

Study on the Scope of Recycled Plastic Roof Tiles in the Civil Construction Market

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Abstract -This research mainly focuses on the use of roof tiles made of recycled plastic, its effects on the environment, the pros and cons of using recycled materials, the sustainability, etc. This would help us understand the use of safe and environmentally friendly materials. With the use of safe roof tiles, it would help to reduce the amount of environmental pollution and it would also reduce the plastic waste. Plastic waste is becoming a very big global issue, so the use of products made out of recycled plastic would help in reducing the plastic waste effectively and efficiently. The paper mainly focuses on the need for such a research and its relevance in the current era. Most of the data used in this research has been collected in the form of questionnaires. The target audience for this research would be the architects who support environmentally sustainable and friendly products and for those people who are interested in finding a cheap and long lasting roofing material. These products would be mainly suitable for customers who are looking for an elegant and aesthetic appearance for their houses or offices. This research would help us understand the acceptance or the awareness of the public to such eco-friendly products.

Keywords -Plastic; Recycled plastic; Roof tiles, PET, Civil construction, Construction.

INTRODUCTION

The construction industry is one of the most resource-intensive sectors globally, contributing significantly to environmental degradation. The use of traditional building materials such as cement, steel, and clay tiles lead to the depletion of natural resources, which affects both the environment and society. Therefore, there is a growing demand for sustainable construction practices that reduce waste, conserve natural resources, and minimize the environmental impact of construction. In this context, recycled plastic roof tiles have emerged as a promising solution. This research

paper aims to investigate the scope of recycled plastic roof tiles in the civil construction market. The study focuses on evaluating the feasibility of using recycled plastic as a raw material for manufacturing roof tiles, as well as the environmental and economic benefits of using recycled plastic roof tiles. The research paper draws on existing literature on recycled plastic roof tiles, examining their properties, durability, and potential as a sustainable construction material.

Previous studies have highlighted the potential of recycled plastic roof tiles as a sustainable alternative to traditional roofing materials. For example, Roy and Varghese (2018) found that recycled plastic roof tiles have similar properties to traditional roof tiles, making them a viable option for use in the construction industry. They concluded that recycled plastic roof tiles were durable, lightweight, and could withstand harsh weather conditions. Additionally, these tiles were also found to be easy to install, making them an attractive option for builders.

More recently, Sridhar and Dhanalakshmi (2021) evaluated the feasibility of using recycled plastic for roof tile manufacturing. The study found that recycled plastic roof tiles were lighter and more durable than traditional roof tiles. The researchers also noted that the use of recycled plastic roof tiles had a positive impact on the environment by reducing waste and decreasing the demand for natural resources.

Building on the existing literature, this research paper aims to contribute to the understanding of the potential of recycled plastic roof tiles in the civil construction market. The study provides insights into the environmental and economic benefits of using recycled plastic roof tiles and explores their potential to reduce waste and promote sustainable construction practices.

BACKGROUND OF STUDY

Recycled plastic roof tiles have been the subject of research for many years. In 2009, researchers found that recycled plastic roof tiles had excellent potential as a roofing material. They concluded that recycled plastic roof tiles were durable, lightweight, and could withstand harsh weather conditions. Additionally, these tiles were also found to be easy to install, making them an attractive option for builders.

More recently, a study by Roy and Varghese (2018) examined the potential of using recycled plastic as a raw material for manufacturing roof tiles. The study found that recycled plastic roof tiles had similar properties to traditional roof tiles, making them a viable option for use in the construction industry. The researchers also noted that recycled plastic roof tiles had the potential to reduce waste and environmental degradation.

RESEARCH QUESTIONS

The questions are as follows:

Have you heard of roofing tiles made of plastic?

In your opinion, how durable do you think plastic roofing tiles are compared to traditional roofing materials?

How important is the appearance of your roof to you?

Would you be willing to pay more for plastic roofing tiles if they were proven to be more durable than traditional materials?

How concerned are you about the environmental impact of the materials used for roofing? Would you consider purchasing plastic roofing tiles if they were environmentally friendly? How important is the cost of the roofing materials to you?

How important is the ease of installation of the roofing materials to you?

Would you consider purchasing plastic roofing tiles if they were priced similarly to traditional roofing materials?

Would you consider purchasing plastic roofing tiles if they were easy to install and required minimal maintenance?

What is your opinion about the Eco-friendly roofing tiles?

PRODUCT DEVELOPMENT

The design and development of the roofs made of

recycled plastic involved a rigorous process to ensure the product's sustainability and durability. The roofs are made of high-density polyethylene (HDPE) and other recycled plastics that are cleaned and processed to ensure they meet the product's required specifications. The product's design includes interlocking panels, which make installation easy and quick, reducing installation costs and time. The roofs are also designed to be lightweight, reducing the load on the building structure.

MARKET RESEARCH

Before the launch of the product, extensive market research was conducted to determine the target market and the product's potential demand. The research revealed that there is a high demand for sustainable roofing materials among homeowners, commercial building owners, and contractors. The product's sustainability, affordability, and ease of installation were identified as significant selling points, making it an attractive option for environmentally conscious customers.

LITERATURE REVIEW

1.(G. O. Bamigboye, 2019) This study investigates the effects of using river sand and PET into the production of roofing shingles. According to the results, recycled PET beats conventional Portland cement at 28 days for 40 and 50 percent plastic composite tile. Strong and absorbent, the plastic roof tiles are suitable for roof tiling. Construction materials include clay, fine aggregates, lumber, coarse aggregates, concrete, reinforcement, steel, and roofing tiles. A roof is necessary for every structure because it protects the interior from all forms of weather.

In order to properly cover a roof, the appropriate material must be utilised. Recycling PET may be utilised as insulation and roofing material in the building sector due to its low thickness, low cost, and ease of production.

2.(Paige Balcom, Juliana Mora Cabrera, Van P. Carey, 2021) In this study, the environmental effects of end-of-life disposal and recycling of plastic/sand roof tiles in Uganda are compared. The study determined that the combining of waste plastic and sand tiles into motorways, followed by pyrolysis, which saved 11,303 MJ/ton of net energy, was the optimal method. Recycling the tiles into pavers resulted in a positive

net exergy value, but burying, depositing in a landfill, and incinerating all resulted in negative values. Planting trees utilizes 0.7% of the energy currently consumed by CO₂ scrubbers in industrialized nations to remove CO₂ from the air. This study may be useful for policymakers, international organizations, and non governmental organizations deciding how to manage solid waste in less industrialized nations.

3. (Rosana Gaggino, Jero'nimo Kreiker, Celina Filippi'n, Mari'a Paz Sa'nchez Amono, Julia'n Gonzalez Lari'a and Lucas Ernesto Peisino, 2018) When Mesopotamian cultures first produced clay roofing tiles, they were superior than straw, branch, and leaf roofs in their ability to endure rain. Since then, roof tiles have been widely employed. The use of color mixtures to make tiles of diverse hues began in the nineteenth century. In terms of cost, simplicity of installation, durability, and color options, concrete roofing tiles outperform ceramic tiles. Nevertheless, they are heavier and require a more robust and costly support structure. From the start of the twentieth century, zinc sheet has been used in residential construction due to its low cost, watertightness, and impact resistance. Plastic roofing tiles have been utilized in high-tech building due to their high-tech character.

4. (Anjerick Topacio, M.Eng, Rochelle C. Arkuino, Katherine V. Romano, and Jayvee C. Abutin, 2018) This study investigated the optimal mix ratio for roof tile components to achieve the required engineering characteristics of light weight, strength, and water resistance. It allowed Expanded Polystyrene plastic to be substituted for concrete in the production of roof tiles that correspond to ASTM specifications. Due of its visual appeal and ability to meet recycling goals, tile roofing is a popular choice for a new roof. Owing to the high price of cement, the purpose of this study is to determine if recovered EPS plastic waste may serve as a binder for concrete. Aggregates for roofing tiles. In addition, water absorption, density, compressive strength, and flexural strength must be determined.

5. (Diptikar Behera, Yirgalem Damtew, Aman Mola, 2018) To protect natural resources and the environment, researchers are looking at the usage of substitute materials. The purpose of this study is to evaluate the effectiveness of recycling used plastic and glass in the creation of hollow plastic blocks, roof tiles, and floor tiles (HPB). Using these waste materials

helps to lower the cost of producing concrete, which contributes to a partial solution to environmental and ecological issues. Indirect advantages of recycling this material include lower disposal costs, energy savings, and environmental protection from potential contamination consequences. Encouragement of recycling and reuse of wastes as useful goods should be looked at to develop recyclable materials into building material.

Environmental and ecological difficulties can be partially resolved by substituting fine river sand for aggregate. The results of a quality control test indicate that molten plastic waste with a ratio of 30% glass and 70% sand produces superior and high-quality roof tiles, while molten plastic waste with a ratio of 32% glass and 68% sand is preferable for low traffic zone floor tiles. When heated, plastics may be moulded into various forms and produce garbage, which can have detrimental consequences on both human and plant life. Plastic management allows for the appropriate disposal and recycling of these materials.

6. (Omosobi Taiwo, Noor Faisal Abas, 2022) This study examines the possibility of creating tiles from PET waste bottles and POFA (Palm oil fuel ash). Several quantities of PET waste were combined with POFA by weight (30% to 100%). After analyzing the physical and mechanical features of the tiles, it was determined that 30% PET tiles had the maximum compressive strength, 8.37 N/mm², while 100% PET samples had the lowest compressive strength and water absorption value (0.12%). All produced tiles exceed ceramic and pure cement tiles in terms of longevity, and they all have extremely low water absorption rates. This might reduce the price of building materials and serve as a waste diversion to mitigate the environmental damage caused by plastic waste.

7. (Christie L Balogh, 1996) Using recycled materials to create residential homes is a revolutionary concept. The Green Builder Program is the first environmental building grading system in the United States, quantifying the amount of recycled materials utilized in construction projects. It proposes seven building principles to conserve materials: buy timber only from sustainably managed forests; choose materials that require little energy to move from raw material to delivered product; avoid materials that are toxic to people and the environment; choose products engineered to save raw materials;

choose products made from recycled and recyclable materials; use locally produced materials; and utilize durable and long-lasting materials. In 1992, the National Association of Home Builders (NAHB) created the Resource Conservation Research House as a component of a buyer and consumer.

SUMMARY OF REVIEW

One possible research gap for a study on the scope of recycled plastic roof tiles in the civil construction market is the lack of studies that have explored the potential of using recycled plastic roof tiles as a sustainable and cost-effective alternative to traditional roofing materials. While there is some literature on the use of recycled materials in construction, there may be few studies that have specifically focused on recycled plastic roof tiles.

For example, a study by Natarajan et al. (2019) investigated the mechanical properties of concrete roof tiles made from recycled plastic waste. While this study provides some insight into the potential of using recycled plastic in roofing materials, it does not specifically focus on the use of plastic in roof tiles. Similarly, a study by Gopalakrishnan et al. (2019) examined the properties of recycled plastic in asphalt pavements, but did not address the use of plastic in roofing materials.

Therefore, a study that investigates the a possible research gap for a study on the scope of recycled plastic roof tiles in the civil construction market is the lack of studies that have explored the potential of using recycled plastic roof tiles as a sustainable and cost-effective alternative to traditional roofing materials. While there is some literature on the use of recycled materials in construction, there may be few studies that have specifically focused on recycled plastic roof tiles. For example, a study by Natarajan et al. (2019) investigated the mechanical properties of concrete roof tiles made from recycled plastic waste. While this study provides some insight into the potential of using recycled plastic in roofing materials, it does not specifically focus on the use of plastic in roof tiles. Similarly, a study by Gopalakrishnan et al. (2019) examined the properties of recycled plastic in asphalt pavements, but did not address the use of plastic in roofing materials.

Therefore, a study that investigates the scope of using recycled plastic roof tiles in the construction market

would fill this gap. This study could assess the mechanical properties, durability, and cost-effectiveness of recycled plastic roof tiles compared to traditional roofing materials. Additionally, the study could investigate the availability and affordability of recycled plastic roof tiles in the market, as well as the environmental impact of their production, use, and disposal. cope of using recycled plastic roof tiles in the construction market would fill this gap. This study could assess the mechanical properties, durability, and cost-effectiveness of recycled plastic roof tiles compared to traditional roofing materials. Additionally, the study could investigate the availability and affordability of recycled plastic roof tiles in the market, as well as the environmental impact of their production, use, and disposal.

Sampling Method

We picked cluster sampling as our sampling technique. Sampling in clusters subdivides the population into subgroups. Each subgroup should share features with the entire sample. Instead of randomly selecting people from each subgroup, we choose the entire subgroup at random. - Less assets for the cluster sampling technique

Since cluster sampling chooses just certain groups from the total population, fewer resources are required for this approach. In general, stratified sampling is less expensive than simple random sample or stratified sampling since it needs fewer administration and travel expenditures. If practical, all people from all sample clusters can be included. If the clusters are big, you may additionally sample individuals from each cluster using one of the aforementioned methods. It is known as multilevel sampling. - more viable

The sampling process is made more feasible by dividing the overall population into homogenous groups. Also, each cluster reflects the complete population, enabling the enrolment of additional individuals.

In this research. This strategy is excellent for managing big, dispersed populations. Used to examine huge populations, particularly geographically scattered ones.

RESEARCH OBJECTIVES

The research objectives of recycled plastic rooftop tiles may include:

- Material properties: To investigate the physical, mechanical, and thermal properties of recycled plastic rooftop tiles, such as their strength, durability, heat resistance, and moisture absorption.
- Environmental impact: To evaluate the environmental impact of using recycled plastic rooftop tiles, such as their carbon footprint, energy consumption, and waste reduction compared to traditional roofing materials.
- Cost-effectiveness: To determine the cost-effectiveness of recycled plastic rooftop tiles, including their production costs, installation costs, and long-term maintenance costs, and compare them to other roofing options.
- Performance testing: To conduct performance testing on recycled plastic rooftop tiles under various weather conditions, such as wind, rain, snow, and extreme temperatures, to ensure their reliability and safety.
- Market demand: To assess the market demand for recycled plastic rooftop tiles, including consumer preferences, trends, and the potential for commercialization in the roofing industry
- Standards and regulations: To investigate the regulatory requirements and standards for recycled plastic rooftop tiles, such as building codes, safety standards, and environmental regulations, and ensure that they comply with them.

HYPOTHESIS

A hypothesis for recycled rooftop tiles could be:

"Recycled plastic rooftop tiles are a sustainable and cost-effective alternative to traditional roofing materials, and their physical properties, environmental impact, and market demand can be comparable or superior to other roofing options."

This hypothesis can be further broken down into specific statements that can be tested through research and data analysis, such as:

- Recycled plastic rooftop tiles have similar or better durability, strength, and thermal performance compared to traditional roofing materials.
- The production and use of recycled plastic rooftop tiles have a lower carbon footprint and reduce waste compared to traditional roofing materials.
- Recycled plastic rooftop tiles are cost-effective over the long term due to their low maintenance and lifespan.
- There is a growing market demand for sustainable

roofing materials, including recycled plastic rooftop tiles, due to increasing environmental awareness and regulations.

RESEARCH APPROACH

The research approach for recycled rooftop tiles could involve a combination of quantitative and qualitative research methods. Some possible research methods and techniques are:

- Literature review: To gather and analyze existing literature on recycled plastic rooftop tiles, including academic articles, technical reports, industry publications, and case studies. This can provide a foundation for the research and help identify knowledge gaps and research questions.
- Experimental testing: To conduct laboratory testing and analysis on recycled plastic rooftop tiles, such as tensile strength, impact resistance, thermal conductivity, and weathering performance. This can provide quantitative data on the physical properties and performance of the tiles and help validate their suitability for roofing applications.
- Life cycle assessment: To conduct a life cycle assessment (LCA) of recycled plastic rooftop tiles, which is a comprehensive analysis of the environmental impact of the tiles throughout their entire life cycle, from raw material extraction to disposal. This can provide data on the tiles' carbon footprint, energy consumption, and other environmental indicators.
- Case studies and surveys: To conduct case studies and surveys of buildings that have installed recycled plastic rooftop tiles, as well as building owners, contractors, and roofing professionals. This can provide qualitative data on the tiles' installation, maintenance, and performance, as well as their market demand and potential for commercialization.
- Cost analysis: To conduct a cost analysis of recycled plastic rooftop tiles compared to traditional roofing materials, including their production costs, installation costs, and long-term maintenance costs. This can provide data on the tiles' cost-effectiveness and potential for economic viability.

TARGET POPULATION

The target population for recycled plastic rooftop tiles would primarily be homeowners or businesses who are

interested in using environmentally sustainable building materials for their roofs. These individuals may be concerned about reducing their carbon footprint, conserving natural resources, and promoting sustainable practices. The population may also include architects and builders who are looking for sustainable roofing options to recommend to their clients. In addition, governments and municipalities that prioritize sustainability may be interested in using recycled plastic rooftop tiles for public buildings or infrastructure projects.

DETERMINING THE SAMPLE SIZE

As for this study, the sampling method used is Cluster sampling method. Accordingly to determine the sample size the population is divided into two major clusters which are:

- 1) Gender based cluster
- 2) Age based cluster

Gender based cluster are sub divided into two sub groups:

- Male gender-based cluster
- Female gender-based cluster

Age based cluster are sub divided into four sub groups:

- 20-30 age group cluster
- 30-45 age group cluster
- 45-60 age group cluster
- Above 60 age group cluster

The cluster sampling is done in three different stages which is:

- 1) One stage cluster sampling
- 2) Two stage cluster sampling
- 3) Multi stage cluster sampling

The cluster sampling stage used to determine the sample size for this study is one stage cluster sampling.

It is used where all the elements within selected cluster are included in the sample. Therefore, for this study sample size includes overall population for the purpose of analysis.

LOCATION OF THE STUDY

The location used for the purpose of collecting the data for this study is Bengaluru.

DETERMINING DATA COLLECTION METHOD

What is data?

Data in research refers to any information gathered,

observed, or measured in order to answer a research question or test a hypothesis. This can include both quantitative data, such as measurements or survey responses, and qualitative data, such as interview transcripts or written observations.

The data collection method used to determine the study is primary data.

TYPES OF PRIMARY DATA

- Qualitative data
- Quantitative data

This study has used qualitative data technique for questionnaire as a tool for data collection

- 1) Have you ever heard of roofing tiles made of plastic?
- 2) In your opinion, how durable do you think plastic roofing tiles are compared to traditional roofing materials?
- 3) How important is the appearance of your roof to you?
- 4) Would you be willing to pay more for plastic roofing tiles if they were proven to be more durable than traditional materials?
- 5) How concerned are you about the environmental impact of the materials?

DATA ANALYSIS TECHNIQUE

Data analysis techniques in research refer to the methods used to analyze and interpret data collected in a study. Data analysis is a crucial part of research because it helps researchers make sense of the data they have collected and draw conclusions from it. The data analysis technique used in research:

Descriptive Analysis.

Diagnostic Analysis.

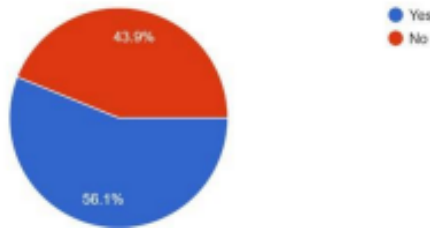
Predictive Analysis.

Prescriptive Analysis

The type of data analysis technique used to determine the study is descriptive analysis technique. In research, descriptive analysis is the process of analysing and describing the characteristics and features of a set of data. This type of analysis is used to summarise and present data in an understandable manner, as well as to identify patterns, trends, and relationships between variables.

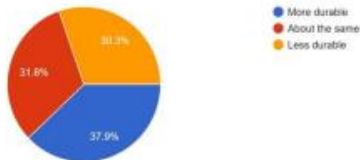
Data analysis

Here are the responses of the participants of our target group: -
 Have you heard of roofing tiles made of plastic?
 66 responses



Fig(i) Among 66 respondents, over 56.1% of respondents have heard about the roofing tiles made of recycled plastic, 43.9% of respondents are not aware of these roofing tiles.

In your opinion, how durable do you think plastic roofing tiles are compared to traditional roofing materials?
 66 responses



Fig(ii) Among 66 respondents, over 37.9 % think plastic roofing tiles are more durable than traditional roofing materials, 32.8% think plastic tiles has the same durability as traditional tiles 30.3% think plastic tiles are less durable than traditional tiles.

How important is the appearance of your roof to you?
 66 responses

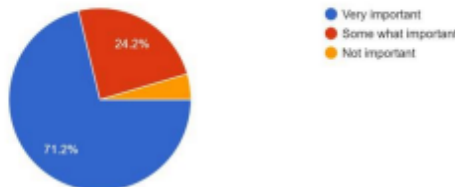


Fig (3) 71.2% of the respondents considers that appearance is very important. 24.1% of the respondents considers its somewhat important, Others, consider that appearance is not important.

How concerned are you about the environmental impact of the materials used for roofing?
 66 responses



Fig (4) 54.5% respondents are very much concerned about environmental impact of material used, 39.4% of the respondents are some what concerned and others are not concerned.

Would you consider purchasing plastic roofing tiles if they were environmentally friendly?
 66 responses

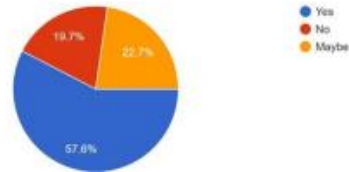


Fig (5) 57.6% of the respondents are Ok with purchasing the product if they are environmentally friendly, 22.7% of the respondents are somewhat concerned with environmental aspects, 19.7% are not concerned with environmental aspects

How important is the cost of the roofing materials to you?
 66 responses



Fig (6) 51.5% of the respondents consider that the cost of the materials is also important, 42.4% of them thinks that cost of the materials is some what important and others think that its not important.

How important is the ease of installation of the roofing materials to you?
 66 responses

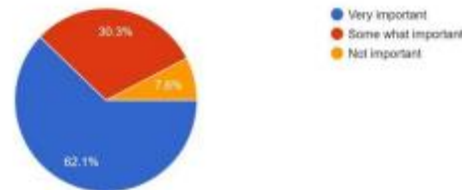


Fig (7)

Would you consider purchasing plastic roofing tiles if they were priced similarly to traditional roofing materials?
 66 responses

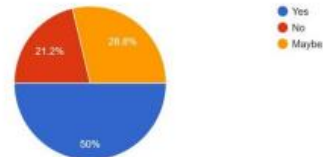


Fig (8) 50% of the respondents considers the price of plastic tiles and the traditional tiles, 28.8% of them somewhat considers the price of plastic tiles and 21.2% of the respondent doesn't consider.

Would you consider purchasing plastic roofing tiles if they were easy to install and required minimal maintenance?
 66 responses

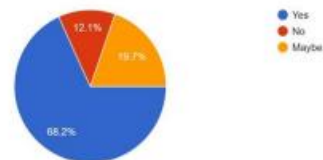


Fig (9) 68.2% of the respondents consider to purchase the tiles if they are easy to install and required minimal maintenance, 19.7% of would think of it and 12.2% of them don't consider.

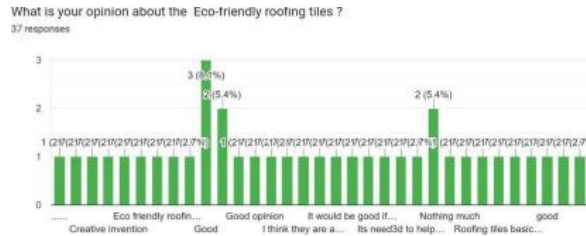


Fig (10) Most of the Respondents have given the positive response over the concept of The Eco friendly roofing tiles.

Limitations of the study:

- The limitation of this study are not having enough members and most of the time people do not want to talk about it more because of lack of time and awareness and this is going to create a huge problem for the data collection for and researcher.
- As we go further there will be an issue of collecting the data from different area.

The future scope of the study:

1. Performance testing: it would be helpful to conduct additional research on the durability to weather, other performance aspects and durability of recycled plastic roofing tiles. Testing could entail testing the tiles under different climate conditions, evaluating their fire resistance and analyzing their capacity to endure impact and other pressures.
2. Cost effectiveness: recycled plastic roofing tiles offers environmental benefits, their cost effectiveness compared traditional roofing materials is an important factor for widespread adoption.
3. Market demand: surveys and market analysis can help determine the interest and willingness of customers to pay for the product and identify potential barriers to adoption.
4. Environmental impact: while these tiles have the potential to reduce waste and promote sustainability, it is also to assess the overall environmental impact. It includes the energy required to manufacture and transport the tiles, their ability to be recycled or reused at the end of their lifespan, and their impact on ecosystems and wildlife.

OUTCOMES

The findings of this study have confirmed the reliability of a low-cost, high-performance composite roofing system made from recycled materials in terms of its durability, installation, engineering, and performance. The endurance of this system in diverse conditions will be shown by continued field data collecting, and the product's general acceptance will be assessed. The adoption of composite construction materials could create significant new markets for recycled plastic and natural fiber products.

SYNTHESIS

It is undeniable that plastic has been established in the majority of human cultures in a period of decades. The advent of plastic and its diverse applications have made it feasible for consumers to get items at a significantly reduced price compared to the past. Plastic is a crucial commodity, but its manufacturing has increased dramatically in recent years, contributing to a serious environmental problem. As a result of escalating plastic usage, the amount of waste dumped in landfills has grown, and plastic is still prevalent in waste streams and clogging drainage canals. As with EPS, plastic waste is not composting but is fully recyclable due to its thermoplastic nature. Thus, academics are examining ways to build a recycling technology.

CONCLUSION

This is a wonderful idea since, as the business grows, you will be able to employ a significant number of people. By employing the ladies who collect your garbage from the streets, for instance, you will give her with a job. In addition to creating employment for the merchants and marketers who will distribute your products to customers, you will contribute to the betterment of the environment by providing inexpensive roofing to builders. In this study, the researchers focus on old plastics that are not currently recyclable and are deemed useless for other reasons. The researcher believes that this strategy will also result in employment opportunities, a cleaner environment, and durable final goods. In this study, the researchers find another method to valorise

the recycled EPS and mix it with sand to produce a new material used as roofing tile. The researchers aim for those waste plastics that currently have no recycling value and are overlooked as being useful, for any kind of reason. With this process, the researchers also aim to provide job opportunities, a cleaner environment and durable end products.

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