Details of the proposed work

Broad subject area: Reuse of Plastic Waste for Energy and other product

Title: Manufacturing of paver blocks using plastic waste

1) Motivation of the present work

The term "Plastics" includes materials composed of various elements such as carbon, hydrogen, oxygen, nitrogen, chlorine and sulfur. plastics are macromolecules, formed by polymerization and having the ability to be shaped by application of reasonable amount of heat and pressure or another form of forces. Now a days, plastic waste become the major cause for different types of pollution, as it is the major constitute of municipal and industrial waste in cities even the rural area is producing more waste due to plastic material packaging, plastic shopping bags, PET bottles and other goods/appliances using plastic as the major component. The world's annual consumption of plastic materials has increased from around 5 million tonnes in the 1950s to nearly 100 million tonnes [1]. The best is to use the worst to construct something of routine use. Hence, these waste plastics are to be effectively utilized. High-density polyethylene (HDPE) and polyethylene (PE) bags are cleaned and added with sand and aggregate at various percentages to obtain high strength bricks that possess thermal and sound insulation properties to control pollution and to reduce the overall cost of construction, this is one of the best ways to avoid the accumulation of plastic waste which is an on-degradable pollutant. Thus, we plan to replace the traditional process of paver block manufacture by our eco friendly method of paver block manufacture using plastic waste. This is not only economical but is expected to have a better strength than the older cement paver block. In this proposed study a very new novel approach is presented to reuse the waste plastic materials by converting into the paver blocks. To develop an efficient way to effectively utilize the waste plastic as that plastic wastes acts as a great threat for sustainment of ecological balance. After formation of blocks to evaluate the mechanical and physical properties of paver blocks prepared from waste plastics for the desired applications.

2) Introduction

Plastics are polymers, created by heating Petroleum And other products under controlled conditions. According to United States Environmental Protection Agency USEPA [1], Plastics are rapidly growing segment of municipal solid waste (MSW) stream.in 2007 the US generated

total plastic waste almost 31 million tons which represented 12.1 percentage of total MSW generation. Figure 1 Shows the average global plastic waste generation.

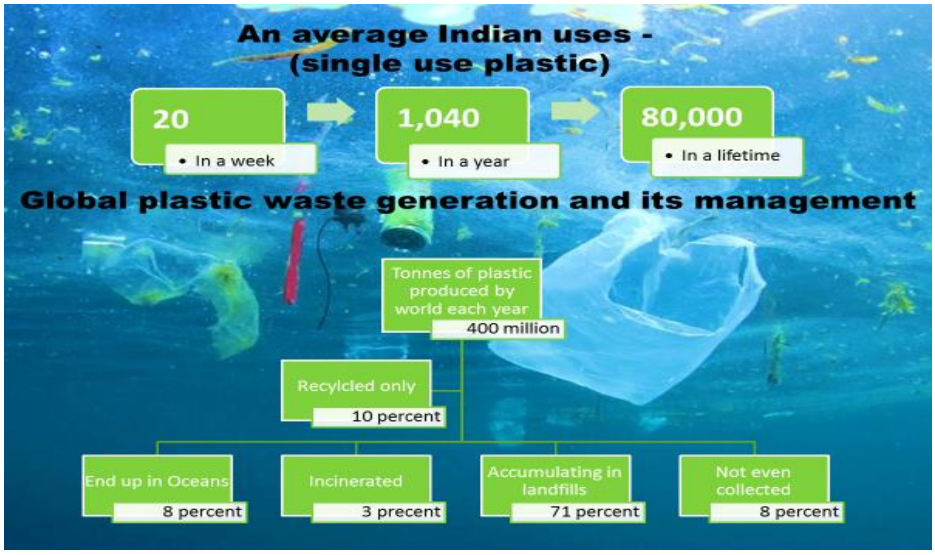


Figure1: Average Global plastic waste Generation

The quantity of plastic waste in Municipal solid waste is expanding rapidly. it is estimated that the rate of expansion is double for every 10 years, this is due to rapid growth of population urbanisation developmental activities and changes and Lifestyle which leading whitespace littering on the landscape. they are non biodegradable and also researchers have found that the plastic waste can remain on earth for 4500 years without degradation. Figure 2 shows the different categories of plastic waste and their applications.

Plastic codes	Short Name	Scientific name	Used in
1 PET	PET	Poly ethylene terephthalate	Water bottles , PET bottles
2 HDPE	HDPE	High density polyethylene	Milk jugs, Detergent bags, oil bottles, toys
3 PVC	PVC	Poly vinyl chloride	Cooking oil bottles, cables , pipes,floorings
4 LDPE	LDPE	Low density polyethylene	Grocery bags , shopping bags, squeezable bottles, shrink wraps, films
5 PP	PP	Polypropylene	Medicine bottles, cereal liners
6 PS	PS	Polystyrene	Foam packaging, tea cups , ice cream cups
7 OTHER	O	Others	Bakelite , Nylon, Melamine

Figure 2: Categorization of plastics Wastes

According to Mehta [2],among primary concrete making materials the emission of carbon dioxide is largely attributable to cement production. Cement typically contain an average of 84% Portland cement clinker, and clinker manufacturing process releases 0.9 tons of carbon dioxide par tonne of clinker [3]. Worldwide the concrete industry consumed nearly 2.77 billion tonnes of cement in 2007. This translated a sizeable carbon footprint, with global carbon dioxide emission rate of 2.07 billion tonnes per year. Current atmospheric concentration of carbon dioxide which makes up 85% of greenhouse gases is 390 ppm the highest in recorded history and rising exponentially.

Most cement paving block constructed performed unsatisfactory in the following main areas of concern :-

- Occasional failure due to excessive surface wear .
- Variability in the strength of the block.
- Phenomenon of efflorescence due to migration of salt to the surface of porous materials.
- Cement typically contains Portland cement clinker and its manufacturing releases 0.9 tonne of carbon dioxide per tonne.
- Exploitation of natural resources in cement production.
- Cost of production is high.

Therefore in this proposal an attempt is made to study manufacture the paver blocks using Low density polyethylene (LDPE) plastic waste and simultaneously to check the mechanical strength of these paver blocks. The LDPE plastic waste is selected due to the following reasons:

- Has good binding properties thus can bind sand particles.
- Classified as a thermoplastic in comparison to thermoset hence liquify easily.
- LDPE is an important industrial material because it is durable , light weight, characteristically inert.
- Melting point for average, commercial LDPE is 105-115 degree Celsius.
- Density range - 0.910 to.940 gram/cc.
- It is non-reactive at room temperature.
- Absorbs almost no water.

3) Review of R&D in the Proposed Area

According to a Technical newsletter “Focus on PET”, Poly ethylene terephthalate belongs to the polyester family of polymers, one of the largest and most diverse of the polymer families. This family of polymers is linked by the common feature of having an ester (-COO-) link in the main chain, but the range of polyester materials is probably the largest of all the polymer families. And, the chemical structure of the PET is having only atomic species that are carbon, hydrogen and oxygen. Therefore, melting of PET won’t result in release of noxious gases and its properties reveal that a melting temperature of 260 ºC is required. Also, from the properties of the PET it can be understood that it has got good chemical resistance and better resistance to UV rays [9]. In a paper “A review on waste plastic utilization in asphalting of roads” [1], the techniques to use plastic waste for construction purpose of roads and flexible pavements, which were developed by various researchers has been reviewed. And collectively emphasizes the

concept of utilization of waste plastic in construction of flexible road pavement. In the construction of flexible pavements, bitumen plays the role of binding the aggregate together by coating over the aggregate. It also helps to improve the strength and life of road pavement. But its resistance towards water is poor. A common method to improve the quality of bitumen is by modifying the rheological properties of bitumen by blending with synthetic polymers like rubber and plastics. Research on "The Use of Recycled Materials in Highway construction" [6] and "Utilization of waste plastic in Bituminous Concrete mixes" [7] to determine the suitability of plastic waste modifier in construction of bituminous mixes, where the heated aggregates are transported on conveyor belts the shredded plastic is sprayed on it. So that plastic makes a coat on the aggregate this plastic-coated aggregate was later blended with hot molten bitumen to result in plastic modified bitumen. The research concluded that this waste plastic usage in bituminous concrete mixes resulted in improved resistivity to water absorption and better bonding with reduced susceptibility to stripping. "Useful products from oil and organic chemistry" [8], classifies the plastic as Thermo softening plastics (Thermo plastics) and Thermo setting plastics (Thermo set plastics). Thermo setting plastics can be made plastic and malleable at high temperatures only once. Modern thermoplastic polymers soften anywhere between 65 ºC and 200+ ºC. In this state they can be molded in several ways they differ from thermo set plastics in that, they can be returned to this plastic state by reheating. They are then fully recyclable. PET used in this project belongs to thermo plastics. Thermo-set plastics differ in that they are not re-moldable. Strong cross links are formed during the initial molding process that gives the material a stable structure. They are more likely to be used in situations where thermal stability is required. They tend to lack tensile strength and can be brittle. Polyester resin, Urea formaldehyde etc. belongs to this type. An attempt to utilize the laterite wastes available abundantly in the laterite quarry for the manufacture of laterite soil bricks using cement as a stabilizing agent [2]. This can be used as an alternative to the usual laterite stone. The laterite soil was procured from the laterite quarry near sullia. The study concluded that laterite soil stabilized with 7% cement for manufacturing of interlocking bricks with a good compressive strength of 4.72 N/mm2 . The concept of interlocking bricks of size 30x20x18cm was adopted which resulted in a cost-effective construction [2]. As per the research work on "Use of Cement-Sand Admixture in Laterite Brick Production for Low Cost Housing" [4], in Makurdi (Nigeria) and other locations within Benue State, abundant lateritic soil deposits exist which can be harnessed for brick production. Results showed that laterite used in this study cannot be stabilized for brick production within the economic cement content of 5% specified for use in Nigeria. However, bricks made with laterite admixed with 45% sand and 5% cement attained a compressive strength of 1.80 N/mm2 which is greater than the specified minimum strength value of 1.65 N/mm2. Cost comparison of available walling materials in Makurdi metropolis showed that the use of bricks made from 45% sand and 5% cement resulted in a saving of 30 - 47% when compared with the use of sand concrete blocks while the use of fired clay bricks resulted in a savings of 19% per square meter of wall. The study therefore recommends the use of laterite bricks in Makurdi and other locations because it is more economical and environmentally friendly than fired clay bricks.

In [10], it describes the use of various types of waste materials in different proportions and adopted different methods to produce bricks. Different tests were conducted on produced bricks to evaluate their properties following the various available standards. compressive strength and

water absorption are two common parameters considered by more researchers as required by various standards. It is noted that although many of the studied bricks made from waste material meet the various standard requirements and several patents have been approved, so far commercial production and application of bricks from waste materials is still very limited. The limited production and application of bricks from waste materials is also related to the absence of relevant standard and the slow acceptance by the industry and public.

Recently, in [11] mentioned that there are various research works have been done to find out the safe and environment friendly disposal of plastics. India generates 56 lakh tons of plastic waste annually, where Delhi accounting for staggering 689. 5 tons a day. Approximately, 60% of total plastic waste is collected and recycle in the country per day and the remaining is uncollected and littered. Besides of that, concrete all over the globe has been utilized for required infrastructure. Both material consumptions are increasing day by day in their respective fields. Thus, Inclusion of waste plastic in sand is one of the appropriate ways to dispose it.

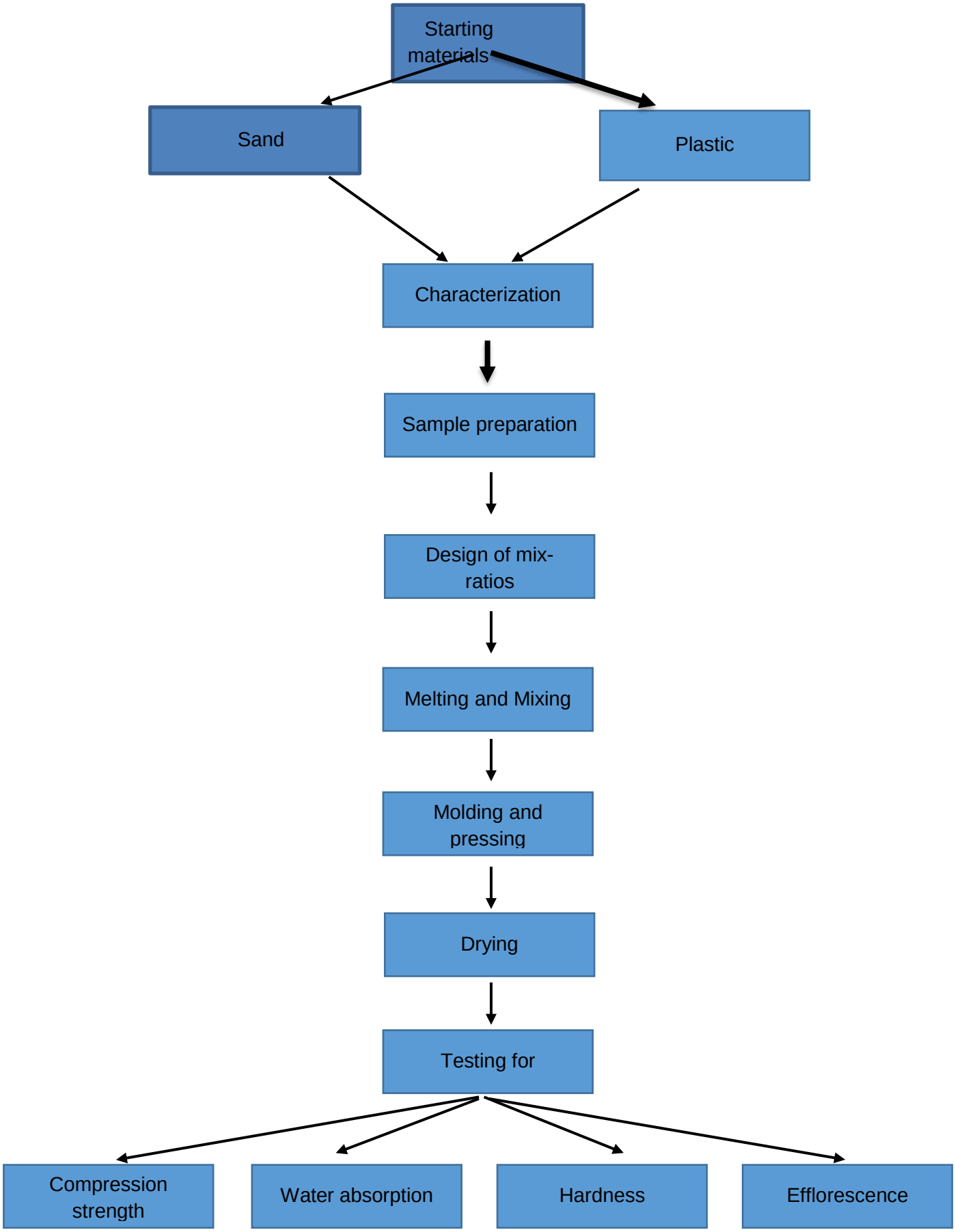
Attempts have been made to incorporate waste in the production of bricks such as use of paper processing residues, cigarette butts, fly ash, textile effluent treatment plant (EPA) sludge, polystyrene foam, plastic fibre, straw, polystyrene fabric granulated blast furnace slag, rubber, craft pulp production residue, limestone dust and wood saw dust, processed waste tea, petroleum effluent treatment plants sludge, welding flux slag and waste paper pulp [12].

4) The various objectives of the proposed work are summarized as follows:

- In this proposal an attempt is made to study regard the properties of the paver blocks manufactured by using LDPE plastic wastes
- To develop an efficient way to effectively utilize the waste plastic as that plastic wastes acts as a great threat for sustainment of ecological balance.
- To evaluate the mechanical and physical properties of paver blocks prepared from waste plastics.
- To replace the conventional plastic waste management techniques with latest eco-friendly scientific techniques.
- To reduce waste plastic quantities on land and water to avoid land and water pollution.
- To produce cost effective product.

5) **Work Plan (including detailed methodology and time schedule)**

Figure 3: Steps to transform plastic waste(LDPE) into paving blocks



Steps to transform plastic waste into paving tiles –

Step1: Sorting the plastics carefully – This is because different types of plastic melt and burn at different temperatures and have different physical qualities.

Step2: Melting until the plastic turn into black liquid – Light a small fire under the metal drum and gently heat it. Add the plastic waste keep adding the plastic gently at the side of the melted plastic until at melts down to a black liquid.

Step3: Mining sand into melt – Keep mining thoroughly until all the plastic has metal and there is a constant black liquid. Stirring and heating must continue until all lumps are removed and a homogeneous paste is obtained.

Step4: Pouring the mixture into moulds – Prepare the mould by making uses it is very clean, with no pieces of plastic on it. Quickly remove the mixture using the spade with the metal shaft and put into the mould.

Step5: Pressing the mixture tightly into moulds - Allow the hot mixture in the mould to set for a few minutes, repeatedly shaking the mould. Keep trying to lift the mould. When the mixture has hardened enough that the slab will not collapse, remove the mould and leave.

Step6: Removing the block from the moulds - Tiles made in this way are as strong as concrete pairing tiles. These can be tested and certified as an approved construction product.

5.1) Mechanical and Physical Testing of Plastic Sand Paver Block

- **Compressive strength test**
- **Water absorption test**
- **Efflorescence test**
- **Impact test**
- **Abrasion resistance test**

MONTH / ACTIVITY	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April
Literature survey									
Discussion and planning about the project									
Design of components									
Analysis of components									
Fabrication of Set up									
Testing of the project									
Report Writing and final submission									

Figure 4: Time Schedule of activities giving milestones through BAR diagram

6. Facilities provided/to be made available at the host institute:

The proposed project will be carried out at Mechanical Engineering Department Madan Mohan Malaviya University of Technology Gorakhpur (U.P.) India. The institute and particularly the Department has qualified and experienced faculty members along with enthusiastic technical supporting staff for proper and effective execution of the project. Along with own departmental laboratory facilities, those of other departments are also available for use as and when required. The facilities like, Internet connectivity, Computational (Software and hardware) with central and departmental facilities, central workshop, central and departmental Library and laboratories are not only for UG & PG teaching but also well equipped for high research work.

6.1) Infrastructural Facilities:

Sr. No.	*Infrastructural Facility*	*Yes/No/ Not required Full or sharing basis*
1.	Workshop Facility	Yes on sharing basis
2.	Water & Electricity	Yes
3.	Laboratory Space/ Furniture	Yes
4.	Power Generator	No
5.	AC Room or AC	Not Required
6.	Telecommunication including e-mail & fax	Yes
7.	Transportation	No
8.	Administrative/ Secretarial support	Yes
9.	Information facilities like Internet/ Library	Yes
10.	Computational facilities	Yes
11.	Animal/ Glass House	No
12.	Any other special facility being provided	No

6.2. Equipment that may be required for the project:

- Furnace Laboratory
- Materials science Lab.
- Mechanical testing lab (Strength of Materials)

6.3) Details of financial requirements:

As most of the setup is available with Mechanical Engineering Department Madan Mohan Malaviya University of Technology Gorakhpur - 273010 (U.P.) India.

Sl. No.	**Head**	**1st Year**
1	**Consumables**	**Rs. 1,90, 000.00**
2	**Travel (within India)**	**Rs. 80, 000.00**
3.	**Contingency**	**Rs. 1,90, 000.00**
4.	**Miscellaneous**	**Rs. 90, 000.00**

Justifications

Consumables:
Consumables like various coated and uncoated cutting tool/ tool inserts, variety of CFRP composites with different fiber orientation and different types of fillers.
Travel:
Intensive travel is required to visit IITs, NITs, Universities labs and other research laboratories and industries to specify the industrial need and research trend across the country. Apart from this, traveling is also required to consult with eminent Professors, researchers and to collect information from libraries of reputed institutes such as IIT, Kharagpur, and Jadavpur University. After conducting machining operations, experimental data may be collected using facilities from other institutes and laboratories such as BRNS, IIT Kharagpur, Jadavpur University, R&D sectors, depending upon the necessity. Fund is essential for travelling for market survey in course of purchase of raw materials/ consumables. For attending different conferences at national/international level, seminar/symposia/workshops and presenting technical reports on outcome of the research in the related field of work, intensive travel will be required.
Contingencies:
This includes expenditure towards advertisement related expenses and selection of supplier for equipment procurement. Stationeries like papers, printer cartridges, CDs, memory devices are to be procured for smooth running of the project. Services from different organizations may be required for testing of the machined products. For purchasing foreign books, journals, periodicals etc fund may be required time to time.

Miscellaneous:
To cover the miscellaneous expenditure required during project work.

7. Expected outcome of the proposed work.

- This method is suitable for the countries which are facing the problem to dispose and recycle the plastic waste. the natural resources consume for the manufacturing of plastic sand bricks and Paver blocks are very much less and compared to its counterparts. The manufacturing cost can be further reduced by replacing the river sand with fly ash or quarry dust or other wastes products.

- The plastics and bricks will possess more advantages which include cost efficiency removal of waste products purse abolishing the land requirement problem for dumping plastic, reduction in the emission of greenhouse gases why conversion of flue gases into synthetic oil and to protect marine wildlife from deadly plastic pollution.

- An eco friendly product, which is complete substitute of plastic in all uses, has not been found till date. In absence of suitable alternative it is impractical to impose a blanket ban on use of plastic all over the country rather than to improve the plastic waste management system.

8. References

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