DEVELOPMENT OF SUSTAINABLE AGRO TECHNOLOGICAL INTERVENTION FOR CEMENTITIOUS COMPOSITES THROUGH CASHEW NUT SHELL ASH

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Keywords:

Cashew nutshell ash, Agricultural waste, Workability, Mechanical characteristics, Durability.

Introduction:

Globally, the construction sector is one of the fastest-growing sectors. Carbon dioxide (CO2) emissions are a major concern in the construction industry due to the energy-intense processes involved in the production of cement The Indian cement industry will play an integral role in building a new India. The huge demand for cement as a building material has led to a concern about its substitute with supplementary cementitious materials (SCM). The use of agro-waste ashes as SCM is a more cost-effective alternative to Industrial Residues (GGBS), since their logistic price is significantly lower. Therefore, the primary focus of the development and characterization of SCMs has been aligned with by-products from the agricultural sector. The effectiveness of various agro-industrial wastes such as rice husk ashes, bagasse ashes, etc has been effectively carried out. Although the several efficacies of SCMs in Portland cement concrete are well-understood for the present, recent research on the materials has focused on discovering new materials. Waste materials causing locational environmental contamination have been used in studies to contribute to the world's sustainability goals.

There have been several studies on using industrial wastes, and biomass ashes but the utilization of Cashew Nutshell Ash (CNSA) as a pozzolanic product or filler will be a great opportunity even though there have been limited studies and evidence on the use of CNSA as a cementitious material.

Objectives:

1. To determine the optimum percentage of Cashew nutshell ash.
2. To study the properties of Cashew nutshell ash on the characteristics of cement paste.
3. To study the effect of Cashew nutshell ash on the behaviour of fresh concrete.

4. To compare the effect of different percentages of Cashew nutshell ash on the mechanical characteristics of concrete.
5. To assess the effect of Cashew nutshell ash on the durability of characteristics of concrete.

Methodology:

Figure 1: Generation of Processed CNSA

Figure 2: Physical Properties of Materials

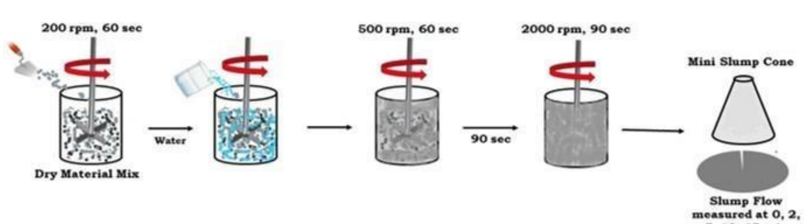

Figure 3: Procedure for Mini Slump Flow

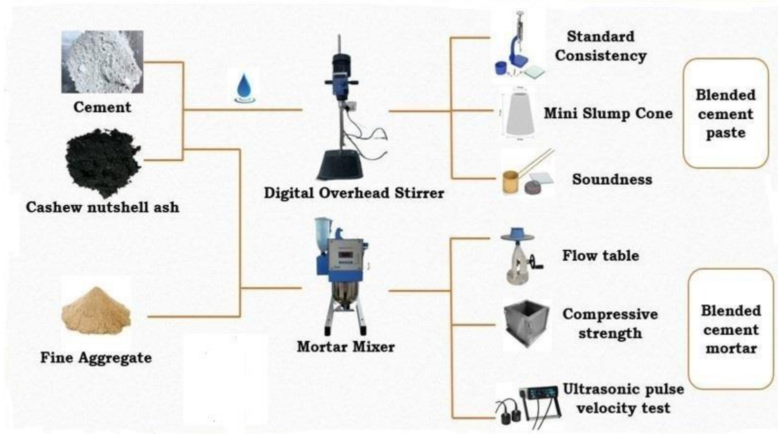

Figure 4: Tests on Blended Cement Mortar

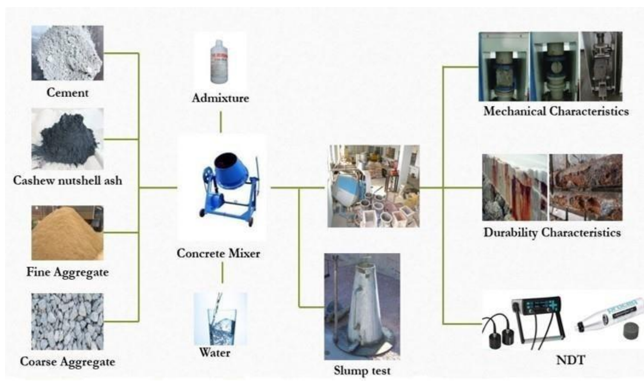

Figure 5: Tests on Blended Cement concrete

1. Raw CNSA is pulverized, Ball milled for 1 hour, and sieved through 75µm to obtain a fine processed CNSA as per Figure 1.
2. Physical properties of all the materials are tested as per the standards.
3. CNSA-based cement mortar and concrete samples were prepared with a CNSA dosage of 5, 10, 15, 20, and 25 weight% relative to cement, and the sand used was washed, sundried, and sieved from 2.36mm to 150µm for mortar and 4.75mm for concrete mixes.
4. Vicat apparatus was used to measure the standard consistency and setting time of the control and CNSA-based cement paste samples according to IS: 4031 (Part 4) – 1988 and IS: 4031 (Part 5) – 1988.
5. The expansion of the control and blended specimens are according to IS: 4031 (Part 3) – 1988
6. For the mini-slump test, a smaller version of the Abrams test was considered in the present study that followed the same characteristic of the cone described in ASTM C1437 as per Figure 3.
7. The flow test was conducted as per the ASTM C 1437 and IS 4031 (Part 7) – 1988 specification.
8. The hardened properties of mortar were determined based on the compressive strength at 1, 3, 7, and 28 days and ultrasonic pulse velocity for 28 days.

9. Workability of concrete is determined using slump and compaction factor test for all the mixes.
10. Mechanical characteristics of concrete are determined using compressive for 7 and 28 days, split tensile and flexural strength of concrete for only 28 days. To check the quality of concrete ultrasonic pulse velocity is conducted for 28 days.
11. Acid attack test was performed to check the durability of concrete.

Results and Conclusions:

1. The addition of CNSA reduces the mini-slump flow diameter of the cement paste. The particle size of CNSA has a considerable effect on the flow.
2. High surface area leads to an increase in the water demand for cement pastes thereby increasing the consistency of cement paste. The setting time results of CNSA have a set acceleration effect on the cement pastes.
3. The soundness of the blended cement is satisfactory at any CNSA replacement level.
4. Workability of mortar is studied through the flow table and the flow diameter of all the mixes was found to be more than 110mm as per the standards.
5. CNSA can be used up to a 10% replacement level as it causes a significant strength loss in cement mortars containing higher amounts. However, maximum compressive strength is obtained at 5% replacement levels of CNSA on all curing days (1, 3, 7, 28).
6. Workability of freshly mixed concrete increased as the content of CNSA in the mix increased.
7. The replacement of cement by CNSA up to 10% has indicated desirable results. However, maximum compressive strength is obtained at 5% replacement levels of CNSA on all curing days (7, 28). Split tensile and Flexural strength results showed similar results as that of compressive strength.
8. The partial replacement of OPC with CNSA in mortars and concrete decreases the UPV values with an increase in the percentage of CNSA.
9. It can be inferred that CNSA blended concrete resisted more acid attack (Sulphuric acid) than conventional concrete.
10. With an extensive industry associated with cashew, this study proves that CNSA is a regional waste material with pozzolanic attributes that can be used in minor amounts.

Scope for future work:

1. Processing methods have a substantial influence on the reactivity and performance of the ashes in concrete composites. Hence, the work can be repeated for the smaller size particles (Less than 75µm) of CNSA.
2. This work is conducted for Normal strength, However, the repercussion of CNSA can be studied for high strength and high-performance concrete.
3. The mechanical characteristics of mortar and concrete can be investigated for

more than 28 days of curing.

4. The effect of CNSA can be studied by incorporating in Self-compacting concrete and Geopolymer concrete.
5. Several Durability tests like sulphate attack, water absorption, and desorption, porosity, etc can be conducted to check the effectiveness of CNSA in adverse exposure conditions.
6. Further applications of CNSA in other construction products such as hollow blocks, tiles, and paver blocks are minimal. Therefore, further studies need to be adopted to understand the effects of these ashes on other construction products.
7. Microstructural studies like scanning electron microscopy (SEM), Thermo gravimetric analysis (TGA), etc., needs in-depth investigation and the results to be validated with the mechanical and durability properties of CNSA concrete.