International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org, editorijettcs@gmail.com
Volume 7, Issue 2, March - April 2018 ISSN 2278-6856

Study On Replacement Of Sago Waste Water In Roofing Tiles

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Abstract: ***In our project study of possible utilization of sago industry waste water in concrete by analysing their durability properties The basic properties of different stages of effluent such as raw effluent, anaerobic process outlet, and tertiary treated outlet, reverse osmosis feed effluent from the industry were tested and the results were found to be satisfactory such that it can be used for construction purposes. By using the four stages of treated effluent, concrete specimens were casted and tested for its mechanical properties and the results were found to be optimum for anaerobic and tertiary treated outle.***

Keywords: Study, Replacement, Sago Waste Water, Roofing Tiles

1. INTRODUCTION

The physico-chemical characteristics of various sago starch samples from South East Asia were determined and compared to starches from other sources. X-ray diffraction studies showed that all the sago starches exhibited a C-type diffraction pattern. Scanning electron microscopy showed that they consist of oval granules with an average diameter around 30 mm. Proximate composition studies showed that the moisture content in the sago samples varied between 10.6% and 20.0%, ash between 0.06% and 0.43%, crude fat between 0.10% and 0.13%, fiber between 0.26% and 0.32% and crude protein between 0.19% and 0.25%. The amylose content varied between 24% and 31%. The percentage of amylose obtained by colourimetric determination agreed well with the values obtained by fractionation procedures and potentiometric titration. Intrinsic viscosities and weight average molecular weight were determined in 1M KOH. Intrinsic viscosity for amylose from sago starches varied between 310 and 460 ml/g while for amylopectin the values varied between 210 and 250 ml/g. The molecular weight for amylose was found to be in the range of 1.41 £ 106 to 2.23 £ 106 while for amylopectin it was in the range of 6.70 £ 106 to 9.23 £ 106.

The gelatinisation temperature for the sago starches studied varied between 69.48C and 70.18C. The exponent '*a*' in the Mark–Houwink equation and the exponent 'a' in the equation *R*g .*kM*a was found to be 0.80 and 0.58, respectively for amylose separated from sago starch and these are indicative of a random coil conformation. Two types of pasting properties were observed.

The molecular size of amylopectin is almost too large to be determined accurately but light scattering studies indicate a value of 106 D-glucosyl residues permolecule which makes amylopectin one of the largest naturally occurring macromolecules

The granule was shown to be made of stacks of amorphous and semi-crystalline growth rings (120–400 nm thick). The semi-crystalline shells are composed of alternating crystalline and amorphous lamellae repeating in 9–10 nm and superimposed to the architecture of amylopectin Starches from different sources differ in overall structure through size distribution of the granules, shape, amylose and lipid content, distribution of chain length in amylopectin and crystalline structure (crystallinity, polymorphic type, crystal size).

Although modern Factories use a fully mechanical process, traditional methods still play an important role in the starch production.

2. METHODOLOGY

Figure 1 shows the methodology

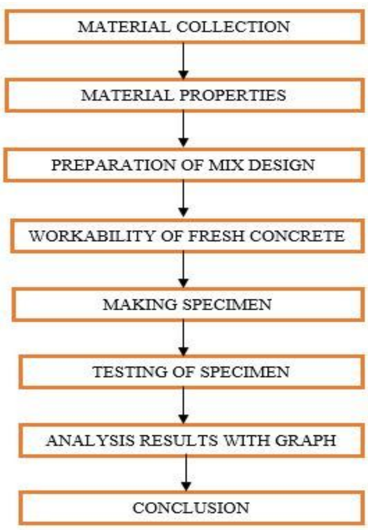

Figure 1 Methodology

3. MATERIALS COLLECTION

3.1 Cement

A cement is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete. Cements used in construction are usually inorganic, often lime or calcium silicate based, and can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).Non-hydraulic cement will not set in wet conditions or underwater; rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting.

3.2 Coarse Aggregate

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and Portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

Aggregates, which account for 60 to 75 percent of the total volume of concrete, are divided into two distinct categories fine and coarse. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8-inch sieve. Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

3.2.1 Composition

Aggregates consisting of materials that can react with alkalies in cement and cause excessive expansion, cracking and deterioration of concrete mix should never be used. Therefore it is required to test aggregates to know whether there is presence of any such constituents in aggregate or not.

3.2.2 Size

The maximum size of a well-graded coarse aggregate of a given mineralogy can have two opposing effects on the strength of normal concrete. Therefore, the result of these two opposing effects when large aggregates are used is only slight. To obtain high strength concrete, coarse aggregate size is usually held to a maximum size of 19 mm, but additional cement is required for the additional surface area. The fine aggregate can generally contain less material passing 300 um and 150 um sieve because of the higher cement content. Proportionally, the amount of fine aggregate should also be somewhat less than that used for normal strength concrete.

3.2.3shape

Shape refers to geometrical characteristics such as round, angular, elongated, flaky, etc. Aggregate particles that are cubicle or spherical in shape and correct mineral composition are ideal for maximizing concrete strength. The use of flat and elongated aggregate particles should be avoided or at least limited to a minimum of 15 percent.

3.3 Fine Aggregate

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. As with coarse aggregates these can be from Primary, Secondary or Recycled sources.

- Grading.
- Durability.
- Particle shape and surface texture.
- Abrasion and skid resistance.
- Unit weights and voids.
- Absorption and surface moisture.

3.4 Fly Ash

Fly Ash is a by-product of the combustion of pulverized coal in electric power generation plants. When the pulverized coal is ignited in the combustion chamber, the carbon and volatile materials are burned off. However, some of the mineral impurities of clay, shale, feldspars, etc., are fused in suspension and carried out of the combustion chamber in the exhaust gases. As the exhaust gases cool, the fused materials solidify into spherical glassy particles called Fly Ash. Due to the fusion-in-suspension these Fly Ash particles are mostly minute solid spheres and hollow ecospheres with some particles even being plerospheres, which are spheres containing smaller spheres.

3.4.1 Advantages of Fly Ash

Fly Ash is a pozzolan. A pozzolan is a siliceous or alumino siliceous material that, in finely divided form and in the presence of moisture, chemically reacts with the calcium hydroxide released by the hydration of Portland cement to form additional calcium silicate hydrate and other cementitious compounds. The hydration reactions are similar to the reactions occurring during the hydration of Portland cement. Thus, concrete containing Fly Ash pozzolan becomes denser, stronger and generally more durable long term as compared to straight Portland cement concrete mixtures. Fly Ash improves concrete workability and lowers water demand. Fly Ash particles are mostly spherical tiny glass beads. Ground materials such as Portland cement are solid angular particles. Fly Ash particles provide a greater workability of the powder portion of the concrete mixture which results in greater workability of the concrete and a lowering of water requirement for the same concrete consistency.

4. MATERIALS AND METHODS

4.1 Scanning Electron Microscopy

Scanning Electron Micrographs (SEM) were obtained ona Deben Genie SEM using powdered starch suspended in 1 : 1 glycerol/water mixtures.

4.2 X-Ray Diffraction

Samples (5–20 mg) were sealed between two aluminum foils to prevent any significant change in water content during the measurement. Diffraction diagrams were recorded using Inel X-ray equipment operating at 40 kVand 30 mA. CuKa1 radiation (l. 0.15405 nm) was selected using a quartz monochromatic. A curved position sensitive detecter (Inel CPS120) was used to monitor the diffracted intensities using 2 h exposure periods. Recrystallised amylose and extruded potato starch were used for A, B and amorphous standards respectively. The measurements were made twice for each starch sample.

4.3 Proximate Analysis

Standard AACC methods (American Association of Cereal Chemists, 1995) were used for the measurement of moisture, ash, fiber and nitrogen. Protein was determined from estimates of total nitrogen using a conversion factor of6.25. Non starch lipids were extracted with petroleum ether (b.p. 408C–608C) for 12 h in a Soxhlet extractor and the solution dried to a constant weight. pH values were determined electrometrically on a suspension of 10 g dry solids in 50 ml of distilled water.

4.4 Determination of Amylose

Amylose in the starch samples was determined by spectrophotometric measurement was carried out at 630 nm instead of 620 nm because the absorbance value was maximum at this wavelength. Standard amylose and amylopectin were purchased from Fluka Chemicals. Solutions of different concentrations were prepared from pure amylose and amylopectin. The amylose content in the starch samples was determined from the standard amylose graph prepared and amylopectin was obtained by difference.

4.5 Intrinsic Viscosity

Amylose and amylopectin samples were dissolved in KOH. All measurements were carried out at 258C. Solutions with concentration of 0.1%–0.4% were prepared, filtered through a 3.0 mm Millipore filter into clean containers and the viscosity determined using a Canon-Ubbelohde semi-micro dilution viscometer size 75. Table 1 shows the characteristics of SAGO waste water.

Table 1: Characteristics of sago waste water

S. No	Characteristics of concern	Standard Level
1	pH	5.5 – 9.0
2	Total Dissolved Solids (TDS)	2100 mg/L
3	Total Suspended Solids (TSS)	100 mg/L
4	Biological Oxygen Demand (BOD)	100 mg/L
5	Chemical Oxygen Demand (COD)	250 mg/L
6	Dissolved Oxygen (DO)	4-6 mg/L
7	Chlorides	1000 mg/L
8	Sulphates	1000 mg/L
9	Calcium	75 mg/L

Figure 2 shows SEM for SAGO starches

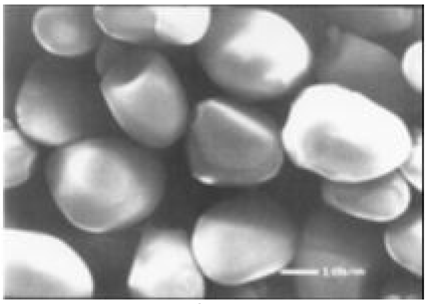

Figure 2 SEM for SAGO starches

4.6 Light Scattering

Amylose and amylopectin samples were prepared in 1 MKOH. The concentration range of the samples depended onthe molecular weight. The initial samples and solvents were filtered through 3.0 mm Millipore filters into clean Burchard cells. All measurements were performed at 258C. All the samples were filtered directly into the measuring cell atleast 3 times using a 0.45 mm Millipore filter. The measuring cell was washed thoroughly with double distilled water and finally with an excess amount of freshly distilled acetone and then dried. During filtration, about 1 ml of the samples were discarded in order to avoid any dust particles from the filter being introduced into the measuring cell and then few mls of the samples were filtered into the cell and the cell was closed using a clean stopper. The cell was then kept in the holder and the laser aligned carefully. The angular dependence of scattering was determined at 108 intervals between 308 and 1508. The actual concentration for all the samples was determined using the phenol–sulphuric acid assay (Dubois et al., 1956). The weight average molecular weights, *M*w were determined from Zimm plots.

4.7 Differential Scanning Calorimetry

Differential scanning calorimetry (DSC) was performed using a micro DSC. Starch samples at 5% on a dry weight basis were prepared and the pH of the suspension adjusted to 5.5 by adding dilute HCl or dilute NaOH. An aliquot of the samples (about 0.95 g) was added into the test cell, the top sealed and the weight recorded. An equal mass of water was added into the reference cell. The cells were heated from 108C to 958C at the rate of0.58C/min.

4.8 Gel Strengths

Starch samples, 6% based on a dry weight basis were prepared by adding the appropriate amount of starch powder to distilled water with constant stirring (400 rpm) and the pH adjusted to 5.5 with dilute HCl or dilute NaOH as appropriate. The samples (200 ml) were immersed in a boiling circulating water bath for 30 min and were stirred at a constant rate of 400 rpm using a mechanical stirring rod. The beaker was reweighed and the volume corrected forany evaporation loss on heating using hot distilled water. The samples were transferred to a storage jar (30 ml) cooled at

258C and stored at that temperature in a circulating water bath before the gel strengths were measured.

5. MIX DESIGN

5.1 Design Stipulations for M20 Grade of Concrete

Grade Designation M-20
Type of cement O.P.C-53grade
Fine Aggregate Zone-I
Sp. Gravity Cement 3.12
Sp. Gravity Fine Aggregate 2.4
Sp. Gravity Coarse Aggregate 2.75

Table 2 shows the mix proportion

Table 2: Mix Proportion

Cement (kg)/m³	FA (kg)/m³	CA (kg)/m³	Waste Water (liter)/m³
383.16	583.076	1162.31	191.58

6. TEST PROCEDURE

6.1 Flexural Strength Test

During the testing, the beam specimens of size 7000mmx150mmx150mm were used. Specimens were dried in open air after 7 days of curing and subjected to flexural strength test under flexural testing assembly. Apply the load at a rate that constantly increases the maximum stress until rupture occurs. The fracture indicates in the tension surface within the middle third of span length. The flexural strength was obtained using the formula (R).

Figure 3 shows the flexural strength test of this study

Figure 3 Flexural strength test

6.2 Water Absorption Test

One of the most important properties of a good quality concrete is low permeability, especially one resistant to freezing and thawing. A concrete with low permeability resists ingress of water and is not as susceptible to freezing and thawing. Water enter spores in the cement paste and even in the aggregate. The permeability of concrete is a measure of the rate at which liquid pass through it. The permeability of concrete depends upon its pore network, which arises from the excess water used during mixing and during initial hardening process. The overall porosity includes closed or logged pores in addition to a network of inter connected pores. Pore size ranges from a few angstroms to about 100 A^0 for the so called 'gel pores', from 100 to 100000 A^0 in 'capillary pores' and a few millimeter in 'air or large pores'. Inter connected pores endow the concrete permeability.

All the hydrated cement products are subjected to attack by sulphates, chlorides, and acids and less by water. This is because of low equilibrium solubility of the hydrated components and low mass transfer of well cured concrete. It is a usual practice to assess the water permeability characteristics when assessing the durability characteristics. Permeability can be measured by conducting standard test methods.

6.3 Permeability Test

- A concrete permeameter apparatus consisting of the following basic components.
- A permeameter cell which can maintain a seal over the circumference of a saturated cylindrical concrete specimen and which is capable of operating effectively under pressures of up to 1000kPa.
- A means of supplying de-aired water to the top surface of the concrete specimen contained within the permeameter cell at a constant pressure head of up to 1000kPa.
- A pressure gauge to measure input pressure and a thermometer to measure ambient temperature.
- Data acquisition equipment to record, at suitable intervals of time, the pressure, volumetric flow of water into and out of the concrete specimen and the ambient temperature.

6.4 Fire Resistant Test

A specimen which is used for construction should not flammable in open flame, so this test was carried out for the bricks. This test was carried out only for fibrous concrete bricks not for adobe specimen. Because adobe specimen was already heated in kiln at high temperature so, it won't burn.

The following are the steps involved in this test.

- First, the specimen was wiped with cloths and all the foreign matters were removed.
- Then the flammable sticks were fired. After that, the specimens were held on the flame for five minutes.
- After five minutes fixing was stopped and the specimens were observed.

Figure 4 shows the fire test.

Figure 4 Fire test

From the above test, it was observed that the fibrous concrete bricks did not burn with an open flame. They smoldered like charcoal. But these brick would be reduced to ashes after burning several hours. If the interior plaster and exterior stucco is provided on the fibrous concrete bricks, the bricks won't burn. The only weak point is inside the block, near electrical outlets, switches and other places where wires gives through walls, into boxes etc. Properly wired places never cause fire. If we apply the plaster without any hole or leakage on the specimen, it won't burn or smolder inside. Because there will be lack of oxygen for burning.

7. TEST RESULT

7.1 Fire Resistant Test

Table 3 shows the fire resistant test

Table 3: Fire resistant test

GRADE	TIME in "hour"	TEMPERATURE
M_{20}	2	17
	3	20
	4	23
	5	56

Figure 5 shows the graph of fire resistant test

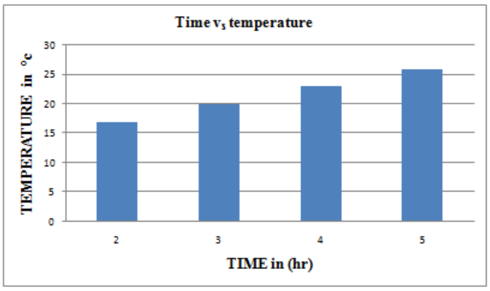

Figure 5 Fire resistant test

7.2 Water Absorption Test

Table 4 shows the water absorption test

Table 4: Water absorption test

Sample	0%	10%
Water absorption (%)	3.41	3.52

Figure 6 shows the graph of water absorption

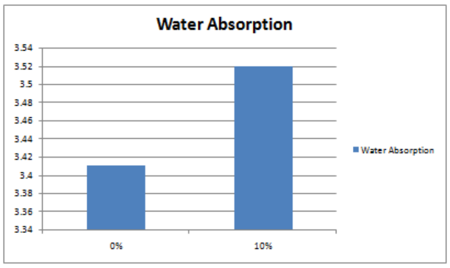

Figure 6 Water absorption (%)

7.3 Permeability Test

Table 5 shows the permeability test

Table 5: Permeability test

Time	Permeability (cm/sec)
15	0.16
20	0.18
25	0.17
30	0.14

Figure 7 shows the graph of permeability test

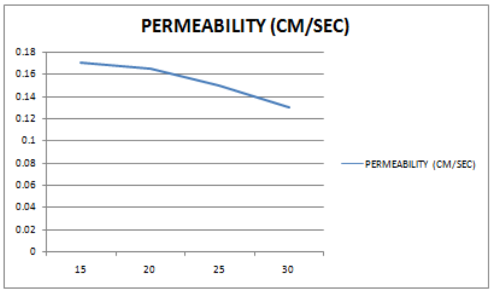

Figure 7 Permeability test

7.4 Flexural Strength Test:

Table 6 shows the flexural strength test

Table 6: Flexural strength test

Sample	0%	10%
Flexural Strength(N/Mm^2)	8	8.3

Figure 8 shows the graph of flexural strength test

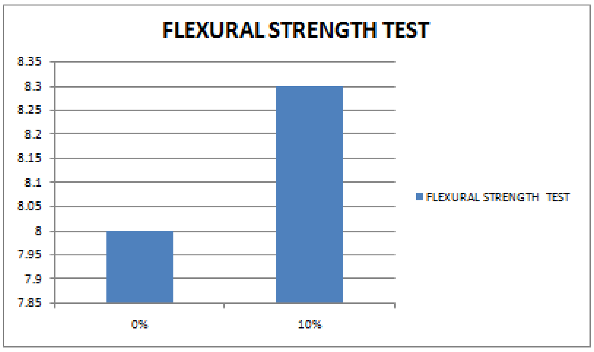

Figure 8 Flexural strength test

8. CONCLUSION

All roof tiles should be designed and tested to conform to the Australian Standards AS 2049-2002 and AS 4046-2002. Tiled roofs combine superior durability, color fastness and strength with a long life. They also help reduce the intrusion of external noises, provide protection against radiant heat in a bushfire, have high levels of thermal insulation, and offer more resistance to wind suction than lightweight sheets. Due to lower thermal mass and thermal conductivity of bare RCC roof, heat entering the room was higher and the roof was more sensitive to solar heat flux variation.

- From experimental results both water absorption & flexural strength will be 3.52, 8.3 N/mm^2 increases at 10% replacement compared to conventional mix.
- If the time increases permeability will decreases as 0.14 cm/sec at 30mins.
- Fire resisting capacity of panel will be higher at 56 in 5hrs duration.

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