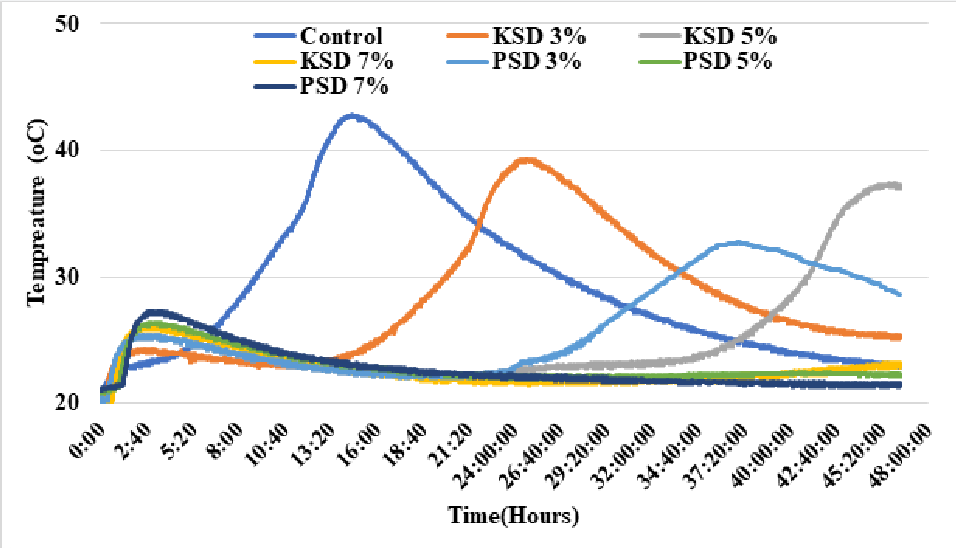

Figure 16: Calorimetric curves of seven SCPs formulations with and without SD.

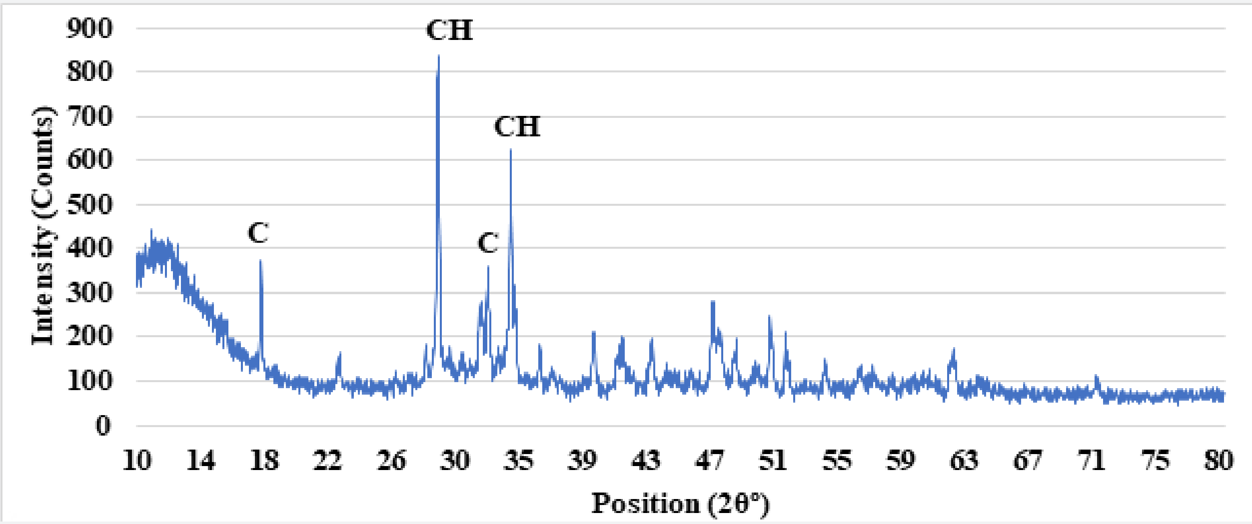

Figure 17: XRD analysis in controlled formation.

X-Ray Diffraction of SCP Formulations Having Wood Saw Dust

To understand the internal chemical mechanism involved and the formation of hydration products particularly calcium carbonate and calcium hydro oxide, XRD analysis was done using the equipment for samples with and without sawdust at 28 days of water curing. The results as shown in Figures 17-19 for control specimen and specimen having 3 percent PSD & KSD sawdust respectively. There was no big change in the XRD pattern of samples even if having sawdust or not, it can be clearly maintained that sawdust being a highly inert material does not participate in the chemical reaction. However, sawdust behaves as an internal curing agent. The XRD of control sample shows higher concentration of calcium carbonate in the form of calcite which

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helps in formation of strength. This calcite gets diminished or have lower intensities in samples having sawdust. Moreover, the formation and concentration of calcium hydro oxide (Portlandite) was much higher in sawdust samples as compared to control.

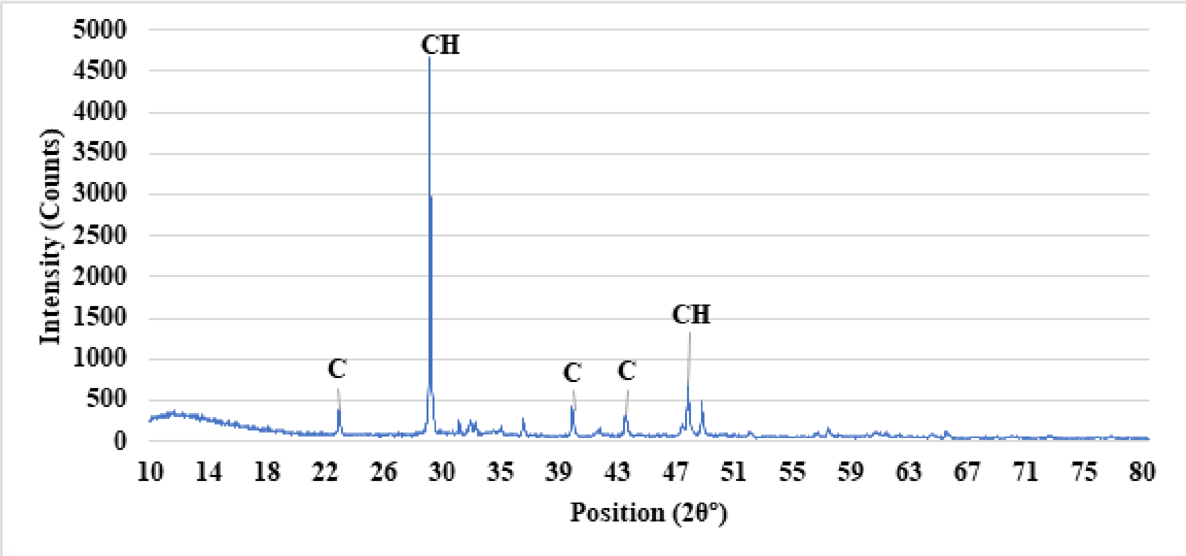

Figure 18: XRD analysis of SCP systems having Kikar saw dust 3%.

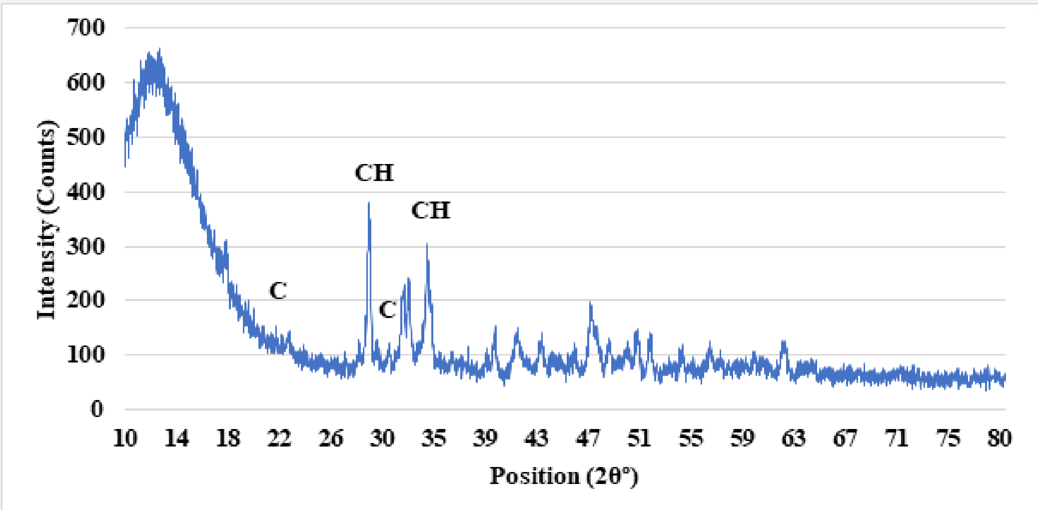

Figure 19: XRD analysis of SCP systems having Partal wood saw dust 3%.

Scanning Electron Microscopy (SEM) Of SCP Systems Having Wood Saw Dust

To study the internal MICROSTRUCTURE of the SCP systems, SEM was performed for systems with and without sawdust at 28 days of water curing, a single sawdust particle within cementitious paste is shown as a whole. As shown in Figures 20-23, the sawdust particle due to its fiber shaped structure induces pores in the cementitious system.

Conclusion

The overall compressive strength of the system in the SCP system decreased due to its greater size than cement particles and irregular fibrous structure of the wood sawdust incorporated. Due to continuous release of water in the system by SD particles, the expansive species are formed during the hydration process which enhance the internal stiffness of the system and that is why the reduction in shrinkage with SD samples was observed more

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than 50 percent. This phenomenon also minimizes the heat of hydration of the system which prevents any early age cracking. The wood saw dust was also probably acting as kind of internal curing agent. No chemical alteration was observed in XRD results of the system when SD used to confirm the role of SD as an inert material. Because of the significant reduction in both weight and Vicat setting times of the system due to SD particles, it can be used as lightweight aggregate cum retarders. It can also be used as an internal curing agent as well as to minimize shrinkage subject to compensation of strength reduction by using strength increasing admixture etc.

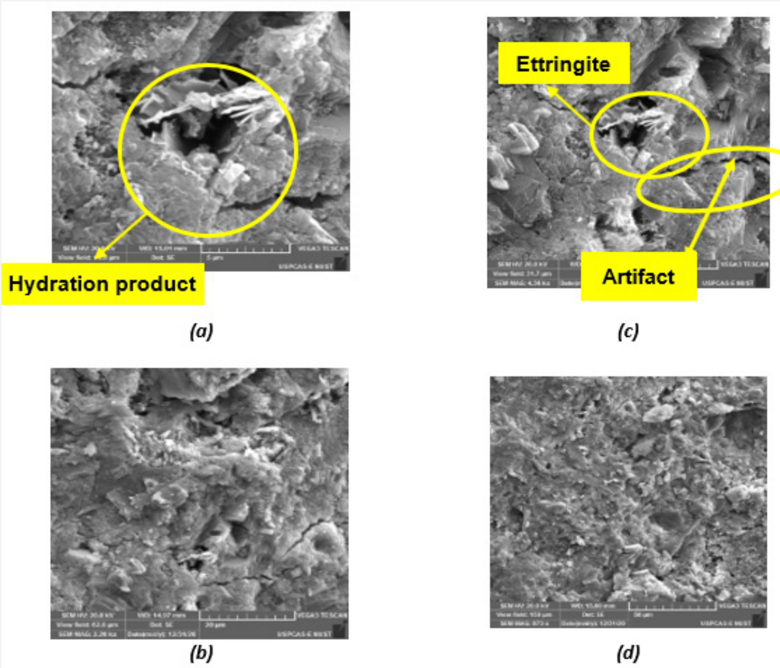

Figure 20: XRD analysis of SCP systems having Partal wood saw dust 3%.

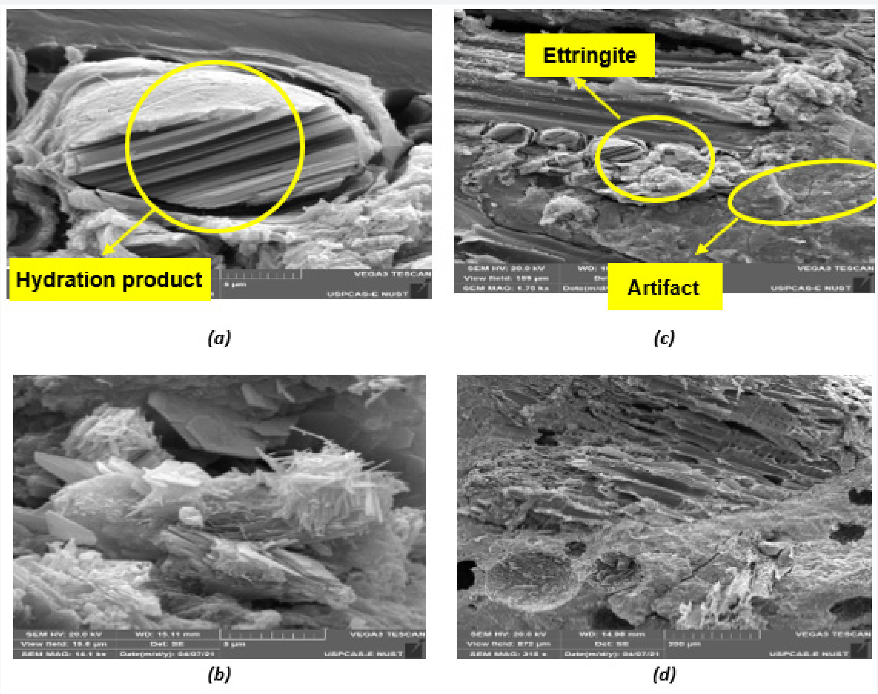

Figure 21: SEM analysis of control samples having saw dust after 28 days of wet curing.

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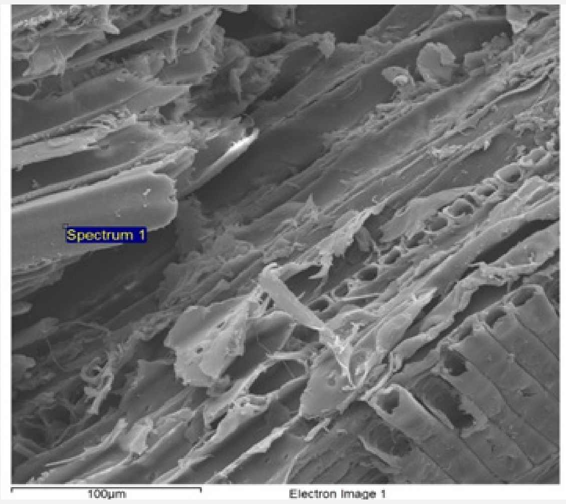

Figure 22: SEM analysis of Partal.

Figure 23: SEM analysis of Kikar.

Recommendations

For strength compensation, it is recommended to use strength increasing admixtures in conjunction with SD in the system. Also, for overall better results kikar sawdust, commonly available especially in tropical countries with reduced size comparable to the cement particle size can be used in the system.

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References

1. Myers JJ (2012) Self-Consolidating Concrete (SCC) for Infrastructure Elements Report A - Shear.
2. Rizwan SA, Bier TA (2012) Blends of limestone powder and fly-ash enhance the response of self-compacting mortars. Construction and Building Materials 27(1): 398-403.
3. Ijigah EA, Jimoh RA, Aruleba BO, Ade AB (2013) An Assessment of Environmental Impacts of Building Construction Projects. Civil and Environmental Research 3(1): 93-105.
4. Shakir AA, Naganathan S, Nasharuddin K, Mustapha B (2013) Development Of Bricks From Waste Material: A Review Paper. Australian Journal of Basic and Applied Sciences 7(8): 812-818.
5. Corinaldesi V, Mazzoli A, Siddique R (2016) Characterization of lightweight mortars containing wood processing by-products waste. Construction and Building Materials 123: 281-289.
6. Wihersaari M (2005) Evaluation of greenhouse gas emission risks from storage of wood residue. Biomass and Bioenergy 28(5): 444-453.
7. Abed JM, Khaleel BA (2019) Effect of wood waste as a partial replacement of cement, fine and coarse aggregate on physical and mechanical properties of concrete blocks units. International Journal of Integrated Engineering 11(8): 229-239.

8. Bouguerra A, Amiri O, Aït MA, Diop MB (2002) Water sorptivity and pore structure of wood-cementitious composites. Magazine of Concrete Research 54(2): 103-112.

9. Adebakin I, Adeyemi A (2012) Uses of sawdust as admixture in production of lowcost and light-weight hollow sandcrete blocks. American Journal of Scientific and Industrial Research 3(6): 458-463.

10. Belhadj B, Bederina M, Montrelay N, Houessou J, Quéneudec M (2014) Effect of substitution of wood shavings by barley straws on the physico-mechanical properties of lightweight sand concrete. Construction and Building Materials 66: 247-258.

11. Bederina M, Marmoret L, Mezreb K, Khenfer MM, Bali A, Quéneudec M (2007) Effect of the addition of wood shavings on thermal conductivity of sand concretes: Experimental study and modelling. Construction and Building Materials 21(3): 662-668.

12. Bederina M, Laidoudi B, Goullieux A, Khenfer MM, Bali A, et al. (2009) Effect of the treatment of wood shavings on the physico-mechanical characteristics of wood sand concretes. Construction and Building Materials 23(3): 1311-1315.

13. Turgut P (2007) Cement composites with limestone dust and different grades of wood sawdust. Building and Environment 42(11): 3801-3807.

14. Turgut P, Murat AH (2002) Limestone dust and wood sawdust as brick material. Building and Environment 42(9): 3399-3403.

15. Pedreño RMA, Morales CMJ, Pérez GF, Rodríguez LC (2017) Eco-efficient acoustic and thermal conditioning using false ceiling plates made from plaster and wood waste. Journal of Cleaner Production 166: 690-705.

16. Morales-Conde MJ, Rodríguez LC, Pedreño RMA (2016) Physical and mechanical properties of wood-gypsum composites from demolition material in rehabilitation works. Construction and Building Materials 114: 6-14.

17. Coatanlem P, Jauberthie R, Rendell F (2006) Lightweight wood chipping concrete durability. Construction and Building Materials 20(9): 776-781.

18. Sant G, Lura P, Weiss J (2006) Measurement of Volume Change in Cementitious Materials at Early Ages. Transportation Research Record: Journal of the Transportation Research Board 1979(1): 21-29.

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