REVIEW ON USE OF COCONUT SHELL AND EGGSHELL AS A REPLACING AGENT IN CONCRETE

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ABSTRACT

Effective organization of bio-waste has been given significance in our society for economic and environmental concerns. Recovery of eggshell from home, bakeries, hatcheries and businesses and a waste material like coconut shell is a proficient and cost beneficial way to lessen garbage removal and prevent serious and dangerous environmental pollution. Coconut shell and eggshell are used in various papers as replacement of coarse aggregate, fine aggregates and even cement. Egg shells waste comprises fundamental natural and inorganic materials that can be treated with other materials for improving the previous property. The major worry in any respectful area is effective development with insignificant expense venture. Coconut shell in powder forms is usually used together with cement to produce high strength, more durability and lightweight concrete for structural component in construction area. The aim of this paper is to spread awareness about the usage of eggshell and coconut shell as a development material in civil engineering designing.

INTRODUCTION

Highway development includes enormous cost of venture. Bitumen is utilized for covering surface in a large portion of the Indian highways. For the development and support of adaptable asphalts, aggregates blended in with bitumen are broadly utilized.

Use of natural aggregate leads to a question about the preservation of natural aggregates sources. Moreover, activities related with aggregate extraction and preparing are the chief reasons for ecological concerns. Considering this, in the contemporary structural designing development, utilizing elective materials instead of natural aggregate is sustainable and environmentally friendly construction material. Different elective waste materials and industrial by products, for example, fly debris, base debris, reused totals, foundry sand, china earth sand, morsel elastic, glass were replaced with natural aggregate and investigated properties of the cements. Apart from above mentioned waste materials and industrial byproducts, coconut shells and eggshell can also be used as a replacement. According to a report, coconut is grown in more than 86 countries worldwide, with a total production of 54 billion nuts per annum. India occupies the premier position in the world with an annual production of 13 billion nuts, followed by Indonesia and the Philippines. Removal of these coconut shells is therefore a genuine natural issue. In this point, the examination on utilization of coconut shells as a substitute or swap for coarse aggregates in asphalt and adding eggshell. As Eggshell is commonly discarded as a waste. The egg shell additionally makes a few hypersensitivities when saved for a more extended time in trash. It makes unwanted smell which can cause disturbance. The main ingredient in eggshells is calcium carbonate (the same brittle white stuff that chalk, limestone, cave stalactites, sea shells, coral, and pearls are made of). The shell itself is about 95% CaCO3 (which is also the main ingredient in sea

shells). The remaining 5% includes Magnesium, Aluminum, Phosphorous, Sodium, Potassium, Zinc, Iron, Copper, Ironic acid and Silica acid. Eggshell has a cellulosic structure and contains amino acids; accordingly, it is relied upon to be a decent bio-sorbent and it was accounted for that a lot of eggshells are created in certain nations, as side-effects and arranged in landfills annually to it is picking up significance as far as conceivable decrease of byproducts in the climate and finding a practical option for non inexhaustible natural stone aggregate. As coconut shell is a waste material and being a hard and not easily degradable material if crushed to size of coarse aggregate can be a potential material to replace coarse aggregate and also is abundantly found in India so to reduce the environmental pollution coconut shell can be used as an replacement of coarse aggregate in asphalt and to add on to this eggshell can be also be used as an replacement because it is a by product of eggs and cannot be disposed off. Egg shell powder (ESP) is a waste material obtained from hotels and restaurants. Coconut is a versatile crop grown all over the world except the continents of Europe and Australia. Coconut is grown in more than 93 countries in the world.

METHODOLOGY

In this, various papers were reviewed

- Different type of mix design by an appropriate method, trial mixes, final mix proportions and grade of mix were used.
- Total quantity of concrete required for the whole project work was estimated.
- Quantity of cement, fine aggregate, coarse aggregate, eggshell shell powder and coconut shells required for the project work was estimated.
- Testing of properties of cement, fine aggregate, coarse aggregate, eggshell powder and coconut shells.
- Preparation of concrete cubes with coconut shells and Eggshell powder.
- Compressive strength test was conducted on those cubes.
- Coconut shell samples and ESP were used in different percentages from 0% -100%.
- Marshall stability test was conducted on coconut shell sample and the stability of the specimen is derived by load taken by the sample and then multiplying it with correlation ratio which is obtained from height or volume of sample.
- Eggshell was treated with virgin soil and plastic characteristics were obtained.

LITERATURE REVIEW

1.Allie.A.M et al, 2018 reviewed the study of eggshell powder as a cement replacing material in concrete. After studying the various researches it was found that the egg shells are very useful material instead of a waste material (harm to the environment) that they were hurled in many hundred tons. The hardness and specific gravity were increased with increasing ESP and the compressive strength increases with increase of percentage of Egg shell powder up to certain limit. It was also seen that the workability of concrete is decreased by increasing the amount of Egg shell powder.

2.Ansari.M et al, 2016 described the experimental result and effect of replacing eggshell powder in cement. The results showed that the eggshell can be used as a replacement and about 10% to 15% replacement is effective and when we increase the percentage of eggshell powder it decreases the compressive strength.

3.Aswathy.A. et al, 2016 investigated the use of coconut shell charcoal as a filler in stone mastic asphalt to compare the results. Binder content was varied from 4-6% and binder of 60/70 penetration grade was used. It posseses the properties such as resistance to crushing, freezing, surface moisture. Stability flow parameters and air void ratio were also

compared among the fillers. Marshall test method was used and the maximum Stability Value obtained was 1037.4 kg by using Stone dust as Filler at Optimum binder of 5.5% . Using Coconut Shell charcoal as filler, an average Stability obtained which was 975.8 kg. As the difference in Stability value was less which was 3.61% therefore Coconut shell charcoal can be used as a substitute as filler.

4.Bhaskar.U.M et al, 2019 replaced partially coarse aggregate with coconut shell at different percentages. In this study M20 and M25 grade concrete were used and various combination of coconut shell of about 0%, 10%, 20% and 30% were prepared. For each concrete mix three sample specimens were casted. The results shows that the normal aggregate can be replaced with coconut shell aggregates but the performance of coconut shell concrete is little bit lower than the conventional concrete. With the increase in replacement of coconut shell the voids in the concrete also increases. By replacing the coconut shell with 30 % then the voids were 40 % more than in the normal conventional concrete. So, the results also showed that we can replace the coarse aggregate with CS up to 30 %.

5.Chandar.S.P et al, 2108 examined the durability performance of quarry dust as fine aggregate and coconut shell as coarse aggregate in concrete. In this experiment tests were conducted for period of curing for 3, 7, 28, 56, 90, 180 days and one year. It was concluded that the durability of conventional concrete and coconut shell concrete with or without quarry dust compare reasonably well.

6.Deepak.M et at 2018 did a experimental study on partial replacement of coarse aggregate with coconut shell and lathe scrap in concrete. In this study M25 grade concrete was used in addition to lathe scrap to cement. Coarse aggregate was replaced by 3%, 6%, 9% of coconut shell in conventional aggregate with water-cement ratio kept as 0.45 and cement was replaced by lathe waste by 0.5% and 1%. It was shown that optimum of 1% of lathe scrap as an addition can be used to improve the strength of fiber reinforced concrete.

7.Dhanalakshmi.M et al 2015 studied the use of eggshell concrete by partial replacement of cement by fly ash. In this study these two waste products were used and various properties like workability, strength and density were determined. Egg shell powder was varied up to 12.5% (0%, 2.5%, 5%, 7.5%, 10% and 12.5%) and fly ash was added to optimum egg shell powder content cement concrete from 0% to 30% (0%, 5%, 10%, 15%, 20%, 25% and 30%). The results showed that the combination of ESP + FA showed the reduction in compressive strength compared control concrete and egg shell powder concrete.

8.Kumar.M.S et al, 2016 studied the mechanical property of high strength concrete using coconut shell as coarse aggregate. In this study ground granulated blast furnace slag and silica fume were added as additives to cement up to 15% to find the mechanical properties. The results showed that the density of coconut shell at 28th day was found to be 1960 to 1990 kg/m^3 and the compressive strength of conventional concrete increases to 26.5% and 28.7% at 3rd day, 45% and 44.4% at 7th day, 41.8% and 39.5% at 28th day, compared to coconut concrete and density of the conventional concrete is also increased compared to the coconut concrete and the flexural strength of conventional concrete increases at 29.5% and 33.3% at 3rd day, 21% and 29.5% at 7th day,26.9% and 23% in 28th day and Split tensile strength of conventional concrete increases to 28.5% and 53.6% at 3rd day, 27.7% and 39.4% at 7th day,28.8% and 34.9% at 28th day and also the impact strength of coconut shell concrete is greater than the conventional concrete at 5.5%, 8% at 7th day and 14.5%, 15.2% at 28th day.

9.Nejres.A.M et al, 2020 studied the natural asphalt obtained from Al-Qayyarah/Iraq to detect its alluvial system using column chromatography and infrared spectrophotometer Moreover, Natural asphalt was then treated by the addition of food waste product particularly eggshell powder (ESP) and commercially available low density polyethylene (LDP) in

different ratios and the asphalt was then separated into four main parts using column chromatography and the results indicated that natural asphalt has a colloidal system of SOL type and its rheological properties are improved by the addition of both additives (ESP and LDP).

10.NNOCHIRI.E.S et al 2017 studied the effect of coconut shell ash on lime stabilized laterite soil for road construction and the soil was collected from burrow pit in Akure, Nigeria. The soil sample was mixed with lime in proportions of 2,4,6,8 and 10%.The results in terms of California bearing ratio and unconfined compressive strength showed that the 4% lime + 4% CSA combination is higher than the 8% lime stabilization.

11.Pennarasia.G et al 2019 studied the relevance of coconut shell aggregate concrete paver block. In this study, total 86 block pavers were produced out of which 43 pavers using conventional concrete and 43 using coconut shell. Based on the results obtained, both conventional concrete and coconut shell aggregate concrete mixes gave zero slumps and these concretes were found to be good enough for the production of paver blocks, individual rubber moulds were used for cast the paver blocks. Coconut shell aggregate concrete paver blocks are light in weight of approximately 20 % (19.55 %) less compared to conventional concrete paver blocks and coconut shell aggregate concrete paver blocks have shown 100 % good results compared with conventional concrete paver blocks in all dimensional properties. As per the compressive strength test results which are ranging from 30 N/mm2 to 55 N/mm2.

12.Pliya.P et al, 2015 used the limestone which was derived from eggshell powder as a replacement in Portland cement. In this experiment a large quantity of eggshells were developed and limestone was added in amount of 0%, 5%, 10%, 15% and 20% by weight. The results showed that the eggshell contains small amount of organic membrane and matrix and also calcite and also the strength of mortar was affected by the addition of various limestone materials and also at last it was found that white and brown eggshells have inferior property compared to natural conventional limestone even with 5% weight replacement.

13.Reddy.B.D et al, 2014 investigated the use of coconut shell as light weight aggregate in concrete. In this study, coarse was replaced with coconut shell, by volume. Specimens were cast by replacing 25%,50%,75% and 100% of coarse aggregate with coconut shells and tests were conducted on the cast specimens after 28 days as mentioned in the IS code. The flexural strength of CSC was approximately 5.36N/mm2, 4.32N/mm2, and 2.4N/mm2 for specimens replacing 25%,50%,100%, of coarse aggregate respectively. But in case of 100% replacement of coarse aggregate flexural strength was not obtained as the specimen failed under its self weight and the splitting tensile strength of CSC was obtained as 2.48N/mm22.22N/mm2,1.27N/mm2 and 0.495N/mm2 respectively.

14.Samuthiram.M et al, 2016 stabilized the expansive soil with eggshell and quarry dust. Soil was taken with various ratios by addition of which 4% of ESP and without ESP followed by the increment of 5% of QD through moisture-density relationship at Standard Proctor Compaction test. In this study the addition of 4% of egg shell powder, the liquid limit decreased by approximately 7% when compared with the soil mixes without ESP. For 30% replacement of soil with quarry dust, the optimum moisture content was reduced by 2% by mass which further increased MDD by 13%.

15.Vijaya.H.M et al ,2018 used the eggshell powder to improve the sub grade properties as the quality of flexible pavement depends on its sub grade soil. Index properties of soil were observed to classify the soil and the results

showed improvement of strength of soil with addition of eggshell in respect of California bearing ratio in unsoaked condition

16.Yacoob.H et al 2017 evaluated the stiffness modulus and dynamic creep properties of the asphaltic concrete containing coconut shell as an aggregate replacement. In this study a bitumen penetration grade 60/70 was used and four coconut shell replacements namely 0% ,10% ,20% ,30% and 40% by weight volumes were used. Results showed that the coconut shell used as a replacement increases the resilient modulus and creep stiffness at approximately 15%.

RESULTS AND DISCUSSION

Compressive strength:

Compressive strength of concrete is the Strength of solidified/hardened concrete estimated by the compression test. The compression strength of concrete is a proportion of the solid's ability to oppose loads which will tend to compress it. It is estimated by crushing concrete specimens in compression testing machine.

In this review different sizes and different mixes were used (M20, M25, M30).

AUTHOR	TYPE OF MIX	PERCENTAGE	COMPRESSIVE STRENGTH (MPA)				
			3 DAYS	7 DAYS	14 DAYS	28 DAYS	
B. Damodhara reddy	Coconut shell	O% R	-	-	-	24.00	
		25% R	-	-	-	22.62	
		50% R	-	-	-	14.93	
		100% R	-	-	-	5.48	
j. karthick	EGGSHELL	0%R	-	14.97	22.03	24	
		10%R	-	13.78	20.11	22.33	
		20%R	-	15.33	22.33	24.32	
		30%R	-	14.21	16.89	21.42	
		40%R	-	8.78	9.55	14.16	
		50%R	-	2.78	3.09	9.67	
M. uday bhasker	Coconut shell	0%R	-	-	-	29.3	
		10%R	-	-	-	27.4	
		20%	-	-	-	26.2	
		30%	-	-	-	25.4	
Mohammad ansari	Eggshell	0%R	-	-	-	Trail1	18.49
						Trail2	17.33
						Trail3	18.65
		10%R	-	-	-	Trail1	22.08
						Trail2	20.81
						Trail3	21.44
		15%R	-	-	-	Trail1	24.00
						Trail2	22.50
						Trail3	23.60
		20%R	-	-	-	Trail1	21.03
						Trail2	18.60
						Trail3	19.11

TABLE 1

Test results for virgin soil obtained from paper:

Soil sample	Plastic limit	Liquid limit	Plasticity index
Virgin soil	7.43	26.2	11.1

TABLE 2

Plastic characteristics of treated and untreated soil with eggshell powder:

Particulars	Soil + 2% ESP	Soil + 4%ESP	Soil + 6%ESP
Plastic limit	8.54	11.78	12.12
Liquid limit	26	24.2	17.5
Plasticity index	17.46	12.42	5.38

TABLE 3

Properties of coconut shell and eggshell powder

Physical properties of ESP

Physical properties	Eggshell powder
Ph	8.3
Shelf life	12 months
Moisture content	1.18
Specific gravity	0.85g/m^3
Bulk density	0.8g/m^3
Particle density	1.012g/m^3
Storage	Dry storage

TABLE 4

Physical and mechanical properties of CS

Physical and mechanical property	Coconut shell
Moisture content	04.20%
Water absorption	24.00%
Average specific gravity	1.05 – 1.20
Apparent specific gravity	1.40 -1.50
%age loss in abrasion test	1.628%

TABLE 5

- Marshall stability: Using coconut shell as a filler, average stability was obtained and it was found that coconut shell can be used as a substitute.
- From table 1, with replacement of 20-30% of coconut shell compressive strength increased.
- From table 1, with replacement of 10-15% of eggshell compressive strength increased.
- From table 3, the best results for plastic limit was obtained from soil added with 4% eggshell.
- From table 3, the best results for liquid limit was obtained from soil + 2% eggshell.
- From table 3, the best results for plasticity index was obtained from soil + 4% eggshell added.

CONCLUSION

Due to the depletion of natural resources, researchers searched for sustainable development which was one of the prime importance in concrete construction and production industries. The use of coconut shell and eggshell powder was found to be encouraging and showed positive results.

From the literature review surveyed on eggshell powder and coconut shell, it can be concluded that these two products are agricultural wastes, produced in bulk and has a potential to be used in concrete.

From the above papers it may be concluded that eggshell powder as well as coconut shell powder is beneficial. It was found that white and brown eggshell have inferior properties and can be used in sub grade. On adding eggshell powder specific gravity increases and also compressive strength increases with increase in ESP but it can be only be replaced up to some limit ie; 10-15% after that its compressive strength decreases. It was also noticed if we add eggshell powder with fly ash its strength reduces. Better physical and mechanical properties of concrete can be obtained with replacement of cement with ESP.

For coconut shell it was found that it can be used as a substitute as fillers. It was also noticed that if we add coconut shell in different percentages. With increase in coconut shell powder, voids in concrete increases. It was found that 20-30% addition is good but when we add 100%, flexural strength decreases. It can be used in road construction. It is good for paver blocks as zero slump is obtained, as its light in weight.

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