International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 4, Issue 12, ISSN No. 2455-2143, Pages 293-297
Published Online April 2020 in IJEAST (http://www.ijeast.com)

DISCUSSING VIABILITY OF RECYCLED PLASTIC BRICKS IN INDIA

Satwik Rajput
University of Delhi
Shaheed Sukhdev College of Business Studies,
Delhi, India

Abstract— **This paper is a detailed analytical discussion on the viability of creating bricks with recycled plastic and assessing feasibility of such a market in India. This paper proposes a dual solution through this one innovation which seeks to somehow tackle both the housing shortage in India and lack of methods to recycle plastic in India.**

Keywords - **Plastic, Recycling, Housing, Shortage, Bricks**

I. INTRODUCTION

What kinds of plastics exist?

Polyethylene terephthalate (PET or PETE or polyester)
Description: PET is the most well known member of the polyester family of plastic polymers. It initially gained widespread use as a wrinkle-free fiber (commonly called "polyester"), and the majority of its production still goes toward textile manufacturing. It has become extremely popular for food and drink packaging purposes because of its strong ability to create a liquid and gas barrier - so oxygen cannot get in to spoil food, and the carbon dioxide that makes drinks fizzy cannot get out. Properties: clarity, lightness, strength, toughness, barrier to liquid and gas.
Typical Use: Bottles (water, soft drink, juice, beer, wine, mouthwash, salad dressing), peanut butter/jam jars, oven-ready and microwaveable meal trays, detergent and cleaner containers. Also used in liquid crystal displays, film for capacitors, insulation for wire and insulating tapes, and as a common finish for wood products such as guitars, pianos and vehicle/yacht interiors.
PET fabric (polyester) is commonly used in textiles (fabric and clothing), padding and insulation (for pillows, comforters, upholstery), carpet, and mouldings. Also for tyre reinforcements, conveyor belts, safety belts, coated fabrics and tarpaulins.

HIGH DENSITY POLYETHYLENE (HDPE)

Description: Polyethylenes are the most widely used family of plastics in the world. The versatile polyethylene polymer has the simplest basic chemical structure of any plastic polymer (repeating units of CH2: one carbon and two hydrogen molecules) making it very easy to process and thus extremely popular for numerous low value applications - especially packaging. HDPE has long virtually unbranched polymer chains which align and pack easily making it dense and very crystalline (structurally ordered) and thus a stronger, thicker form of of polyethylene. Properties: stiffness, strength, toughness, resistance to moisture, permeability to gas, ease of processing.
Typical Use: Plastic bags (grocery), opaque milk, water, and juice containers, bleach, detergent and shampoo bottles, garbage bags, dishes, yogurt and margarine tubs, cereal box liners, some medicine bottles. Also used in Tyvek insulation, PEX piping, plastic/wood composites.

POLYVINYL CHLORIDE (V OR VINYL OR PVC)
Description: Long the second most widely used plastic resin in the world (after polyethylene), PVC (or vinyl) use has decreased because of serious health and environmental pollution issues associated with its manufacture, use and disposal -- it's whole life cycle is toxic. But it is still popular and in common use because of its cost-effective versatility. The base monomer is vinyl chloride - the presence of chlorine is the cause of many of PVC's problems - which can be combined and blended with numerous chemicals (including plasticizers such as phthalates) to create resins with properties ranging from rigid to filmy to soft to leathery. Properties: versatility, ease of blending, strength, toughness, clarity, transparency.
Typical Use: Soft PVC (softened with plasticizers) used in toys, clear food (e.g., take-out) and non-food packaging (e.g., blister wrap, cling wrap), squeeze bottles, shampoo bottles, mouthwash bottles, cooking oil and peanut butter jars, detergent and window cleaner bottles, loose-leaf binders, shower curtains, blood bags and medical tubing, "pleather" clothing, Naugahyde upholstery, wire and cable insulation, carpet backing and flooring. Rigid PVC used for blister packs and clamshell packaging, credit cards, piping (e.g., for plumbing), vinyl siding, window frames, fencing, decking, and other construction materials.

POLYPROPYLENE (PP)
Description: Polypropylene is used for similar applications as polyethylenes, but is generally stiffer and more heat resistant - so is often used for containers filled with hot food. It too has a simple chemical structure (many methyl groups of CH3 - one

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 4, Issue 12, ISSN No. 2455-2143, Pages 293-297
Published Online April 2020 in IJEAST (http://www.ijeast.com)

carbon and three hydrogen molecules) making it very versatile. It's crystallinity (structural order affecting hardness & density) is quite high, somewhere between LDPE and HDPE. Properties: strength, toughness, resistance to heat, chemicals, grease & oil, barrier to moisture.

Typical Use: Food containers (ketchup, yogurt, cottage cheese, margarine, syrup, take-out), medicine containers, straws, bottle caps, Britta filters, Rubbermaid and other opaque plastic containers, including baby bottles. Other uses include disposable diaper and sanitary pad liners, thermal vests, appliance parts and numerous car parts (bumpers, carpets, fixtures).

POLYSTYRENE (PS)

Description: Polystyrene is commonly associated with the trade name Styrofoam food containers and packing peanuts made of expanded PS (EPS), which is essentially foamed PS that has been puffed up with air. PS synthesis requires benzene, a known carcinogen, to form the monomer styrene, which is reasonably anticipated to be a human carcinogen. Apart from low cost, low strength foam, PS can be made as a clear, glassy, hard polymer used for things like cutlery and cd cases; also higher impact versions exist for harder applications. Properties: versatility, clarity, easily formed.

Typical Use: EPS: Styrofoam food containers, egg cartons, disposable cups and bowls, take-out food containers, deli food plates, packaging, packing peanuts, bike helmets. Harder clear/opaque PS: disposable cutlery & razors, compact disc & dvd cases. High impact PS: hangers, smoke detector housing, licence plate frames, medecine bottles, test tubes, petri dishes, model assembly kits.

OTHER (O) - ALL OTHER PLASTICS

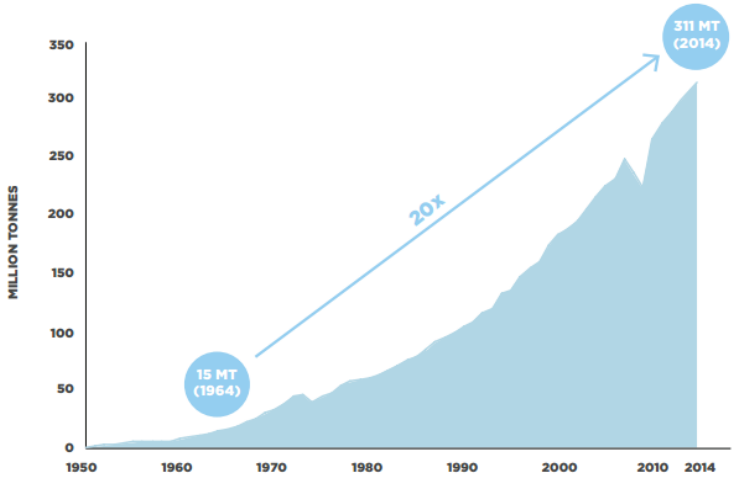
This category does not identify one particular plastic resin. It is a ***general catch-all*** for all plastics other than those identified by numbers 1-7, and can include plastics that may be layered or a mixture of various plastics. It includes the new bioplastics.

Polycarbonate (PC) is an extremely common plastic in this category and is often associated with this category (sometimes a product will have the number 7 on it with the letters "PC" underneath), so we describe it below -- But keep in mind that polycarbonate is not the only plastic in this category and if a product has a number 7 on it *without* the letters PC under it, the product could be made of polycarbonate or it could be any other plastic (and there are thousands!). The only way to know for sure is to ask the manufacturer or have the plastic tested.

II. LITERATURE REVIEW

It takes approximately 1,000 years for plastic to degrade. (Chakraborty & Satapathy et al.2015) Tossing those bottles and containers into landfills doesn't mean they're gone. They're guaranteed to be here centuries later as a testament to our excessive wastefulness. Today, 95% of plastic, or $80–120 billion annually, is lost to the economy after a short first use. (Banerjee et al. 2014) More than 40 years after the launch of the first universal recycling symbol, only 14% of plastic packaging is collected for recycling. When additional value losses in sorting and reprocessing are factored in, only 5% of material value is retained for a subsequent use.(Bhushaiah, Mohammad, & Rao et al.2019) Plastics that do get recycled are mostly recycled into lower-value applications that are not

Figure 1: Growth in Global Plastics Production 1950–2014



Note: Production from virgin petroleum-based feedstock only (does not include bio-based, greenhouse gas-based or recycled feedstock)
Source: PlasticsEurope, Plastics – the Facts 2013 (2013); PlasticsEurope, Plastics – the Facts 2015 (2015).

again recyclable after use. The recycling rate for plastics is far below the global recycling rates for paper (58%) and iron and steel (70–90%). Many innovations and improvement efforts show potential to counter the same, but to date these have proved to be too fragmented and uncoordinated to have impact at scale.(Gangani, Suthar, Pitroda, & Singh et al.2016)

Housing troubles in India

According to a report submitted by a technical committee to the Ministry of Housing and Urban Poverty Alleviation (MHUPA), India's urban housing shortage is estimated at nearly 18.78 million households in 2012. Besides those living in obsolescent houses, 80 percent of these households are living in congested houses and are in requirement of new houses.(Gupta et al.2018) The report also highlights that nearly one million households are living in non serviceable katcha houses, while over half a million households are in homeless conditions. Growing concentration of people in urban areas has resulted in an increase in the number of people living in slums and squatter settlements. Skyrocketing prices of land and real estate in urban areas have induced the poor and the economically weaker sections of the society to occupy the marginal lands typified by poor housing stock, congestion and obsolescence. It is apparent that substantial housing shortage looms in Urban India and a wide gap exists between the demand and supply of housing, both in terms of quantity and quality. Shortage amplified for the EWS Urban housing

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 4, Issue 12, ISSN No. 2455-2143, Pages 293-297
Published Online April 2020 in IJEAST (http://www.ijeast.com)

shortage is prominent across the economically weaker sections (EWS) and low income groups (LIG) which together constitute over 95 percent of the total housing shortage. The shortage amongst the middle income groups (MIG) and above is estimated at 4.38 percent.

Finding a link, between plastic recycling and housing shortage is usually unheard of. However, extensive studies and analysis shows, that an opportunity beckons: using the plastics innovation engine to move the industry into a positive spiral of value capture, not only bridging the housing shortage, but also stronger economics and better environmental outcomes.

III. Research Gap And Problem

The need for a revolutionary technology that complements both the environment and the economy, is inevitable.
This paper is is an effort to understand if we can build affordable bricks from a composite mixture containing plastic. The idea was born from the very basic concept of the childhood toys of Lego bricks, that taught mankind how sturdy structures can be made without any need of adhesives. Since The houses are assembled without using any type of adhesive, it makes them portable houses that can be disassembled easily in order to transport and reassemble them. The paper seeks to reverse the damage that plastic causes to the planet and use it to benefit those most in need.

When one considers the same in light of an economy like India, the need for the paper is heightened exponentially. Indian prime minister Narendra Modi has extensively highlighted the lack of toilets and affordable houses as a roadblock in complete development of the nation. Even the President's Address to Parliament in June 2014 mentioned a similar aim. The same commitment was made in the Budget for 2014-15 where the Finance Minister had announced a Housing for All programme. The Finance Minister had said "Our government is committed to endeavour to have housing for all by 2022. For this purpose, I intend to extend additional tax incentive on home loans to encourage people, especially the young, to own houses. I propose setting up a Mission on Low Cost Affordable Housing which will be anchored in the National Housing Bank. Schemes will be evolved to incentivize the development of low cost affordable housing."
This paper wishes to find a one-stop solution to this problem, which is not only environmentally feasible, but also extremely affordable and has the capability to be produced in a mass amount. The excessive wastage and improper disposal of plastic only adds to the utility of our paper. Considering the example of Chennai alone, the 3,400 tons of plastic is generated in the city every day, out of which 35 to 40 tons is plastic waste.(Nallathiga, 2014) And it's a problem facing countries across the world: each year, an estimated 500 billion to 1 trillion plastic bags are consumed worldwide, which is about over one million a minute and most of them end up in the dustbin in a few minutes. Closer home, every supermarket outlet in the city receives an average of 15,000 plastic bags a month. (Iki & Homma, 2015)
others.

IV. Critical Discussion on possibility of production

The process of making bricks from recycled plastic is extremely economical and simple.
The first and foremost step in the production process is the collection of plastic waste. Now collection of waste in a country like India is no Herculean task. The waste can easily be collected by contacting local landfills. By establishing proper communication, municipal corporations can also be contacted to ensure government co-operation and contribution to the same.
The second step involves melting and pouring of plastic waste into a mould to produce plastic blocks that work like Lego pieces. This is where the technical aspect steps in. In order to achieve this, the plastic must be slowly heated in metal forms and the molds must be a constant temperature throughout. It's not like in a steel plant where ingots are manufactured from a melt. But when plastics are melted, they must be heated evenly and the mold is most likely inside of an oven. Plastic does not melt like many people think. If exposed to a direct flame it will not ignite but actually begin to melt. But it doesn't melt like you think. The object's matter will change slightly. The resulting byproducts are carbon monoxide, which vanishes, and of course you'll notice a sticky hard caramel colored film that is impossible to remove off anything it touches. The actual composition is quite useless. So the plastic must be gently baked into a flexible and softer consistency. In simple words, the plastic is shredded then baked and then put into molds.

The plastic that can be incorporated in this process include- Polyethylene terephthalate, Polypropylene, and Polystyrene.
The third step is inculcated to ensure sturdiness and durability of the product. The materials contain additives that makes them resistant to fire and because the structure is plastic-based, it is earthquake resistant. Since #1 plastic (Polyethylene terephthalate) doesn't hold up well to sunlight exposure and expands and contracts too much, which is why it would need to be mixed with several plastics. Namely plastic #5 and #6. Efforts are also being made to inculcate plastic #3, which is used to make pvc pipes, to ensure even greater tensile strength. Polymeric sand is added to give the bricks the beautiful characteristic grayish shade.
After the bricks are produced, the next step is building the houses, which again is no gargantuan feat to achieve. Since the bricks can be lego shaped of fitted to be made like pieces of a jigsaw puzzle, a full fledged house for 4 members can be made in less than 5 days without any requirement of prior construction experience. Pun intended, this literally makes the construction of the house a "child's play."

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 4, Issue 12, ISSN No. 2455-2143, Pages 293-297
Published Online April 2020 in IJEAST (http://www.ijeast.com)

The construction can either be done by construction professionals, or even by laymen in requirement of the houses, depending upon the scheme that is developed.

V. IMPLEMENTATION

The acute shortage of proper housing in India is not a problem you can solve in a day. It is a gradual process that would lead the nation to successfully drive out homelessness and poverty from the nation. This project can be catered to through a factory capable of reusing 100 tons of plastic per month initially. Later this can be expanded to 300 tons per month that would enable the building of 50 average sized homes per month. Accordingly the government can be seeked to co-ordinate for any large scale expansion of the same.
The labor requirement for the same is not too numerous either. A standard size of laborers for carrying out the day to day processes of collection of waste, and the production processes in the factory, along with the technical supervisor is all that shall be required for the project.

VI. FINANCIAL VIABILITY

Expenditure per month land	= 50,000
Machinery	= 12,500
Vehicle	= 6,000
Wages	= 75,000
Bills	= 70,000
Raw material	= 1,85,000
Total expenditure	= 4,00,000/month

Cost of bricks

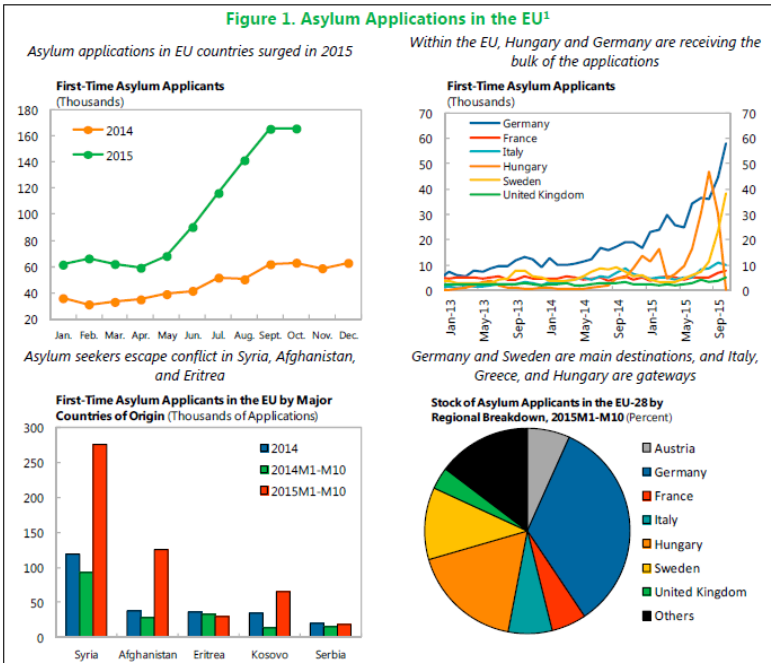
Production of plastic in 1 month = 300 tones = 3,00,000 kg
Weight of 1 brick= 1.5 kg
No. of bricks produced in 1 moth = 2,00,000
cost of 1 brick = 2

profit
profit on 1 brick = 4.5 – 2 = 2.5
profit per month = 5,00,000
annual profit = 60,00,000

VII. CONCLUSION

India
If the urban homelessness is not enough evidence of the sheer urgency in requirement of this project in India, India is also home to an shocking amount of IDPs, with over half a million IDPs belonging to Kashmir alone. Not only due to communal / political violence, a lot of people in India unfortunately lost their homes due to natural calamities too. The ongoing floods that have plagued extremely populous regions of North India and parts of East India have caused immense displacement too.

It is situations like these that call for innovations like this. Economical, sturdy, quick, and resistant; homes build by plastic bricks are the perfect solutions for saddening events like these.



Rest of the world
Another global phenomenon that needs no further introduction is the Refugee/ Migrant crisis in Europe. The number of forcibly displaced people worldwide reached almost 60 million at the end of 2014, the highest number in the past 70 years. If there has ever been a need for the world to come together, build together, and add together, its now. The understandable failure of countries in housing such a huge population brings to the fore the requirement of an innovation exactly like this.

SDGs
The Sustainable Development Goals (SDGs), officially known as Transforming our world: the 2030 Agenda for Sustainable Development, are an intergovernmental set of aspiration Goals with 169 targets. The usage of such innovation can aid in fulfillment of the goals stated by UN provided all governments contribute towards the spreading of the same. The objectives that can be achieved using our products are:
-No Poverty
-Decent Work and Economic Growth
-Responsible Consumption and Production
-Climate Action

VIII. ACKNOWLEDGEMENTS

This project has been a brainchild of mine ever since I first delved into the idea 4 years ago. Along the path, a plethora of guidance has helped me put this research to paper as it can be viewed today. Sincere gratitude goes out to Ravinder Singh, who been invaluable guidance has been immensely helpful to me. My professor Nidhi Khanna has also been a constant mentor. I would also like to thank Dr. Manoj Kumar Upadhyay from Niti Aayog for his teachings on how to conduct and pen down a proper research. Lastly, I would like to thank Poonam Singh, my mother, for always providing me moral support to be able to complete this project.

IX. REFERENCES

1. Banerjee, T. (2014). *Plastics waste management in India : An integrated solid waste management PLASTICS WASTE MANAGEMENT IN INDIA : AN INTEGRATED SOLID WASTE*. 1-5
2. Bhushaiah, R., Mohammad, S., & Rao, D. S. (2019). *Study of Plastic Bricks Made From Waste Plastic*. 1122–1127.
3. Chakraborty, S., & Satapathy, S. (2015). *RECYCLING IN PLASTIC INDUSTRIES IN INDIA : AN ANALYSIS OF ITS BARRIERS RECYCLING IN PLASTIC INDUSTRIES IN INDIA : AN ANALYSIS OF ITS BARRIERS THROUGH FUZZY-AHP APPROACH*. 3-7.
4. Gangani, M. G., Suthar, H. N., Pitroda, J., & Singh, A. R. (2016). *A Critical Review on Making Low Cost Urban Housing in India*. *2*(5), 21–25.
5. Gupta, A. R. N. (2018). *The Challenges in "Affordable Housing" for Urban Poor in India – Deciphering the "Housing for All by 2022" - A Comprehensive Approach to Decrement Housing Shortage – A Case Study of Delhi*. *9*(7), 341–372.
6. Iki, K., & Homma, R. (2015). *Study on Housing Scenario and Affordability in Rising Metropolitan Area in India -A Case of Bhubaneswar City , Odisha-* .
7. Nallathiga, R. (2014). *Housing Policy in India : Challenges and Reform The Changing role of Housing Policy in India : Challenges and Reform*. https://doi.org/10.1177/0972266120070103