Manufacturing of Pavement Blocks by Utilizing Waste Plastics with Sand and Comparative Study of the Parameters

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Abstract— Day by day our environment is polluted by large amount of plastic wastes. However there are several plastic waste recycled & reused, they are not done effectively. In order to prevent the Environment pollution caused by plastic waste, we decided to utilize it effectively in the manufacturing of paver blocks. Large amount of plastic wastes have been collected from several places such as tourist and public places etc. High density polyethylene bags are collected, cleaned and used as a replacement for cement in the manufacturing of Paver Blocks. The molten state of plastic is added with Fine aggregate (sand) at different percentages to obtain high strength Paver Blocks that possess good thermal properties and Compressive strength. The plastic waste is available in large quantity and hence the cost factor comes down. Different shades can be obtained by mixing coloring agents such as red oxide. Hence in this Project an attempt is made to study regard the properties of Paver blocks. This is manufactured using plastic waste. Hence the project is helpful in reducing plastic waste in a useful way. In this project we have used plastic waste in different proportions with quarry dust, coarse aggregate and ceramic waste. The paver blocks were prepared and tested and the results were discussed.

Keywords: Waste Plastics, River Sand, Paver blocks, Recycled Plastics

I. Introduction

A. *Background to the Study*

Economic growth and changing consumption patterns are resulting in the rapid increase in the use of plastics in the world. The consumption of plastic materials has increased from 5 million tons in the 1950s to 100 million tons in the 2000s.

In Tripura, about 30 to 35% of our municipal solid wastes produced consist of plastics. The amount of plastic waste is ever increasing due to increase in human population, developmental activities, and changes in lifestyle and socio-economic conditions. Plastic waste is a significant portion of the total municipal solid waste. Therefore there should be the need for proper waste management system.

Solid waste management is one of the major environmental concerns in Tripura. Landfills are becoming scarce and the cost in building landfill sites are increasing. The only ones we have here is the dumping sites which is been managed by the Agartala Municipality Corporation (AMC).

During transportation of wastes from homes and industries by these AMC workers to the dumping sites some fallout from the trucks into gutters. Moreover plastics are being littered and misused all over the City and now causing threat to the nation. Some of these problems associated with plastic waste in Agartala include:

1) Plastics block drains and gutters and causes floods.
2) Plastics release toxic gas into the atmosphere when burnt.
3) Plastic bottles and containers act as breeding ground for mosquitoes when filled with rainwater.

Fortunately, there are various ways in which waste plastics could be reuse or converted to other products. Recycling technology has been the solution of choice in the developed states, but in developing states, like Tripura it may not be economically important since it involve a lot of capital. High density polyethylene (HDPE) waste is used in making bags and dustbins. These materials serve as an alternative for the metallic dust bins and leather bags. Many developing States including Tripura are currently experiencing rapid urbanization and industrialization and as a result a lot of infrastructure developments are going on in these States. Expanded polystyrene (EPS) based waste, high density polyethylene (HDPE), polyethylene terephthalate (PET) waste bottles, polypropylene fibers and polyethylene bags have all been used in different forms by researchers in concrete. PET plastic is one major component of Municipal Solid Waste (MSW) which is becoming a major research issue for its possible use in pavement blocks. Polymer modified pavement blocks has applications in road construction and buildings.

Hence waste PET plastic can therefore, be mixed in concrete mass in some form, without significant effect on its other properties or slight compromise in strength (Polymer Modified Concrete). In this study waste Voltaic bottles found on ICFAI University, Tripura campus were shredded into flakes and was used in the production of pavement blocks.

B. *Problem Statement*

In Tripura, solid waste management is among the primary essential services provided by municipal authorities in the state to keep urban centers clean. However, it is among the most poorly rendered services in Tripura. Systems applied are not scientific, outdated and inefficient, population coverage is low.

Polymer wastes take years to degrade in the natural environment. The slow degradation properties of waste polymer materials cause environmental and ecological problems such as:

1) The burning of waste plastic release toxic gas into the atmosphere
2) Breeding sites for mosquitoes.
3) Causes floods

Therefore there is the need for an efficient and reliable method for solid waste management in Tripura mostly in Agartala. A developing State like Tripura is currently experiencing rapid urbanization and industrialization and as a result a lot of infrastructure developments are going on. These developments come with problems such as shortage of construction materials, high cost of building due to importation of cement and other building materials.

PET plastics waste can be used as a complement of cement or aggregate in the manufacturing of concrete which can help solve the above problems.

C. Main objective

The aim of this research is to determine the suitability of waste voltaic bottles (PET bottles) in the development of pavement blocks for construction.

D. Specific objectives

1) To prepare various proportions of Plastic Sand paver blocks using recycled PET with Sand.
2) To determine water absorption content of Plastic Sand paver blocks.
3) To determine the Hardness of the Plastic Sand Paver Block
4) To determine the engineering property (compressive strength & Flexural strength) of samples of prepared Plastic Sand paver blocks.

E. Scope of the study

In this research work, waste PET plastics found on ICFAI University, Tripura campus were collected, washed and shredded into flakes, heated and then used to replace cement completely whiles some were shredded into pieces and were used to replace quarry dust partially. In order to complement this research and to gain a comprehensive perspective on the growing volume of research on polymer modified pavement blocks, established fundamental and empirical laboratory tests such as compressive strength, water absorption and effect of acids on the mechanical properties were employed to determine the suitability of the pavement blocks made with waste PET bottles in the construction work.

F. Justification

Despite the economic importance of plastics to Tripura's economy, its contribution to waste generation and management problems in the State has resulted in threats by Municipal Corporation and the central government to impose levies on its production or ban its production outright. These threats if carried out will increase the cost of production of plastics and worsen the unemployment situation in Tripura.

Polyethylene, polypropylene, polyethylene terephthalates and polystyrene which are non-degradable polymers form a major composition of the plastic wastes in the environment. Therefore, there is the need for an economically recycling and value addition to the plastic waste generated in our communities. Several studies have been carried out in countries like Egypt, Ghana, Australia, and U.S.A where waste plastics have been converted to other products. India is yet to document a work done on the reuse of plastics into pavement blocks.

This study defines the potentials and benefits in the addition of plastic waste in the concrete mixture to produce a more flexible and durable concrete pavement blocks and at the same time being an alternative way to recycle the plastic waste. The fundamental advantage of plastics replacing aggregates would be reducing the bulk density of the composite and hence improved cost.

II. LITERATURE REVIEW

A. Concrete

Concrete consist of sand or stone, known as aggregate combined with cement paste to bind it. It consist of binding material called cement, composed of lime, silica, alumina and gypsum, that is mixed with sand, aggregate and water. The aggregate can be of various sizes. It is broadly categorized as fine or commonly sand and coarse (typically crushed stone or gravel). In every concrete mixture, the greater proportion is the aggregate which is bulky and relatively cheaper than the cement. Concrete is the most widely used construction material in the world due to its low cost, high availability, and simple constructability. However, the use of cement is a main contributor to high-energy usage, CO2 and dust emissions, natural resource depletion, air pollution, ozone layer destruction, global warming, and continuous environmental deterioration. Concrete is relatively durable and robust building material, but it can be severely weakened by poor manufacture or a very aggressive environment. There are a number of historic concrete structures which exhibit problems that are related to their date of origin. Such problems are being solved by application of polymer in concrete construction.

B. Concrete Pavement Blocks

Concrete pavement blocks were first manufactured in the Netherlands in 1924. It was probably World War II that led to the growth of concrete pavement blocks. Large areas of the Netherlands were destroyed during the War and, because clay bricks were in short supply, concrete pavement blocks were introduced as an alternative (Concrete Manufacturers Association, 2009).

These blocks are rectangular in shape and have more or less the same size as the brick.

Common names for the concrete blocks include paving blocks, pavers, paving stones, interlocking paving blocks and road stones. Paver sizes are a nominal 4x8 inches (100 x 200mm). Block thickness is specified according to traffic and SABS 1200 MJ specifies standard thicknesses of 50, 60, 80, 100 and 120mm. It is not normally economical to manufacture the last two sizes (Cement & Concrete Institute, 2002).

Concrete pavement blocks (paver) have been used in pavements for more than 50 years in Europe. Pavers have being used in heavy industrial port and airfield pavement since 1970's in Europe. This is why recently concrete block pavements have become an attractive engineering and economical alternative to both flexible and rigid pavements. The strength, durability and aesthetically pleasing surfaces have made paving blocks attractive for many commercial, municipal and industrial applications such as parking areas, pedestrian walks, and traffic inter- sections, container yards and roads. Water-retentive concrete block pavements are also used in areas frequented by many people including sideways, parks, and plazas, and such applications are expected to grow in the future.

1) Properties of Concrete Pavement Block

1) Blocks should meet structural requirements for paving (specified in terms of block compressive strength).

2) Blocks should be durable: they should be able to withstand abrasion, impact and chemical attack.
3) Blocks should be of uniform dimensions to facilitate correct and easy placing and ensure good readability.

2) Specification Requirements of a Good Concrete Pavement Block

In some applications concrete blocks are required to be aesthetically attractive. The specification requires that the pavers comply with certain tolerances, and have a compressive strength of 20MPa, for lightly trafficked situations, or 35MPa, for more severe conditions or where a wheel load greater than 30kN is encountered (cement & concrete institute, 2002).

The average absorption of pavement blocks should not exceed 5%, with no individual unit greater than 7% according to American Society for Testing and Materials (ASTM) specification (936).

C. Polymers

The word polymer literally means many (poly) units (mer). A small, simple chemical unit appears to repeat itself a (very) large number of times in the structure of a polymer molecule or macromolecule. The so called repeat unit may consist of a single atom, or more commonly a small groups with the distinctive feature that the repeated units are successively linked to one another on each side by covalent bonds.

Polymers are substances whose molecules have high molar masses and are composed of a large number of repeating units. Polymers can be natural or synthetic. Some naturally occurring polymers are proteins, starches, cellulose, and latex. Synthetic polymers are produced commercially on a very large scale and have a wide range of properties and uses. The materials commonly called plastics are all synthetic polymers.

Polymers are produced by chemical reactions in which a large number of molecules called monomers are joined sequentially, forming a chain. In many polymers, only one monomer is used. Others too consist of two or three different monomers combined. Polymers are also classified by the characteristics of the reactions by which they are formed. If all atoms in the monomers are incorporated into the polymer, the polymer is called an addition polymer. On the other hand, if some of the atoms of the monomers are released into small molecules, such as water, the polymer is called a condensation polymer.

Most addition polymers are made from monomers containing a double bond between carbon atoms. Such monomers are known as olefins, and most commercial addition polymers are polyolefin. Condensation polymers, are formed from monomers that have two different groups of atoms which can join together to form, for example, ester or amide links. Polyesters are an important class of commercial polymers, as are polyamides normally known as (nylon).

The physical and chemical properties of polymers depend on the nature, arrangement of chemical groups of their composition and the magnitude of intra or intermolecular forces that is primary and secondary valence bonds present in the polymer. Degradation process occurs due to the influence of thermal, chemical, mechanical, radioactive and biochemical factors occurring over a period of time resulting in deterioration of mechanical properties and color of polymers.

Polymers have a number of vital properties, which exploited alone or together, make a significant and expanding contribution to constructional needs.

1) Durable and corrosion resistant.
2) Good Insulation for cold, heat and sound saving energy.
3) It is economical and has a longer life.
4) Maintenance free (such as painting is minimized)
5) Hygienic and clean
6) Ease of processing / installation
7) Light weight

D. Polymer Modified Concrete

Polymers have been used in construction as long ago as the fourth millennium B.C., when the clay brick walls of Babylonia were built using the natural polymer asphalt in the mortar. The temple of Ur-Nina (King of Lagash), in the city of Kish, had masonry foundations built with mortar made from 25 to 35% bitumen (a natural polymer) until in the year 1950's where synthetic polymers were incorporated in Portland cement mortars and concrete.

The use of polymers in construction works is becoming common in the world. It physical properties and relatively low cost makes it the most widely used construction material than conventional Portland cement concrete. Conventional Portland cement concrete has a number of limitations, such as low flexural strength, low failure strain, susceptibility to frost damage and low resistance to chemicals. These limitations are well recognized by the engineer and can usually be allowed for in most applications. Polymer modified binders also show improved adhesion and cohesion properties.

In some situations, these problems can be solved by using materials which contain an organic polymer or resin (commercial polymer) instead of or in conjunction with Portland cement. These relatively new materials offer the advantages of higher strength, improved durability, good resistance to corrosion and reduced water permeability. There are three principal classes of composite materials containing polymers. These are:

1) Polymer Impregnated Concrete

The first type which is the polymer impregnated concrete is made by impregnation of pre-cast hardened Portland cement concrete with low viscosity monomers (in either liquid or gaseous form) that are converted to solid polymer under the influence of physical agents (ultraviolet radiation or heat) or chemical agents (catalysts).

The monomers which are widely used in the impregnation of concrete are the vinyl type, such as methyl methacrylate (MMA), styrene, acrylonitrile, t-butyl styrene and vinyl acetate. The preferred impregnated materials are acrylic monomer systems such as methyl methacrylate or its mixtures with acrylonitrile, because they have low viscosity, good wetting properties, high reactivity, relatively low cost and result in products with superior properties. The applications of concrete impregnated in depth in building and construction include structural floors, high performance structures, food processing buildings, sewer pipes, and storage tanks for seawater, desalination plants and distilled water plants, marine structures, wall panels, tunnel liners, prefabricated tunnel sections and swimming pools.

2) Polymer Cement Concrete

The polymer cement concrete is a modified concrete in which part (10 to 15% by weight) of the cement binder is replaced by a synthetic organic polymer. It is produced by incorporating a monomer, pre-polymer-monomer mixture, or a dispersed polymer (latex) into a cement-concrete mix. To affect the polymerization process of the monomer or pre-polymer-monomer, a catalyst is added to the mixture.

Generally, polymer cement concrete made with polymer latex exhibits excellent bonding to steel reinforcement and to old concrete. Its compressive, flexural strength and toughness are usually higher than those of unmodified concrete and also the modulus of elasticity may or may not be higher than that of unmodified concrete, depending on the polymer latex used. Generally, as the polymer forms a low modulus phase with the polymer cement concrete, its creep is higher than that of plain concrete and decreases with the type of polymer latex used in the following order: polyacrylate, styrene-butadiene copolymer, polynvinylidene chloride, unmodified cement

The major application of latex-containing polymer cement concrete is in floor surfacing, as it is non-dusting and relatively cheap and also because of its lower shrinkage, good resistance to permeation by various liquids such as water and salt solutions, and good bonding properties to old concrete, it is particularly suitable for thin (25 mm) floor toppings, concrete bridge deck overlays, anti-corrosive overlays, concrete repairs and patching.

3) Polymer Concrete

Polymer concrete (PC) is a composite material in which the binder consists mainly of a synthetic organic polymer. It is variously known as synthetic resin concrete, plastic resin concrete or simply resin concrete.

The use of a polymer instead of Portland cement represents a substantial increase in cost; polymers should be used only in applications in which the higher cost can be justified by superior properties, low labor cost or low energy requirements during processing and handling.

E. Interactions between polymer and cement

Polymer modified concrete or mortar is a composite material consisting of two solid phases. These phases are: the aggregates which are discontinuously dispersed through the material and the binder which itself consists of a cementations phase and a polymer phase. According to the volume fraction of the polymer in the binder phase the material shifts from PCC, i.e. polymer cement concrete, to PC, i.e. polymer concrete. In the case of PCC, the binder consists of a polymer-cement co-matrix. The polymer is added to the fresh mixture as an emulsion or as re dispersible polymer powders. During hardening and curing, cement hydration and polymer film formation take place resulting in a co-matrix in which polymer film is intermingled with cement hydrates. Cement hydration in polymer modified material is influenced by the presence of the polymer particles and polymer film in the fresh state, during hydration as well as in the hardened state. The properties such as strength of the fresh mixture are influenced to a large extent by the surfactants present at the surface of the polymer particles. The cement particles are better dispersed in the mixture and a more uniform material is formed. The hydration of the cement is reflected in the strength evolution of the material.

The influence of the polymer modification is in two fold; firstly, due to the polymer and the surfactants, a retardation process of the cement hydration can be observed. This is especially visible in the compressive strength of the mortar beams. On the other hand, due to the film formation or due to the interaction between the cement hydrates and the polymer particles, the tensile strength of the binder matrix as well as the adhesion strength between the aggregate and the binder increase. The mutual influences between the cement hydrates and the polymer particles and film are incorporated in an integrated model of structure formation. Immediately after mixing, the cement particles and polymer particles are dispersed in the water. The first hydration of the cement takes place, which results in an alkaline pore solution. This is indicated as the first stage.

In the second step, a portion of the polymer particles is deposed on the surface of the cement grain and the aggregate. The polymer-cement ratio determines the amount of polymers present in the pore solution and present at the aggregate surface. Part of the polymer particles may coalesce into a continuous film. This preferably takes place at the surface of the cement hydrates where extra forces are exerted on the polymer particles due to the extraction of water for cement hydration. The polymer film can partly or completely envelop a cement grain, which results in a retardation or even a complete stop of the hydration of the cement grain.

The final step includes further hydration and final film formation. Through the cement hydrates, a continuous polymer film forms as water is further removed from the pore solution. The part of the polymer particles, that is still present in the dispersion, is restricted to the capillary pores and at the interface of the aggregates and the bulk polymer-cement phase. It is this part which contributes the most to the elastic and final strength properties. The continuity of the polymer phase through the binder matrix is more pronounced in the case of a higher polymer- cement ratio. If the polymer dispersion is much more elevated than the curing temperature, the polymer particles may not coalesce into a continuous film, but remain as closely packed polymer particles.

F. Polyethylene terephthalate (PET)

Polyethylene terephthalate (PET) is thermoplastic in nature, meaning it can be recycled after use. It’s also known as “polyester, which often causes confusion, because polyester resins are thermosetting materials (Mishra, 2016).

PET is generally produced via two different routes or mechanisms; transesterification of dimethyl terephthalate (DMT) with ethylene glycol (EG) and direct esterification of purified terephthalicacid (TPA) with EG. The first stage of the two routes, known respectively as transesterification (ester interchange) and direct esterification, both produce a mixture of ethylene glycol ester of terephthalic acid. This mixture of linear oligomers (mainly bis-hydroxyethyl terephthalate) is subjected to a further stage known as polycondensation that produces polyethylene terephthalate of fiber-forming molecular weight. Solid state polymerization is required only for the production of bottles. Poly (ethylene terephthalate) known by the trade names Mylar, Dacron , ethylene, recon has high crystalline melting temperature (260°C), and the stiff polymer chains possess in the PET polymer imparts high mechanical strength, toughness and fatigue resistance of150- 175°C as well as good chemical, hydrolytic and solvent resistance. Poly (ethylene terephthalate) fiber has a very good crease resistance, good abrasion resistance and can be treated with cross-linking resin to impart permanent wash and wear properties. The fiber can be blended with cotton and other cellulosic fibers to give better feel and moisture permeation. Thus PET fiber is used for applications such as wearing apparel, curtain, upholstery, thread, tire cord filaments, industrial fibers and fabric for industrial filtration.

1) Properties of Polyethylene Terephthalate (PET)

PET is hygroscopic, which means that it absorbs water from its surroundings. However, when this "damp" PET is then heated, the water hydrolyzes the PET, decreasing its resilience. Thus, before the resin can be processed in a molding machine, it must be dried. Drying is achieved through the use of a desiccant or dryers before the PET is fed into the processing equipment.

The polymer is composed of repeating un its each unit having a physical length of about 1.09 nm and a molecular weight of ~200.The aromatic ring coupled with short aliphatic chain makes the polymer a stiff molecule as compared to other aliphatic polymers such as polyolefin or polyamide. The lack of segmental mobility in the polymer chains results in relatively high thermal stability.

2) Polyethylene terephthalate (PET) in concrete work.

PET is a transparent polymer, which has good mechanical properties and good dimensional stability under variable load.

To date, there are only three major ways which have been identified to recycle waste PET bottles into construction materials. Firstly, waste PET bottles can be depolymerized into unsaturated polyester resin to produce polymer mortar and polymer concrete. It benefits include that, the polymer concrete has higher compressive and flexural strength than conventional Portland cement concrete , and that polymer concrete achieves over 80% of its ultimate strength within 1 day. However, the properties of polymer concrete are sensitive and subjected to temperature and the cost of producing polymer concrete from waste plastic is high.

The second method employs the use PET fiber to reinforce concrete. The use of PET fiber can enhance the ductility of quasi-brittle concrete and, therefore, reduce the cracking caused by plastic shrinkage. However, the water-resistance and low surface energy of plastic materials result in a weak mechanical bond between the fiber and the cement matrix. Poor mechanical bond strength may cause internal micro-cracks in the interfacial mechanical bond area between the fiber and the cement matrix

The last recycling method is to substitute PET waste for apportion of the aggregate used in the production of lightweight concrete or asphalt concrete. This method provides the most economical way to accomplish two important goals: to dispose of waste plastic and to produce lightweight concrete. However, the addition of PET waste negatively affects the quality of the concrete by decreasing its compressive strength, splitting tensile strength, and modulus of elasticity Recently, a fourth method has been attempted whereby a recycled PET bottle flakes are directly used as binder. The PET plastics are heated and with two types of soil, clay and sand, to attain a uniform fused mix named plastic-soil. Recycled PET bottles used to produce mortar, have a promising results.

In short, blocks with PET replacement have the following features as compared to conventional blocks:

1) Greater weather resistant due to chemically inert PET and HDPE;
2) Less stress or load on foundation (due to lighter blocks);
3) Economical foundation (since the stress on foundation is less)
4) Less manual labor in making blocks (mixture is lighter);
5) Less cost of transportation (due to lighter blocks)
6) Good sound insulation;
7) Variable strengths (dependent on size and nature of plastic aggregate);
8) Better shock absorption
9) Deduction in the dead load of concrete structure which allows the contractor to reduce the dimension of columns, footing sand other load bearing elements(precast strips with circular gaps) or by executing frames which have led to easy forms (caissons, - shaped roof elements etc.).

G. Solid waste management in Agartala, Tripura.

The Agartala Municipality was instituted in 1871 AD during the reign of Maharaja Chandra Manikya (1862- 96 AD). The 1st British Political Agent, Mr. A.W.B. Power appointed for hill Tipprah in 1871 AD, was offered the honor of being the Chairman of the Agartala Municipality. The Municipal Administration in Agartala was established in 1874 A.D and the city became a planned city by the then Maharaja Bir Bikra Manikya Bahadur in 1940s.This erstwhile Princely State Capital of Tripura merged with India on 15th October 1949. Present area of AMC is 58.84 sq km. The estimated quantity of Municipal Solid Waste (MSW) generated worldwide is 1.7 – 1.9 billion metric ton. With rapid urbanization, the situation is becoming critical. The urban population has grown fivefold in the last six decades with 285.35 million people living in urban areas worldwide as per the 2001 Census. Solid waste management is one of the basic essential services provided by municipal authorities in the country to keep urban centers clean. However, it is among the most poorly rendered services in Tripura .The systems applied are unscientific, outdated and inefficient; population coverage is low; and the poor are marginalized. Solid Waste is littered all over leading to insanitary living conditions in our communities. Municipal laws governing the urban local bodies do not have adequate provisions to deal effectively with the ever- growing problem of solid waste management.

Municipal solid waste" (MSW) is a term usually applied to a heterogeneous collection of wastes produced in urban areas, the nature of which varies from region to region. The characteristics and quantity of the solid waste generated in a region is not only a function of the living standard and lifestyle of the region's inhabitants, but also of the abundance and type of the region's natural resources. Urban wastes can be subdivided into two major components -- organic and inorganic. In general, the organic components of urban solid waste can be classified into three broad categories:

putrescible, fermentable, and non-fermentable. Putrescible wastes tend to decompose rapidly and unless carefully controlled, decompose with the production of objectionable odors and visual unpleasantness. Fermentable wastes tend to decompose rapidly, but without the unpleasant accompaniments of putrefaction.

III. METHODOLOGY & INVESTIGATION

A. *Materials*

1) *Waste plastics*

By definition the plastics can be made to different shapes when they are heated in closest environment it exists in the different forms such as cups, furniture's, basins, plastic bags, food and drinking containers, and they are become waste material. Accumulation of such wastes can result into hazardous effects to both human and plant life. Therefore, need for proper disposal, and, if possible, use of these wastes in their recycled forms, occurs. This can be done through process of plastic management. Waste management in respect to plastic can be done by recycling. If they are not recycled then they will become big pollutant to the environment as they not decompose easily and also not allow the water to percolate in to the soil and they are also poisonous.

Fig. 1: Waste plastics

SI.NO	PHYSICAL PROPERTIES	VALUES
1	Tensile Strength	1700 (Mpa)
2	Heat of Fusion	166 (J/g)
3	Water Absorption (after 24hrs)	0.5%
4	Melting Point	265 (°C)
5	Density	1.38–1.40 g/ml
6	Breaking Strength	50 (Mpa)

Table 1: Physical Properties of Pet

2) *River Sand*

Sand is naturally occurring granular material which is composed of mineral particles and finely divided material. The composition of sand varies depending on the local rock conditions and sources, but the most constituent of sand in Inland continental settings and non-tropical coastal region is silica dioxide (Sio2) in the form of quartz. The second commonly used sand is the calcium carbonate, for example aragonite, which has mostly been created, over the past half billion years, by various forms of life, like coral and shellfish. Sand are now used in all the construction process.

Fig. 2: River Sand

SI.NO	PROPERTIES	VALUES
1	pH	7.25
2	Specific gravity	2.6
3	Hardness	5-6 Mohs
4	Melting Point	1649 (°C)
5	Bulk Density	1.71 kg/m3
6	Water absorption	3%

Table 2: Properties of River Sand

B. *Control Mix Design*

In order to find the Plastic Soil Paver blocks that they possess high compressive strength with various mix proportions are made and they are tested using compressive testing machine. The mix proportions were in the ratio of (1:2, 1:3, 1:4, 1:5, and 1:6). These are the ratio which represents the plastic, river sand respectively.

In first step we should collect the waste plastic water bottles are sorted out and remaining is disposed safely. Next the collected waste Bottles are cleaned with Water and dried to remove the water present in it after this the plastics are burned out by using Kerosene (Fuel) ACC Blocks and firewood.

The ACC Blocks are arranged to hold the Iron casted Stock Pot and the firewood is placed in the gap between the ACC Blocks and it is ignited. The Stock Pot is placed over the above setup and it is heated to remove the moisture present in it. Then the plastic water bottles are added to the Stock Pot one by one and the river sand is added to the plastic when it turns into hot liquid. The sand is added is mixed thoroughly using rod and trowel before it hardens. The mixture has a very short setting hence mixing process must not consume more time on the other hand the process should be complete.

Fig. 3: Mix Design Making

C. Test Conducted

To know the quality of plastic sand paver blocks following tests can be performed. In these tests some are performed in laboratory and the rest are on field.

1) Compressive Test

Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material. Generally five specimens of blocks are taken to laboratory for testing and tested one by one. In this test a paver block specimen is put on crushing machine and applied pressure till it breaks. The ultimate pressure at which block is crushed is taken into account. All five paver block specimens are tested one by one and average result is taken as paver block's compressive strength. The plastic sand paver blocks of different ratios are tested one by one and in this the high compression.

Fig. 4: Compressive strength for plastic sand paver blocks

SI NO	Ratio of PAVER BLOCK	Sand (in Kg)	Plastic(in Kg)	VALUE
1	Plastic Sand Blocks (1:3 Mix Ratio)	1	3	23.5N/mm^2
2	Plastic Sand Blocks (1:4 Mix Ratio)	1	4	22 N/mm^2

Ratio (Sand: Plastic Bottle)	Compressive strength (MPa)	Average of Compressive strength (MPa)
(1 : 3)	13.87	14.13
	14.32	
	14.19	
(1 : 4)	17.09	17.02
	16.93	
	17.05	

Table 2: Compressive strength of Plastic sand paver

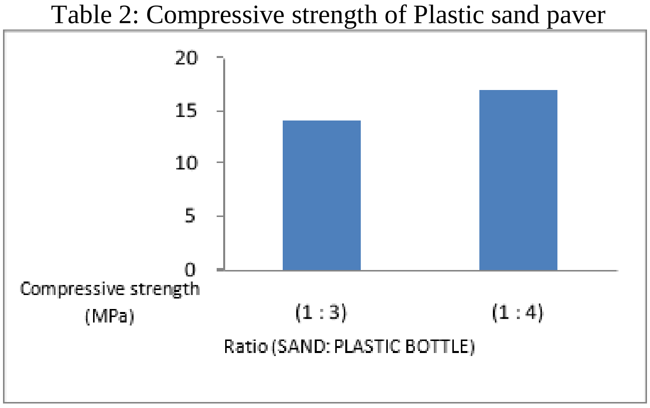

Fig. 1: Compressive Strength (Mpa) V/S Ratio (SAND: PLASTIC BOTTLE)

2) Flexural Strength

The flexural strength of a material is defined as its ability to resist deformation under load. For materials that deform significantly but do not break, the load at yield, typically measured at 5% deformation/strain of the outer surface, is reported as the flexural strength or flexural yield strength.

Fig. 5: Flexural strength for plastic sand paver blocks

SI NO	Ratio of PAVER BLOCK	Sand (in Kg)	Plastic(in Kg)	VALUE
1	Plastic Sand Blocks (1:3 Mix Ratio)	1	3	2.95N/mm^2
2	Plastic Sand Blocks (1:4 Mix Ratio)	1	4	3.12 N/mm^2

Table 3: Flexural strength of Plastic sand paver

3) Water absorption test

In this test, paver blocks are weighed in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion, those are taken out from water and wipe out with cloth.

Then paver block is weighed in wet condition. The difference between weights is the water absorbed by the paver block. The percentage of water absorption is then calculated.

The less water absorbed by the paver block the greater its quality. Good quality paver block doesn't absorb more than 5% of its own weight.

Water absorption of test specimen = 2.2 %

As per IS 15658:2006 water absorption percentage within 5%, the result of specimen is 2.2% hence it is satisfied.

4) Fire resistance test

The Plastic is highly susceptible to fire but in case of Plastic sand Paver blocks the presence of sand imparts insulation. There is no change in the structural properties of block up to 180ºC above which visible cracks are seen and the blocks deteriorate with increase in temperature.

5) Hardness test

In this test a scratch is made on block surface with steel rod (any hard material can be used) which was difficult to imply the blocks were hard. This shows the brick possess high quality.

6) Rebound Hammer Test

When the plunger of rebound hammer is pressed against the surface of the paver block, the spring controlled mass rebounds and the extent of such rebound depends upon the surface hardness of paver block. The surface hardness and therefore the rebound is taken to be related to the compressive strength of the paver block. The rebound is read off along a graduated scale and is designated as the rebound number or rebound index.

Ratio (SAND: PLASTIC BOTTLE)	Compressive strength (MPa)	Rebound Number (N_R)		Average of Rebound Number (N_R)	
		Horizontal Hammer Position	Vertical Hammer Position	Horizontal Hammer Position	Vertical Hammer Position
(1 : 3)	13.87	22.30	18.56	22.58	18.92
	14.32	22.84	19.20		
	14.19	22.60	19.00		
(1 : 4)	17.09	26.90	22.40	26.68	22.19
	16.93	26.34	21.93		
	17.05	26.80	22.23		

Table 4: (Rebound Hammer Test)

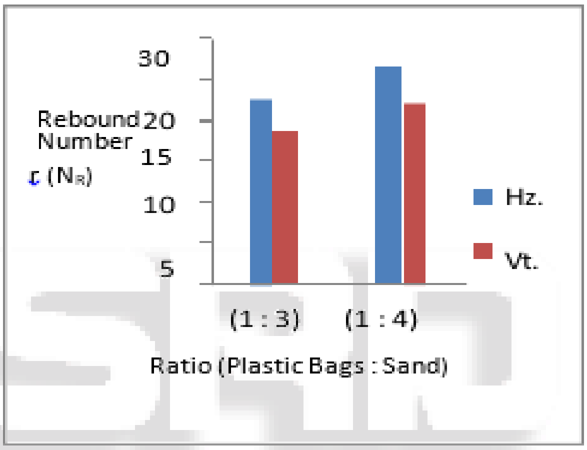

Fig. 2: Rebound Number (Nr) V/S Ratio (Plastic Bags: Sand)

IV. CHAPTER FOUR RESULTS AND DISCUSSION

A. Result

	Abrasion Value (%)	Compressive strength (MPa)	Rebound Number (N_R)		Cost Per Block (Rs.)
			Horizontal Hammer Position	Vertical Hammer Position	
Plastic Paver Block	12.13	22.02	26.68	22.19	12 /-
Concrete Paver Block (Reference 1, 3)	14.70	23.89	26.10	21.84	28 /-
Difference	2.57	1.87	0.58	0.35	16 /-

Table 5: (Comparison between Concrete Paver Block and Plastic Paver Block)

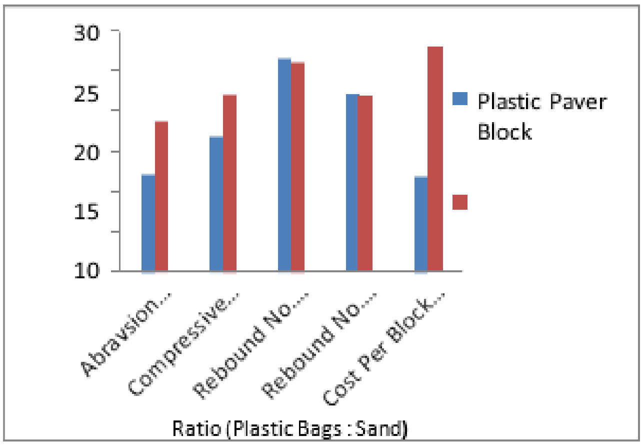

Fig. 3: Plastic Paver Block V/S Concrete Paver Block

V. CONCLUSION

A. Conclusion

Living organisms, particularly marine animals, can also be affected through entanglement, direct ingestion of plastic waste, or through exposure to chemicals within plastics that cause interruptions in biological functions.

The Plastic Sand Paver Blocks possess more advantages which include Cost efficiency, Removal of waste products thus abolishing the land requirement problem for dumping plastic, Reduction in the emission of greenhouse gases by the conversion of flue gases into synthetic oil etc.

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