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Utilizing Tetrapak Recyclables in Sustainable Building Practices

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Abstract

In contemporary Civil Engineering, a pressing challenge lies in developing construction materials that meet the dual criteria of sustainability and durability. The accumulation of solid waste stands as a significant threat to the global environment. Among these waste streams, Tetra Pak cartons, commonly employed in food packaging, contribute substantially. Comprised mainly of paper, with paperboard constituting 75% of its composition, polyethylene 20%, and aluminum 5%, Tetra Paks pose a recycling challenge. Recent research by TERI on used beverage carton (UCB) management revealed a recycling rate of 54% in India in 2019, with active recycling at 31% and inactive recycling at 23%. In response, efforts were made to explore innovative uses for Tetra Pak waste in construction material development. This involved crafting boards without conventional resin binders, relying instead on the adhesive properties of melted aluminum foil and polyethylene inherent in Tetra Paks. These boards show promise for construction panel applications, with tests conducted on compressive and flexural strength, swelling index, flame resistance, and other parameters comparing favorably to standard boards. These findings suggest the potential for integrating this material into lightweight construction practices.

Keywords: *Tetra Pak, Construction Practices, TERI, Shredding, Molding, Construction Panel*

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INTRODUCTION

A major problem in the Civil Engineering sector nowadays is the creation of a sustainable and resistant building material. Solid waste is one of the most crucial components endangering the world's future. Unfortunately, technological advancements and the world's rising population have resulted in an increase in solid waste. Changes in consumer habits also have an impact on the composition of garbage. It is also common knowledge that such trash is a major worldwide issue that must be addressed immediately.

Recycling rates in India are high, owing to increased market needs for low-cost items, with around 27 per cent of paper and 60 per cent of plastic recycled. However, because Indian towns create around 1,61,000 tonnes of Municipal Solid Waste every day, which ends up in landfills, this demands a great deal of attention. Tetra Pak cartons, which are used for food packing, are a major source of trash. According to research done by The Energy and Resources Institute (TERI) on used beverage carton (UBC) management for Tetra Pak, the recycling rate in India in 2019 was 54 per cent. The entire quantity of UBCs created in that year was 18272 tonnes, while the total amount of UBCs uncollected and unrecovered was 9136 tones. In their study, they also provided the results of the active and inactive recycling processes of UBCs, with active recycling accounting for 31% and inactivity recycling accounting for 23%. Based on these data, we might conclude that India would soon require land the size of Delhi to accommodate the growing trash. As the situation worsens, it is necessary to return materials to the circular economy loop through recycling. This will assist in saving resources such as water and electricity, reduce greenhouse gas emissions, and reduce waste loads in cities while recovering valuable materials.

MATERIAL AND METHODOLOGY

Tetra Pak

Tetra Pak cartons are mostly comprised of paper, with 5% aluminium and 20% polyethene. The remaining 75% of the Tetra Pak carton is made of paperboard. Using pressure and heat, these materials are placed together to produce a six-layered armour that protects the contents from light, oxygen, air, dirt, and moisture. Tetra Pak containers have the advantage of being lightweight, easy to carry, and 100% recyclable. The benefit of the tetra pack is that its aseptic technique keeps the goods inside fresh without the need of preservatives.

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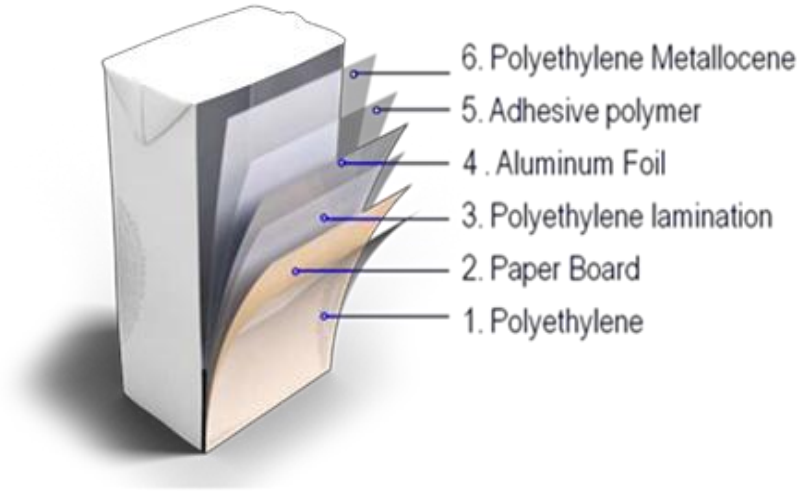


Fig 1: Layers of Tetra Pak.

1. Polyethylene - safeguards against external moisture
2. Paperboard - for sturdiness, strength, and smoothness
3. Polyethylene - a layer of adherence;
4. Aluminium foil - Barrier to oxygen, flavour, and light
5. Polyethylene - a layer of adhesion
6. Polyethylene - keeps the liquid within

METHODOLOGY

Boards constructed of tetra pack material are typically created by gathering raw material, washing and drying it, shredding the tetra pak pieces, combining with resin, moulding and pressing using a hydraulic press machine, chilling the board, and allowing it to dry. The casted tetra pack board approach used is collecting raw material.

Cleaning: Cartons should be thoroughly washed two or three times to eliminate any undesired elements such as milk, juice, and so on. Clean water should be used to clean it.

DRYING

Shredding: Tetra Pak boxes are shredded into little bits. The size of the tetra paks should be consistent for improved adhesion.

Moulding: Boards of the requisite size and thickness were created.

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Heating: Once the shredded pieces are appropriately inserted in the moulds, the hot press machine is set to 1700°C to 1800°C for 5 to 7 minutes at a pressure of 25 kg/cm square.

Cooling: It is then chilled to room temperature.

TEST

Flexure Test.

Flexural testing was carried out using a three-point bending test rig. The tests were carried out with the aid of IMAL universal testing equipment. Flexural strength was evaluated for all examined samples. Each sample had five specimens, and the average results were presented.

Thickness Swelling and Water Absorption and

The composite boards' thickness, swelling, density, and water absorption were measured. The water absorption and swelling test samples were weighed and measured. Specimens were submerged in water heated to 20°±1°C. After 2 hours and 24 hours of immersion, the thickness, swelling, water absorption, and performance of the composites were measured. Based on the weight and starting thickness of each specimen, the thickness swelling and water absorption values were computed after 2 hours and 24 hours of water soaking.

Density test

This test is performed on the specimen soon after it has been removed from the heating environment. On the weighing machine, weigh the Tetra Pak board (W). Determine the board's volume (V). Density should be calculated.

Compression Test

The boards are removed from the hot press and allowed to cool. The dimensions of the boards are precisely measured. The specimen is centred on the platform such that the weight is given to all sides of the boards except the top and bottom.

The stress is gradually applied, and the load at which the specimens fail is recorded. The compressive crushing strength of three such specimens is tested in the same manner as described before, and the average compressive strength is calculated.

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Fire Test

Make a candle. The edge of the test specimen is then held horizontally above the flame for about 60 seconds. Take note of any changes in the specimen's physical properties. Check for any signs of fire, smoke, or a change in the colour of the flame, as well as any distortion or deformation of the board.

Drilling Test

Tighten the board around the specimen. Mark the drilling location. Drill the designated area using several types of drill bits. Examine the Tetra Pak boards for any signs of deformation.

RESULTS

According to the compressive strength test results on both conventional tetra Pak board and casted tetra Pak board, the casted tetra Pak board had a compressive strength of 6.19 N/mm2, whereas the traditional tetra Pak board had a compressive value of 4.0 N/mm2.

Flexural tests on conventional tetra Pak board and casted tetra Pak board revealed that the casted tetra Pak board had a flexural strength of 0.97 N/mm2 while the traditional tetra Pak board had a flexural strength of 0.067 N/mm2.

The density of conventional tetra Pak board and casted tetra Pak board was found to be 1.14 kg/cm3 for casted tetra Pak board and 8.75 kg/cm3 for conventional tetra Pak board.

Moisture content tests on both boards revealed that the moisture content of casted tetra Pak board was 5.63 per cent, and that of traditional tetra Pak board was 4.28 per cent. In a fire test on casted boards, small vapours were seen, but the board did not catch fire after 60 seconds of exposure to flame. The layers of the board remained intact, and the board did not generate any residue.

The normal board is 10 x 10 x 0.8 cm with resin as a binder material, while the casted boards are 7.0 x 7.0 x 1.5 cm without resin as a binder but with melted aluminium and polyethylene acting as a binder.

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Water absorption and swelling tests were performed on conventional tetra Pak board and cast tetra Pak board after they were immersed in water for 24 hours. The results showed that casted tetra Pak board had more water absorption and swelling, 39.86 per cent and 9.75mm, respectively, and conventional tetra Pak board had less water absorption and swelling, 23.85 per cent and 16.62mm, respectively.

CONCLUSION

By casting tetra Pak boards and comparing their physical properties to 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 use as wall boarding material. The aluminium and polyethylene from the Tetra Pak melt and act as a binder in the casted board. Overexposure to epoxy resin fumes emitted by typical boards that may be used as a walling material may cause dermatitis, severe irritation, chemical burns, and respiratory irritation if the boards are sensitive to fire in the event of fire danger.

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