Recycling And Reusing Super Absorbent Polymer from Sanitary Waste

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Abstract: - This project aims to address the issue of waste generation from sanitary products and cotton by exploring potential solutions for their recycling and reuse. The project focuses on three main areas: using Super Absorbent Polymers (SAPs) in concrete, the potential use of SAPs as agricultural water retainers, and the creation of fuel pellets from residual cotton wastes. The project will investigate the strength of SAP-concrete versus normal concrete under compression, tension, and flexural strength, determine the potential benefits of using SAPs in agriculture, and identify effective methods for creating fuel pellets from cotton and sanitary wastes. The insights gained from this research could include improved strength, durability, and sustainability of SAP-concrete, increased crop yields and reduced water usage, and important implications for waste reduction and energy generation. Overall, the project aims to promote sustainability and reduce waste in the sanitary and cotton industries through innovative solutions.

Key Words: - ***Superabsorbent polymers, SAPs, Concrete, Agricultural water retention, Fuel pellets.***

I. Introduction

Around 12.3 billion sanitary napkins, amounting to 113,000 tonnes of waste, reached India's landfills every year, according to a new study. Sanitary wasted are not bio-degradable and lead to health and environmental hazards. Open and unsanitary landfills contribute to contamination of drinking water and can cause infection and transmit diseases. Sanitary waste is a worldwide concern, largely because disposable pads are 90% plastic.

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Plastic takes 500 – 800 years to “degrade”, which means to break down into smaller pieces. The smaller the plastic becomes the more easily it can enter our homes, food, air and water. In India, there is currently no standardized method of sanitary waste disposal. In in interim, the government has proposed the incineration of pads. Unless regulated, incineration can release toxic chemicals such as dioxin, a known carcinogen. Mini incinerators may be unsafe because they do not reach high enough temperatures to destroy harmful emissions. We can reduce sanitary waste by switching to reusable products like cloth pads and menstrual cups.

As per the National Family Health Survey (NHFS-4), a country-wide survey conducted by the Ministry of Health and Family Welfare, Government of India, with the International Institute for Population Sciences serving as the nodal agency,4 around 41.8 per cent of women in the age group 15–24 use disposable sanitary napkins while 16.4 per cent use locally produced napkins. According to recent government statistics, use of disposable sanitary pads is continually increasing among women aged 15–24. In Bihar, for example, 58.8 per cent of girls and women in this age group used such products, an increase of nearly 90 per cent in just four years, i.e. 2016–19. Their use increased to 85.1 per cent in 2019–20 in Andhra Pradesh, up from 67.5 per cent in 2015–16. A similar trend is seen in most Indian states.

In the context of baby diapers, a one-month-old infant typically has three to four bowel movements a day and wets at least six or more diapers a day, adding up to six to 12 disposable diapers a day.6, 7 Assuming a one-month-old infant uses 10 diapers a day—or 300 diapers per month—a single one-month-old baby could generate around 3,600 used diapers every year. According to the United Nation Children's Fund (UNICEF), 25 million children are born in India each year8 and the average weight of the soiled diaper is 800 g.9 India thus generates approximately 548 tonne of baby diaper waste daily, or 200,000 tonne annually.

CSE estimates that India's consolidated daily generation of sanitary napkins and baby diaper waste (excluding adult diapers, tampons, condoms, incontinence sheets, and similar waste) is approximately 925 tonne, which accounts for 0.65 per cent of total solid waste. Given the increasing volume of sanitary waste, including sanitary napkins, diapers, tampons, condoms, incontinence sheets and similar items, the total percentage of sanitary waste in municipal solid waste could reach approximately up to 3–4 per cent. The percentage may not seem much, but sanitary waste is voluminous and infectious in nature, and plastic is a primary material used in the manufacture of disposable sanitary products, underlining the need for sanitary waste management in India.10 Due to unorganized sanitary waste management in cities and villages, poor source segregation, and inadequate collection, transportation and disposal networks, most sanitary waste ends up in landfills mixed with solid waste or dumped openly, posing significant health and environmental hazards.

1.1 Super Absorbent Polymers (SAPs)

Superabsorbent polymers (SAPs) or hydrogels are loosely cross-linked, three-dimensional networks of flexible polymer chains that carry dissociated, ionic functional groups. They are basically the materials that can absorb fluids of greater than 15 times their own dried weight, either under load or without load, such as water, electrolyte solution, synthetic urine, brines, biological fluids such as urine sweat, and blood.

They are polymers which are characterized by hydrophilicity containing carboxylic acid, carboxamide, hydroxyl, amine, imide groups and so on, insoluble in water, and are cross-linked polyelectrolytes.

Because of their ionic nature and interconnected structure, they absorb large quantities of water and other aqueous solutions without dissolving by solvation of water molecules via hydrogen bonds, increasing the entropy of the network to make the SAPs swell tremendously. The factors that supply absorbing power to polymers are osmotic pressure, based on movable counter-ions, and affinity between the polymer electrolyte and water. The factor that suppresses absorbing power, in contrast, is found in the elasticity of the gel resulting from its network structure. Not only are they of high fluid absorbing capacity, but the absorbed fluid is hard to release, as they merely immobilize the fluid by entrapment rather than by holding it in the structure.

SAPs possess a number of attributes that make them attractive in many different applications. SAPs have supplanted much of the traditional absorbents in infant diapers and have made significant improvements in the performance of feminine hygiene products and adult incontinence products as a result of superior water-absorbing properties. Because of their excellent characteristics, SAPs are widely used in many fields, such as agriculture, horticulture, sanitary goods, and medicine. The basic property of water absorption has suggested the use of SAPs in many other applications, including paper towels, surgical sponges, meat trays, disposable mats for outside doorways and in bathrooms, household pet litter, bandages and wound dressings. The ability of the swollen gels to release the water to the surroundings as vapor has also been used in various ways, for example, as humidity-controlling products or as soil conditioners.

SAPs may also be used to release water soluble substances from within the network structure into the surroundings as a solution. For example, pharmaceuticals and fertilizers may be incorporated into SAPs to yield controlled release products. Another characteristic of the swollen polymer is its rubbery nature, which has been used to control the consistency of products as diverse cosmetics or concrete or to contribute a soft, yet dry, feel to a product like hot or cold packs for sore muscles. The soft, rubbery nature may also be employed to impact sealing properties to products that are in contact with water or aqueous solutions, for example, underground wires and cables. Since they are widely applied not only in the fields of personal care products, bio-sorbent, biomaterial, pharmaceutical, drug delivery systems, but also in agriculture, forestation, industrial, construction, communication industries, and environmental applications, SAPs provide ways for water management for both wanted or unwanted water depending on its particular purposes.

II. Problem Identification

Sanitary waste is a major environmental and health issue that affects communities worldwide. This waste includes items such as sanitary pads, tampons, and baby diapers, which are typically made of plastic and take hundreds of years to decompose. When improperly disposed of, sanitary waste ends up in landfills or is dumped into water bodies, causing serious pollution and health hazards. In addition, improper disposal practices can lead to the spread of diseases and infections, particularly in low-income areas where sanitation infrastructure is inadequate.

2.1 Huge Quantity SAPs

About 90-95% of the total solid wastes in Malaysia are dumped in landfill. Soiled disposable diapers are commonly disposed off in landfill. As shown in Figures 2 and 3, diaper constitutes 10.68 % and 14.35 % weight of KL MSW in 2014 and 2016, respectively. This contributes significantly to the amount of space in the landfill, clogging the landfill as the non-biodegradable disposal diapers will remain buried in the landfill in their original weight, volume and form. The problem of landfilling soiled disposable diapers continues to persist inexorably due to the growing population, rising disposable incomes and increasing demand for convenience. The rising cost of solid waste management and the unavailable landfill space contribute further to the problem.

2.2 Decomposition of Diapers

The disposal diapers due to its durable plastics and superabsorbent polymer require 500 years to decompose. In order to decompose, disposal diapers need to be exposed to sunlight and air. This is not possible even for 'eco-friendly biodegradable' diapers as the modern airtight landfill design necessitate daily compaction and covering of refuse with clean fill and the impermeability of the liners.

2.3 Contamination of Surface and Groundwater

A soiled disposable diaper containing feces increases the threat of the viruses and bacteria leaching into surface and ground water. Leachate containing viruses from human feces could leak into the earth and seep into surface and underground water supplies especially in rainy seasons. Sackey and Meizah reported landfill leachate contaminated with various pathogens such as total coliform, fecal coliforms, Escherichia coli, Salmonella spps, Vibrospp and Bacillus spp. Both Anilkumar et al.and Hossain et al. found the presence of fecal coliform in the ground water located next to landfills. Another potential health hazard is the chemicals incorporated in the diaper leaching out and entering ground and surface water, concentrating at dangerous levels that would pose a health threat. Surrounding groundwater or surface water will get contaminated by leaking leachate from landfills without any proper leachate treatment facilities. Only 3% of Malaysian sanitary landfills have leachate recirculation system and 5% are with leachate treatment whereas the rest are open dumpsites, open-tipping sites and landfills without any leachate treatment. Treated leachates are discharged into the nearby rivers. Yusoff et al.found the groundwater within and surrounding the Ampar Tenang landfill, about 40 km southeast of Kuala Lumpur, contaminated due to the landfill leachate. Tengku Ibrahim et al. finding shows Sembilang River water quality not suitable to be used as water supply as it is affected by the nearby Jeram Sanitary Landfill which has a leachate treatment plant. On 8th July,2017, the Natural Resources and Environment Minister, Datuk Seri Dr. Wan Junaidi Tuanku Jaafar said six solid waste landfills in Malaysia which include the former Taman Beringin landfill was found to have serious leachate contaminant which cause sediment discharged to flow into nearby rivers.

2.4 Health Hazard of Diapers

The mountain of soiled diapers with baby's feces added to landfills each year poses a potential health hazard due to the transmission of communicable disease that might be found in human feces. The viruses in the feces could multiply in the moist and warm environment of the landfill. Hepatitis B and polio viruses from vaccines given to newborns can spread in the landfill. Surrounding communities would be at serious health risk of contracting various diseases. The risk of disease being transferred increases when rodents, flies, insects and birds that are attracted to landfill as they also pick-up the virus and spread it.

III. Objectives

We are focusing on 3 solution which we saw feasible and reduces the environment pollutions caused by the sanitary wastes.

- SAPs in concrete.
- SAPs in agricultural fields
- Residual wastes as fuel pellets.

3.1 SAPs in Concrete

A SAP can ensure very efficient internal water curing, which is defined as "incorporation of a curing agent serving as an internal reservoir of water, gradually releasing it as the concrete dries out."7 Internal water curing has been used for decades to promote hydration of cement and to control the shrinkage of concrete during hardening. Saturated lightweight aggregate was previously the only material used as an internal curing agent. But there are some major problems connected to the use of lightweight aggregates for internal water curing, including difficulties in controlling consistency and significant reductions in strength and elastic modulus. These difficulties are minimized with the use of SAPs.

The shrinkage of concrete due to loss of water to the surroundings is a well-known cause of cracking both in the plastic and in the hardened state. This type of cracking can effectively be mitigated by slowing down or preventing the water loss. By acting as a water source, SAPs may potentially be used in relation to this.

3.2 SAPs in Agricultural Fields

The use of super-absorbent resin reduces soil's water loss, improves water content, and also improves soil conditions to a certain extent. It is conducive to the germination and growth of plant seeds and can significantly increase the output of crops such as grain, cotton, vegetables, and fruits. The water absorption of SAPs includes water absorption ability water absorption speed and moisture absorption ability; its water absorption ability mainly depends on the composition and structure of the water-absorption resin itself, as well as on the salt in the water solution and the water's pH value The polymer absorbent resin becomes a gel after absorbing water. The absorbed water evaporates under natural conditions.

Macromolecule absorbent resin has strong absorption, water retention, and good water retention characteristics. It is applied to the soil to improve soil absorption capacity in irrigation and precipitation, reduce the evaporation loss of soil water, and increase the soil water content.

3.3 Residual Wastes as Fuel Pellets

Fuel pellets are economically efficient, as it is made from waste. They are environmentally friendly. Reduces CO2 by using biomass chips instead of fossil fuel. Chips are made from apparant material (diapers). No hazardous materials are included in the production of fuel pellets. Diapers are made based on burninng after use. They have high calorific value. Diapers include polymer and pulp.By mixing recycled plastics and adjusting the volume, calorific level can be controlled.They are compact. In the form of pellets, they are easy to handle and save space.

IV. Pre-Recycling Processes

The process helps to prepare the waste materials for further processing, ensure the safety of the recycled materials, and reduce the environmental impact of diaper waste. By implementing an effective pre-recycling process, the project can achieve its objectives of promoting sustainability and environmental responsibility while creating valuable new products from waste materials.

Sanitary Waste Collection: The first step in the recycling process is the collection of sanitary waste. Sanitary waste refers to used diapers and other personal hygiene products. The waste is typically collected from households, healthcare facilities, and other locations where it is generated. The collection process involves using specially designed waste collection bins, which are lined with a plastic bag to prevent leakage and odor. The collected waste is transported to the recycling facility for further processing.

Shredding: The second step in the recycling process is shredding. The collected waste is loaded into a shredder, which grinds the waste into small pieces. The shredding process helps to reduce the size of the waste and prepare it for further processing.

Separation of SAP from Cotton: The third step in the recycling process is the separation of SAP from cotton. Diapers are made up of three main components: an outer layer of plastic or cloth, a cotton absorbent layer, and a super absorbent polymer (SAP) layer. The SAP layer is responsible for absorbing large amounts of liquid and locking it away. To separate the SAP from the cotton, the shredded waste is mixed with water and agitated in a tank. The SAP particles separate from the cotton fibers and sink to the bottom of the tank, while the cotton fibers float on top. The SAP particles are then collected and sent for further processing.

Sterilization: The next step in the recycling process is sterilization. After the SAP has been separated from the cotton, both materials need to be sterilized to ensure that they are safe for use in new products. Sterilization involves subjecting the materials to high temperatures or chemical treatments to kill any bacteria or viruses that may be present.

Cleaning: After the materials have been sterilized, the next step is to clean them to remove any remaining contaminants. The cleaning process can involve using water, chemicals, or other cleaning agents to ensure that the materials are free of any residual contaminants.

Drying: Once the materials have been cleaned, the final step is to dry them. Drying is important for ensuring that the materials are free of moisture, which can lead to the growth of bacteria and other microorganisms. The drying process can be done using heat or other drying methods.

V. SAPs In Concrete

Superabsorbent polymers (SAPs) can be used in concrete as an additive to improve the durability and mechanical properties of the material. SAPs are hydrophilic polymers that can absorb water several times their own weight and release it slowly. When added to concrete, SAPs can improve the workability, shrinkage, and cracking resistance of the material.

SAPs work by absorbing excess water in the concrete mix, which reduces the amount of free water in the material. This reduction in free water helps to prevent the formation of voids, which can weaken the concrete and make it more prone to cracking

5.1 Making Concrete

- First, the ingredients for the concrete mix are gathered. For the SAP-added concrete, the mixture will contain 1 part cement, 0.45 parts water, 1.98 parts sand, and 2.71 parts gravel. Additionally, 0.88% of the weight of the cementitious material will be SAP [32].
- The dry ingredients (cement, sand, and gravel) are mixed together thoroughly in a dry mixer.
- Water is then added to the mixture and stirred until the concrete has an even consistency.
- SAP is then added to the mixture, and the concrete is mixed again until it is uniform.
- The concrete mixture is then poured into molds to create the cylindrical, cube, and beam-shaped blocks. The dimensions for each block are given as 30cm x 15cm for the cylindrical block, 15cm x 15cm x 15cm for the cube block, and 10cm x 10cm x 50cm for the beam block (As per Indian standard for testing hardened concrete: IS 1199-1959).
- The molds are then left undisturbed for 24 hours to allow the concrete to set.
- After 24 hours, the molds are removed and the blocks are left to cure for 7 days and 28 days.

5.2 Testing Concrete

Tensile Test: The cylindrical block is used for this test. The block is placed on a testing machine, and a force is applied to the ends of the block until it fractures. The maximum force applied before the block fractures is recorded as the tensile strength of the concrete.

Compression Test: The cube block is used for this test. The block is placed on a testing machine, and a force is applied to the top of the block until it fractures. The maximum force applied before the block fractures is recorded as the compressive strength of the concrete.

Flexural Test: The beam block is used for this test. The block is placed on a testing machine, and a force is applied to the center of the beam until it fractures. The maximum force applied before the beam fractures is recorded as the flexural strength of the concrete.

The above tests are conducted on both the SAP-added concrete and normal concrete after 7 days and 28 days of curing. The results are then compared to determine the impact of SAP addition on the strength of the concrete.

VI. SAPs As Agricultural Water Retainer

Superabsorbent polymers (SAPs) have been increasingly used as an agricultural water retainer due to their ability to absorb and retain large amounts of water. These hydrophilic polymers can absorb water several times their weight and release it slowly, making them ideal for use in agriculture to improve water retention in soil.

SAPs are particularly useful in arid and semi-arid regions where water resources are limited. They can be used in a variety of agricultural applications, including crop production, landscaping, and reforestation. By reducing the amount of water needed for irrigation, SAPs can help to conserve water resources and increase crop yields. As the plants grow, the SAPs slowly release the water they have absorbed, providing a steady supply of moisture to the plants. This helps to reduce the need for frequent irrigation and can improve the growth and health of the plants.

SAPs can also help to reduce soil erosion, increase soil fertility, and improve the structure of the soil. These benefits can help to improve the sustainability of agriculture and reduce the environmental impact of farming practices. The use of SAPs as an agricultural water retainer has the potential to improve water efficiency and increase crop yields, while also promoting sustainable farming practices. As water resources become increasingly scarce, the use of SAPs in agriculture is likely to become more widespread, helping to address the challenges of water scarcity and food security. The soil which we used to find the water retaining capacities are

Normal soil

Soil with cocopeat

Soil with SAPs

6.1 Testing the Water Holding Capacity and Moisture Content Using the Oven Dry Method Involves the Following Steps:

Mix the soil samples thoroughly to create a homogeneous mixture.

Weigh an empty, clean and dry container, such as a small plastic cup, and record the weight as W1.

Add a measured amount of soil to the container and weigh the container and soil together, recording the weight as W2.

Add a measured amount of water to the container and mix the soil and water thoroughly. The amount of water added should be equal to the water holding capacity of the soil. This can be determined by adding water gradually to the soil until it can no longer absorb any more water.

Weigh the container and soil plus water together, recording the weight as W3.

Place the container with the soil and water in an oven at a temperature of 105°C to 110°C for 24 hours.

After 24 hours, remove the container from the oven and allow it to cool to room temperature.

Weigh the container with the dry soil, recording the weight as W4.

Calculate the water holding capacity of the soil using the following formula:

Water holding capacity (WHC) = (W3 – W2) / (W2 – W1) x 100

Calculate the moisture content of the soil using the following formula:

Moisture content (MC) = (W2 – W4) / (W4 – W1) x 100

VII. Fuel Pellets From Residual Wastes

If the residual cotton is able to be separated and collected efficiently, it could potentially be used to produce fuel pellets. Cotton is a renewable resource that has a high energy content and can be easily compressed into a dense pellet form.

There are several ways to create fuel pellets from cotton cloth and fabrics:

Compression: This involves compressing the cotton cloth and fabrics into small pellets using a specialized pelletizing machine. The pellets are then heated to remove any moisture and bind the fibers together to create a solid fuel source.

Briquetting: Similar to compression, this involves compressing cotton cloth and fabrics into briquettes using a specialized machine. The briquettes can then be used as fuel for stoves or boilers.

Carbonization: In this process, cotton cloth and fabrics are heated in the absence of air, resulting in the production of charcoal. The charcoal can then be crushed and formed into pellets for use as fuel.

Pyrolysis: Pyrolysis involves heating the cotton cloth and fabrics in the presence of a catalyst, which breaks down the material into gas, liquid, and solid components. The solid component can then be compressed into pellets for use as fuel.

Torrefaction: Torrefaction involves heating the cotton cloth and fabrics at a low temperature in the presence of a small amount of oxygen. This process removes moisture and volatile compounds, resulting in a solid, denser fuel source that can be compressed into pellets.

VIII. Result And Discussion

The project focuses on the utilization of superabsorbent polymers (SAPs) in different fields such as concrete and agriculture, as well as the utilization of residual waste cotton as a source of fuel pellets. The use of SAPs in concrete and agricultural fields is a promising approach to address water scarcity and improve crop yields, while the utilization of residual waste cotton as a fuel source is a sustainable solution to address the growing energy demand.

The purpose of this project is to investigate the effectiveness of SAPs in enhancing the properties of concrete and improving water retention in agricultural fields. The project also aims to explore the feasibility of using residual waste cotton as a source of fuel pellets. The results of this project can help to inform the development of sustainable and innovative solutions for addressing water scarcity, improving crop yields, and reducing waste.

The project involves experimental investigations of the properties of concrete and soil treated with SAPs, as well as the production and characterization of cotton-based fuel pellets. The results of this project will be analyzed and discussed in terms of their effectiveness, sustainability, and potential for commercialization.

8.1 SAPs in Concrete

Concrete block are made and the tests for tensile, compression and flexural strength were conducted after 7 & 28 days of curing.And the results were noted in tabluar column.

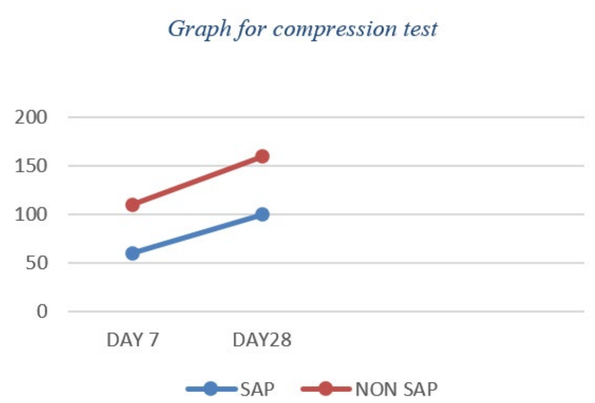
Table.1. Results obtained after 7 days of curing

TEST CONDUCTED	SAPs added concrete (kN)	Reference (kN)
Compression	60	110
Tensile	160	350
Flexural	4	8.5

Table.2. Results obtained after 28 days of curing

TEST CONDUCTED	SAPs added concrete (kN)	Reference (kN)
Compression	100	160
Tensile	300	340
Flexural	16	9

8.2 Compression Test Result



The graph shows the results of a compression strength test conducted on two types of concrete, one with the addition of superabsorbent polymers (SAP) and the other without (Non-SAP). The test was conducted at two different time intervals, 7 days and 28 days, to evaluate the strength of the concrete over time.

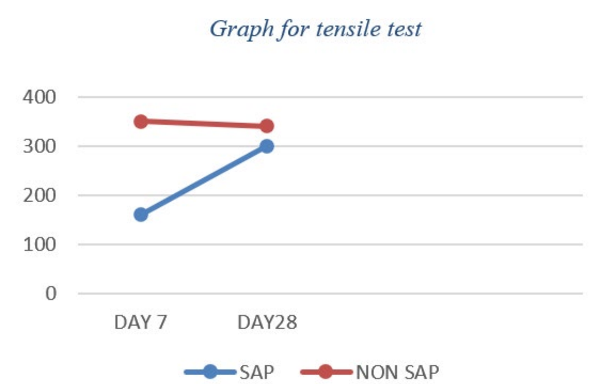
The results of the test indicate that the compression strength of Non-SAP concrete is higher than SAP concrete for both time intervals.

At 7 days, the compression strength of Non-SAP concrete was 110 kN, which is significantly higher than the compression strength of SAP concrete, which was 60 kN. Similarly, at 28 days, the compression strength of Non-SAP concrete was 160 kN, while that of SAP concrete was 100 kN.

These results suggest that the addition of SAP to the concrete mixture had a negative effect on the compression strength of the concrete, especially in the early stages ofcuring. This could be due to the fact that SAP absorbs water, which could have led to a reduction in the amount of water available for the cement to hydrate and bind the aggregates. However, it is important to note that the use of SAP in concrete can still be beneficial in terms of improving the water retention and durability of the concrete over the long term.

Overall, the graph provides important information about the comparative strength of SAP and Non-SAP concrete, which can help to inform decisions about the appropriate use of SAP in concrete applications.

8.3 Tensile Test Result



The graph shows the results of a tensile strength test conducted on two types of concrete, one with the addition of superabsorbent polymers (SAP) and the other without (non-SAP). The test was conducted at two different time intervals, 7 days and 28 days, to evaluate the tensile strength of the concrete over time.

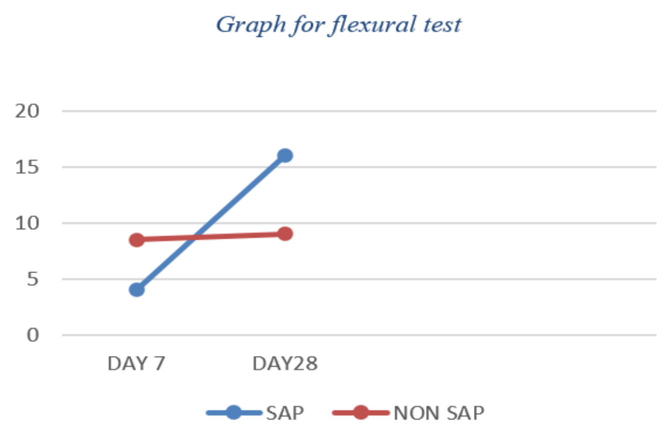
The results of the test indicate that the tensile strength of Non-SAP concrete is generally higher than SAP concrete at both 7 days and 28 days. Specifically, at 7 days, the tensile strength of SAP concrete was 160 kN, which is significantly lower than the tensile strength of Non-SAP concrete, which was 350 kN.

Similarly, at 28 days, the tensile strength of SAP concrete increased to 300 kN, while the tensile strength of Non-SAP concrete decreased slightly to 340 kN.

These results suggest that the addition of SAP to the concrete mixture had a negative effect on the tensile strength of the concrete, especially in the early stages of curing. This could be due to the fact that SAP absorbs water, which could have led to a reduction in the amount of water available for the cement to hydrate and bind the aggregates. However, it is important to note that the use of SAP in concrete can still be beneficial in terms of improving the water retention and durability of the concrete over the long term.

Overall, the table provides important information about the comparative tensile strength of SAP and Non-SAP concrete, which can help to inform decisions about the appropriate use of SAP in concrete applications.

8.4 Flexural Test Result



The graph presents the flexural strength of two types of concrete, namely Self-Compacting Concrete (SAP) and Non-SAP, measured in kilonewtons (kN) at two different time intervals, 7 days and 28 days.

The results indicate that at 7 days, the flexural strength of Non-SAP concrete is higher than that of SAP concrete, with Non-SAP having a strength of 8.5 kN compared to 4 kN for SAP. However, at 28 days, the flexural strength of SAP concrete increases significantly to 16 kN, which is higher than the flexural strength of Non-SAP concrete at 9 kN.

Overall, the results suggest that the flexural strength of SAP concrete is lower than Non-SAP concrete at an early age, but it increases over time and surpasses Non-SAP concrete at 28 days. This finding may be useful for applications where long-term.

strength is more critical than early age strength, such as in the construction of bridges and other infrastructure.

8.5 SAPs as Agricultural Water Retainer

Result of testing the water holding capacity and moisture content of soil, cocopit added soil, and super absorbent polymer (SAP) added soil using the oven dry method is shown in table. Soil water holding capacity (WHC) and moisture content (MC) are two important characteristics that determine the ability of soil to hold and supply water to plants.

WHC refers to the maximum amount of water that soil can hold after it has been fully saturated and excess water has drained away. It is expressed as a percentage of the weight of the dry soil. In other words, it is the amount of water that soil can hold against the force of gravity.MC, on the other hand, refers to the amount of water present in soil at a given point in time. It is expressed as a percentage of the weight of the dry soil. MC can vary depending on factors such as rainfall, temperature, humidity, and soil type.

Table.3. Result for Water holding capacity and moisture content testing

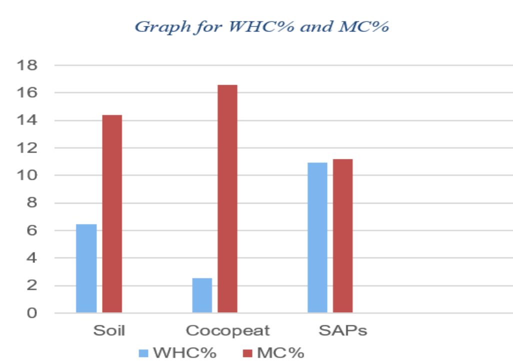
SAMPLE TYPE	WHC (%)	MC (%)
NORMAL SOIL	6.451	14.4
SOIL WITH COCOPEAT	2.533	16.6
SOIL WITH SAPs	10.958	11.2

The results obtained from testing soil for WHC and MC depend on the type of soil and any amendments or additives that have been added. In the given results, it can be seen that:

Normal soil has a WHC of 6.451% and an MC of 14.4%.

Soil with cocopeat has a lower WHC of 2.533% and a higher MC of 16.6%.

Soil with SAPs (superabsorbent polymers) has a higher WHC of 10.958% and a lower MC of 11.2%.



These results indicate that the addition of cocopeat to soil reduces its water holding capacity but increases its moisture content. This is because cocopeat is a highly absorbent material that can hold water well, but it also reduces the space available for water to move through the soil.

On the other hand, the addition of SAPs to soil increases its water holding capacity while decreasing its moisture content. This is because SAPs can absorb large amounts of water and release it slowly, which can help to maintain soil moisture levels over a longer period of time.

8.6 Residual Wastes as Fuel Pellets

In the several ways to create fuel pellets from cotton cloth and fabrics the most efficient one we found effective is using Compression and Briquetting. Because Both compression and briquetting methods are capable of producing pellets with consistent quality and high energy content. They also do not require the use of chemicals or additives, which can be harmful to the environment. Therefore, they are considered better options for making fuel pellets from cotton.

Carbonization and pyrolysis are more complex processes that require specialized equipment and expertise, but they can produce higher-quality pellets with lower moisture content and higher energy density. Torrefaction is a relatively new technology that is still being developed and tested, but it has the potential to produce high-quality pellets with low emissions and good stability.

IX. CONCLUSION

In conclusion, this project focused on recycling sanitary waste through the creation of SAPs in concrete, SAPs in agricultural fields, and residual wastes as fuel pellets. The project aimed to develop an environmentally sustainable method for managing and recycling sanitary waste while addressing issues related to water scarcity and waste management.

The addition of SAPs to concrete had a negative effect on the compression and tensile strength of the concrete, especially in the early stages of curing. However, the flexural strength of SAP concrete increased over time and surpassed Non-SAP concrete at 28 days. This indicates that SAPs could be used in concrete, but careful consideration needs to be given to the curing time and strength requirements of the application.

The addition of SAPs to agricultural fields increased the water holding capacity of soil while decreasing its moisture content. This indicates that SAPs could be used in agriculture to address issues related to water scarcity and soil degradation. The slow release of water from SAPs can help to maintain soil moisture levels over a longer period of time, reducing the need for frequent irrigation and improving plant growth.

The proposal for using residual cotton wastes as fuel pellets offers several methods, including compression, briquetting, carbonization, pyrolysis, and torrefaction. These methods can convert the waste into a valuable resource, reducing the environmental impact of waste disposal and providing an alternative source of fuel. But the most efficient method of all is compression and briquetting.

Overall, this project highlights the potential for recycling sanitary waste through innovative methods that can provide environmental and economic benefits. The use of SAPs in concrete and agricultural fields and the conversion of residual wastes into fuel pellets offer promising avenues for sustainable waste management. However, further research and development are needed to optimize these methods and ensure their viability in practical applications.

In conclusion, this project demonstrates the importance of exploring alternative solutions for managing and recycling waste to address the challenges of water scarcity and environmental degradation. By implementing sustainable waste management practices, we can help to create a more sustainable future for ourselves and future generation.

Future Scope:

The negative effects observed on the strength of the concrete in the early stages of curing suggest that further research is required to optimize the composition of the concrete and minimize these effects.

In the future, researchers could explore the use of different types and concentrations of SAPs in the concrete mixture to determine the most effective combination. The use of effective design of experiment (DOE) techniques, such as Taguchi's robust design method, Response surface method (RSM), Factorial method can help in optimize the composition of the concrete and identify the critical factors that affect its strength. DOE techniques can help to identify the key factors that influence the strength of the concrete and determine the optimal levels of each factor that will produce the desired strength. This approach can save time and resources by reducing the number of experiments required to identify the optimal composition of the concrete. Additionally, future research could investigate the use of other additives, such as fly ash, silica fume, and metakaolin, in combination with SAPs to improve the strength and durability of the concrete. The use of admixtures such as superplasticizers could also be explored to improve the workability and fluidity of the concrete while maintaining its strength.

In conclusion, the future scope of this project includes further research into the composition of concrete containing SAPs and the use of DOE techniques to optimize its strength and durability.

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