Recycling Tetrapak into Ecofriendly Building Materials

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***Abstract*—A big challenge for Civil Engineering nowadays is to procure for the development of a construction material that is both sustainable and resistant. One of the most significant components, that threatens the future of the world are solid wastes. One of the segments of waste that is generated are Tetra Pak cartons that are used for food pakaging. Tetra Paks are primarily made from paper from which 75% of the tetra Pak carton is made from paperboard, 20% of polyethylene and 5% of aluminium. According to a study conducted by TERI on the used beverage carton (UCB) management, it was found out that the recycling rate in India was found out to be 54% in the year 2019. In their study they gave the result of active and inactive recycling process of UBCs, that is, active recycling is 31% and inactive recycling is 23%. Hence in this project an attempt was made to produce boards from the Tetra Pak waste without the use of any resin as a binder but allowing the melted aluminium foil and polyethylene present in the tetra pak to act as a binder. These boards could be used as a paneling material for a building. Parameters like compressive and flexural strength, swelling index, flame test etc. was found out and compared with the conventional board. It was concluded that such material could be used in light weight construction**

***Keywords*—Tetra Pak, paneling material, resin.**

INTRODUCTION

A big challenge nowadays in the Civil Engineering industry is to procure for the development of a construction material that is sustainable and resistant. Solid waste are one of the most significant components that threatens the future of the world. Unfortunately, technological developments and growing population of the world has resulted in an increase in solid wastes. Also, the changes in consumption habits affect the composition of the waste. It is also a well-known fact that such waste is a substantial global problem that needs to be urgently addressed.

In India recycling rates is high, it is due to the rising market demands for low price products that about 27% paper and 60% of plastic is recycled. However, this requires a lot of attention because Indian cities generate around 1,61,000 tonnes of Municipal Solid Waste every day, which ends up in landfills. Tetra Pak cartons which are used for food packaging is one of the main segments of waste. A study conducted by The Energy and Resources Institute (TERI) on the used beverage carton (UBC) management for Tetra Pak found out that the recycling rate in India for the year 2019 was 54%. The total UBCs generated in that year was 18272 tonnes, they also found out the total amount of UBCs uncollected and unrecovered was 9136 tonnes for that year. In their study they also gave the result of active and inactive recycling process of UBCs that is active recycling is 31% and inactive recycling was found out to be 23%. Based on these figures we can say that soon India may require land of the size of Delhi for the increasing waste. Due to this worsening situation, it is required to move back material to circular economy loop through recycling. This will help in conserve resource such as water and energy, lower greenhouse gas emissions and also it will help in reducing waste burdens from cities and recover valuable materials.

I. MATERIAL AND METHODOLOGY

Tetra Pak

Tetra Pak cartons are primarily made from paper from which 5% is aluminium, 20% is polyethylene, 75% of the Tetra Pak carton is made from paperboard. These materials are layered together using pressure and heat to form a six layered armour which protects the contents from light, oxygen, air, dirt and moisture. The advantage of Tetra Pak cartons are that they are easy to transport, fully recyclable and lightweight. The advantage of tetra pak is that their aseptic technology allows the product inside to stay fresh, without the need of any preservatives.

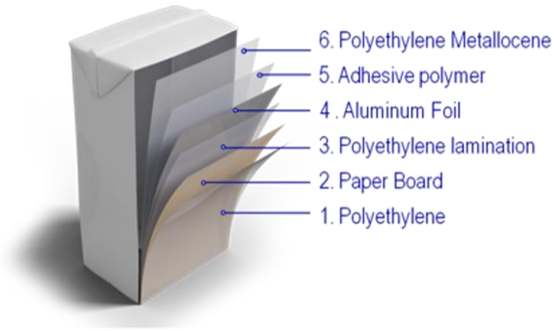

Fig 1: Layers of Tetra Pak.

1) Polyethylene - protects against outside moisture
2) Paperboard - for stability and strength and smoothness
3) Polyethylene - adhesion layer;
4) Aluminium foil - oxygen, flavour and light barrier
5) Polyethylene - adhesion layer
6) Polyethylene - seals in the liquid.

II. METHODOLOGY

It is normally seen that boards made from tetra pak material are made by collecting raw material, cleaning and drying, shredding the tetra pak pieces, blending with resin, moulding and pressing using hydraulic press machine, cooling the board and letting it to finish. The methodology of casted tetra pak board adopted is

collecting raw material

Cleaning: Cartons should be cleaned properly to remove any unwanted materials present in cartons such as milk, juice etc. two or three times. It should be cleaned with clean water.

Drying

Shredding: Shredding of tetra pak cartons into small pieces. The size of the tetra pak should be uniform for better binding with each other.

Moulding: Boards were made in required size and thickness

Heating: once the shredded pieces are properly placed in the moulds the hot press machine is kept at 170^0C to 180^0C for 5 to 7min at 25 kg/cm sq.

Cooling: Then it is cooled at room temperature.

The conventional board considered is 10 x 10x 0.8 cm with resin as a binder material and the casted boards size is 7.0 x 7.0 x 1.5 cm without using resin as a binder but allowing the melted alumninium and polyethylene to act as a binder.

III. TEST

Flexure Test.

Three-point bending test setup was used for conducting flexural test. The tests were performed using an IMAL universal testing machine. Flexural strength of all tested samples was determined. Five specimens of each sample were used and their average values reported.

Thickness Swelling and Water Absorption and.

Thickness swelling, density and water absorption of the composite's boards were determined. The water absorption and thickness swelling test samples were measured and weighed. Specimens were immersed in water at a temperature of 20°±1°C. Thickness swelling and water absorption and performance of the composites were determined after 2 hours and 24 hours immersion period. Thickness swelling and water absorption values of the specimens after 2 hours and 24 hours water soaking period were calculated based on the weight and initial thickness of each specimen.

Density test

This test is conducted on the specimen immediately after taking out the specimen from the heating condition. Weigh the Tetra Pak board on the weighing machine (W). Find the volume of the board (V). Calculate density.

Compression Test

The boards are taken out of hot press and kept for cooling.
The dimension of the boards are measured accurately.
The specimen is centrally placed on the platform in such a way that the load is applied on the other sides of boards as casted except top and bottom.
The load is applied gradually and the load at which the specimens fail is noted.
Three such specimens are tested for compressive crushing strength in the same manner as described above and the average compressive strength is determined.

Fire Test

Light a candle. Then the test specimens' edge is held horizontally over the flame for about 60 seconds. Observe the specimen to note the changes in its physical characteristics check if the board catches fire, if there is release of smoke, change in colour of flame, check for any sort of distortion or deformation of the board.

Drilling Test

Take the specimen and tighten the board. Mark the point to be drilled. Drill the marked spot using different types of drill bits. Check and note the any sort of distortion of the Tetra Pak boards

IV. RESULTS

According to the compressive strength test conducted on both conventional tetra Pak board and casted tetra Pak board it was noted that the casted tetra Pak board showed compressive strength of 6.19 N/mm^2 compared to conventional tetra Pak board which had compressive strength of 4.0 N/mm^2.
The flexural test conducted on conventional tetra Pak board and casted tetra Pak board gave results which showed that the casted tetra Pak board had flexural strength of 0.97 N/mm^2 and conventional tetra Pak board has flexural strength of 0.067 N/mm^2 .
The density of the conventional tetra Pak board and casted tetra Pak board was seen that the density of casted tetra Pak board was 1.14 kg/cm^3 and the density of conventional tetra Pak board was 8.75 kg/cm^3.
Moisture content test conducted on both the boards, showed that moisture content of casted tetra Pak board was 5.63% and the moisture content of conventional tetra Pak board was 4.28%. Fire test on casted boards is slight fumes were observed the board did not catch fire on exposure to flame for 60 seconds the layers of the board were intact and the board did not produce any residue.

Conventional tetra Pak board and casted tetra Pak board were immersed in water for 24 hours, then water absorption test and swelling test were conducted which gave the results that casted tetra Pak board showed more water absorption and swelling i.e., 39.86% and 9.75mm respectively, and conventional tetra Pak board had less water absorption and swelling i.e., 23.85% and 16.62mm respectively.

V. CONCLUSION

From the experiments conducted during the course of the project, by casting tetra Pak boards and comparing its physical characteristics with the conventional tetra Pak board we can conclude that by increasing the thickness of the conventional board from 0.8 cm to 1.5 cm and without using a resin as a binder which is traditionally used in boards the casted boards can be advantageous for using as wall boarding material. In the casted board the aluminum and polyethylene from the Tetra Pak melts and acts as a binder.

It may be noted that overexposure to epoxy resins fumes released from the conventional boards that may be used as a walling material may cause dermatitis, severe irritation, chemical burns and respiratory irritation when the boards are susceptible to fire in case of a fire hazard.

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