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TITLE OF PROJECT REPORT

Submitted in partial fulfillment of the requirements

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Bachelor of Engineering

in

Civil Engineering

by

15CE32 Momin Mohd Shabee
16CE36 Sayed Ali
17CE10 Aarif Abdul Sattar
17CE31 Mansuri Mohd Saqlain

Under the guidance of

Prof. Dhaval Shah

Department of Civil Engineering

Anjuman-I-Islam's Kalsekar Technical Campus
Sector 16, New Panvel , Navi Mumbai
University of Mumbai

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CERTIFICATE

Department of Civil Engineering

Anjuman-I-Islam's Kalsekar Technical Campus
Sector 16, New Panvel , Navi Mumbai
University of Mumbai

This is to certify that the project entitled **Recycling of Plastic Waste in Civil Engineering** is a bonafide work of **Mohd Shabee (15CE32), Sayed Ali (16CE36), Aarif Abdul Sattar (17CE10), Mansuri Mohd Saqlain (17CE31)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of Bachelor of Engineering in Department of Civil Engineering.

Supervisor	Examiner
Head of Department	Director

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Project Report Approval for Bachelor of Engineering

This project entitled " **Recycling of Plastic Waste in Civil Engineering"** by **Mohd Shabee , Sayed Ali , Aarif Abdul Sattar , Mansuri Mohd Saqlain** is approved for the degree of **Bachelor of Engineeringin Civil .**

Examiner

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I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Momin Mohd Shabee
(15CE32)

Sayed Ali
(16CE36)

Aarif Abdul Sattar
(17CE10)

Mansuri Mohd Saqlain
(17CE31)

Date:

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15CE32 Momin Mohd Shabee
16CE36 Sayed Ali
17 CE10 Aarif Abdul Sattar
17CE31 Mansuri Mohd Saqlain

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Abstract

Recycling of Plastic Waste in Civil Engineering

The Plastic Pavers is prepared by utilizing the waste plastics. Plastic waste which is increasing day by day becomes eyesore and in turn pollutes the environment, especially in Metropolitans areas. A large amount of plastic is being brought into the separation regions are discarded or burned which leads to the contamination of environment and air. Hence, these waste plastics are to be effectively utilized. The waste plastic is heated and added with sand at various percentages to obtain Paver blocks to control pollution and to reduce the overall cost of construction. Hence in this work, an attempt is made to study regard the properties of the Plastic Paver block which is manufactured using plastic wastes. In this present work the Plastic paver are made by adding 40%, 50%, 60% and 70% of plastic waste by weight of sand required to fill mould of pavers. In that four trail work, it is found that minimum 60% waste additive is required to get desired shape of mould and 70% waste additive Trail is found have minimum compressive strength of 14.7 MPa.

KEYWORDS: Plastic waste, quarry dust, Plastic Pavers.

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Contents

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List of Abbreviations

PE	Poly Ethylene
PVC	Polyvinyl Chloride
PP	Poly Proplylene
PS	Poly Sterene
PET	Poly Ethylene Terephthalene
LDPE	Low Density Poly Ethylene
FA	Fine Aggregate
CA	Coarse Aggregate

Chapter 1

Introduction

1.1 General

• Plastic waste is increasing due to increase in population, urbanization and development. The disposal of waste plastic has become a serious problem globally due to their nonbiodegradability.

• The average plastic waste produced in India per year is15432 tones among which 6000 tones remains uncollected. In India the plastic waste are majorly disposed by burning and only less amount of plastic waste is recycled

• The largest component of the plastic waste is polyethylene, followed by polypropylene, polyethylene Terepthalate and polystyrene. Fortunately, there are various ways in which waste plastics could be reuse or converted to other products. High density polyethylene (HDPE) waste is used in making bags and dustbins. Polymer modified pavement blocks has applications in road construction and buildings. Hence waste plastic bags can therefore, be mixed in concrete mass in some form, without significant effect on its other properties or slight compromise in strength.

• The replacement of plastic waste for cement provides potential environmental as well as economic benefits. With the view to investigate the behaviour of quarry rock dust, recycled plastic, production of plastic paver block from the solid waste a critical review of literature was taken up.

1.2 Objective

• To determine the suitability of waste plastic materials in the development of pavement blocks for construction and to reduce the burden of waste plastic by reusing into pavement.

• To evaluate the performance of plastic concrete for paver blocks for use in pavements and other application areas.

• To produce cost-effective paver block which a common person can afford easily.

1.3 Why to recycle plastic ?

- Plastic in the oceans is responsible for the deaths of millions of sea animals
- Plastic never degrades
- Incinerating plastic contributes to greenhouse gases
- Plastics contain harmful chemicals
- Making new plastic requires significant amounts of fossil fuels

1.4 Advantages:

- Recycling one ton of plastic can save 7.4 cubic yards of landfill space
- It reduces the water pollution and air pollution (from land filling) by reducing the need for conventional waste disposal and it reduces greenhouse gases emissions.
- Plastic Recycling helps to reduce energy usage
- Plastic can be used in building , construction , electronics , packing and transportation industries .

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Chapter 2

Literature Review

2.1 General

The work done by the various investigators is referred and summarized here in this chapter. The referred journal and conference papers and reports are presented below. At the end, the research gaps have been reviewed.

2.2 Review of Literature

1) Aditya Singh Rawat1, R. Kansal, PET Bottles as Sustainable Building Material: A Step Towards Green Building Construction,Journal of Civil Engineering and Environmental Technology Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 1, Number 6; August, 2014 pp. 1-3. This paper proposes theuse of waste plastic PET bottles as construction entity to standardizedbricks. As plastics are non-biodegradable its disposal has always been a problem. Waste plastic bottles are major cause of solid waste disposal.Polyethylene terephthalate is commonly used for carbonated beverage andwater bottles. This is an environmental issue as waste plastic bottles aresdifficult to biodegrade and involves processes either to recycle or reuse. Today the construction industry is in need of finding cost effectivematerials for increasing the strength of structures. This project deals withthe possibility of using waste PET bottles as a partial replacement. It can be concluded that benefit of the use of PET bottles include both improved ductility in comparison with raw blocks and inhibition of crack propagation after its initial formation. The solution offered in the paper is one of the answers to long standing menace of waste disposal.

2) Karasawa et al. (2003) studied that tests were conducted on the fresh properties and the strength characteristics of concrete paver blocks in which a large amount of raw fly ash was used in place of fine aggregate. Concluded that concrete paver blocks with the FA replacement ratio of 25% and satisfied the production target value of the plastic deformation (at most 1 mm). The mix with the FA replacement ratio of 25%, the dry cast concrete blocks for pavement satisfied the production target value of the

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plastic deformation (at most 1 mm). Also founded that fly ash (40% content) was considered inappropriate as a substitute for fine aggregate in concrete.

Aslantas Onur et al. (2004) concluded that concrete paving blocks show best performance at specific water content called optimum moisture content. By testing abrasion resistance the pigments used for the upper part of the mix has an effect on the abrasion resistance. As the cement content in a mix increases to obtain higher strengths, the W/C ratio should be lowered as higher water contents cause some stability and segregation problems.

Nataraja M. C. Et al. (2007) investigated that various properties such as compressive, split tensile, bending strength and water absorption of paver blocks consisting of crushed granite, unconventional materials such as kadapa and broken paver for various percentage replacement of coarse aggregate were studied as per IS 15658: 2006. broken paver Aggregate was not suitable in making paver blocks as water absorption was more than 7 %. However, 50% replacement of paver aggregate with natural aggregate may be used

3) Youcef Ghernouti et al. 1 The study present the partial replacement of fine aggregate in concrete by using plastic fine aggregate obtained from the crushing of waste plastic bags. Plastic bags waste was heated followed by cooling of liquid waste which was then cooled and crushed to obtained plastic sand having finesse modulus of 4.7. Fine aggregate in the mix proportion of concrete was replaced with plastic bag waste sand at 10%, 20%, 30% and 40% whereas other concrete materials remain same for all four mixes. In fresh properties of concrete it was observed from the results of slump test that with increase of waste content workability of concrete increases which is favorable for concrete because plastic cannot absorb water therefore excessive water is available. Bulk density decreases with increase of plastic bags waste. In harden state, flexural and compressive strength were tested at 28 days and reductions in both strengths with increasing percentage of plastic bag waste sand in concrete mix. Plastic waste increases the volume of voids in concrete which on other hand reduce the compactness of concrete simultaneously speed of sound in concrete is also decreased. Strength reduction in concrete mix was prime concern; however they recommend 10 to 20% replacement of fine aggregate with plastic aggregate. Use of admixtures to address the strength reduction property of concrete with addition of plastic aggregate is not emphasized.

4) Raghatate Atul M.2 The paper is based on experimental results of concrete sample casted with use of plastic bags pieces to study the compressive and split tensile strength. He used concrete mix by using Ordinary Portland Cement, Natural River sand as fine aggregate and crushed granite stones as coarse aggregate, portable water free from impurities and containing varying percentage of waste plastic bags (0%, 0.2%, 0.4%, 0.6% 0.8% and 1.0%). Compressive strength of concrete specimen is affected by the addition of plastic bags and with increasing percentage of plastic bag pieces compressive strength goes on decreasing (20% decrease in compressive strength with 1% of addition

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of plastic bag pieces). On other hand increase in tensile strength of concrete was observed by adding up to 0.8% of plastic bag pieces in the concrete mix afterward it start decreasing when adding more than 0.8% of plastic bags pieces. He concluded that utility of plastic bags pieces can be used for possible increase in split tensile strength. This is just a basic study on use of plastic bags in concrete. More emphasis was required by varying the shape and sizes of plastic bags to be use in concrete mixes.

5) Praveen Mathew et al. [2013]3 They have investigated the suitability of recycled plastic as partial replacement to coarse aggregate in concrete mix to study effect on compressive strength, modulus of elasticity, split tensile strength and flexural strength properties of concrete. Coarse aggregate from plastic was obtained by heating the plastic pieces at required temperature and crushed to required size of aggregate after cooling. Their experimental results shown that plastic aggregate have low crushing (2.0 as compare to 28 for Natural aggregate), low specific gravity(0.9 as compare to 2.74 for Natural aggregate), and density value(0.81 as compare to 3.14 for Natural aggregate), as compare to Natural coarse aggregate. Their test results were based on 20% substitution of natural coarse aggregate with plastic aggregate. Increase in workability was reported when slump test for sample was carried out. Volumetric substitution of natural aggregate with plastic aggregate was selected best in comparison with grade substitution. At 400 centigrade temperature Plastic coarse aggregate shown considerable decrease in strength as compare to normal concrete. An increase of 28% was observed in compressive strength but decrease in split tensile strength and modulus of elasticity was observed. They recommended that with use of suitable admixture @0.4% by weight of cement will improve the bonding between matrix and plastic aggregate; however they demand more research to address the tensile behavior of concrete prepared with 20% plastic aggregate.

6) R L Ramesh et al. 4 They have used waste plastic of low density poly ethylene as replacement to coarse aggregate to determine its viable application in construction industry and to study the behavior of fresh and harden concrete properties. Different concrete mix were prepared with varying proportions (0%, 20%, 30% & 40%) of recycle plastic aggregate obtained by heat treatment of plastic waste (160-200 centigrade) in plastic granular recycling machine. A concrete mix design with 1: 1.5: 3 proportions was used having 0.5 water/cement ratio having varying proportion of plastic aggregate as replacement of crushed stone. Proper mixing was ensured and homogeneous mixture was prepared. A clear reduction in compressive strength was reported with increase in percentage of replacing plastic aggregate with crushed aggregate at 7, 14 and 28 days of casted cubes (80% strength achieved by replacing waste plastic up to 30%). The research highlights the potential application of plastic aggregate in light weight aggregate. Their research was narrowed down to compressive strength of concrete with no emphasis given to flexural properties of concrete. They suggest future research scope on plastic aggregate with regard to its split tensile strength to ascertain its tensile behavior and its durability aspects for beams and columns.

7) Zainab Z. Ismail et al. [2007]5 they have conducted comprehensive study based on large number of experiments and tests in order to determine the feasibility of reusing plastic sand as partial replacement of fine aggregate in concrete. They conducted tests on concrete samples for dry/fresh density, slump, compressive and flexural strength and finally toughness indices on room temperature They have collected waste plastic from plastic manufacture plant consist of 80% polyethylene and 20% polystyrene which was crushed (varying length of 0.15-12mm and width of 0.15-4mm). Concrete mix were produce with ordinary Portland cement, fine aggregate (natural sand of 4.74mm maximum size), coarse aggregate (max size below 20mm) and addition of 10%, 15% and 20% of plastic waste as sand replacement. Their test results indicate sharp decrease in slump with increasing the percentage of plastic, this decrease was attributed to the presence of angular and non uniform plastic particles. In spite of low slump however, the mixture was observed with good workability and declared suitable for application. Their tests also revealed the decrease in fresh and dry density with increasing the plastic waste ratio; however increase was reported in dry density with time at all curing ages. Decrease in compressive and flexural strength was observed by increasing the waste plastic ratio which can be related to decrease in adhesive strength between plastic waste particles with cement. However, load-deflection curve of concrete containing plastic waste showed the arrest of propagation of micro cracks which shows its application in places where high toughness is required. The study has shown good workability in spite of low slump but w/c content kept constant in all samples. They should have reduced the water content in order to improve the strength when workability was not an issue.

2.3 Gaps and Findings

A. The researchers have represented different forms of plastic waste which can be use in production of concrete. They proposed the replacement of various concrete ingredients with suitable plastic waste material. Their proposals were based on results obtained from experimentation of various casted concrete samples.

B. Most of the researchers have restricted their work to analyze the specific concrete property which does not reflect the true behavior of concrete containing plastics. Concrete is a composite material in which all the properties have direct or indirect relation.

C. The main focus of researchers was on the compressive strength of concrete containing plastics and very less attention was given to other properties of concrete.

D. All the researchers used the typical concrete ingredients with plastic waste and no attention was given to admixtures and use of fly ash etc which can alter the properties of concrete.

E. A plastic with low specific gravity have great potentials in light weight concrete but was not comprehensively covered by any of the researcher.

F. Based on above literature work we reached to a conclusion that Plastic waste can be successfully use in concrete. Reduction in density and compressive strength was reported by all researchers. The area of focus of all the researchers was limited to compressive strength and a wide gap is left for further research on other properties of concrete produce by using plastic wasted. Plastic waste material requires detail investigation on behavior of its various types in concrete.

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Chapter 3

Experimental Procedure

3.1 Properties of Materials

A) Plastic:- Plastic is a synthetic material made from a wide range of organic polymers such as polyethylene, PVC, nylon, etc., that can be moulded into shape while soft, and then set into a rigid or slightly elastic form. Looking seriously at the global issue of environmental pollution posed by post consumer plastic wastes, research is being focused in depth on finding out more ways and means to consume this waste material on a massive scale in an efficient and environment friendly manner. PET is used for high impact resistant container for packaging of soda, edible oils and peanut butter. Used for cereal box liners, Microwave food trays. Used in medicine for plastic vessels and for Implantation. Plastic is heat resistant and chemically stable PET is resistant to acid, base, some solvents, oils, fats. PET is difficult to melt and it is transparent.

Table 1 : Thermal Behaviour of Polymer

Sr. No.	Polymer	Softening Temp. (in °C)	Decomposition Temp. (in °C)	Ignition Temp. range (in °C)
1	PE	100 -120	270 – 350	>700
2	PP	140 - 160	270 – 300	>700
3	PS	110 - 140	300 – 350	>700

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Plastic have many good characteristics which include:

Versatility

- Lightness
- Hardness
- Resistant to chemicals, water and impact

Plastic is one of the most disposable materials in the modern world. It makes up much of the street side litter in urban and rural areas. It is rapidly filling up landfills as choking water bodies. Plastic bottles make up approximately 11% of the content landfills, causing serious environmental consequences.

Types of Plastic	Percentage of Plastic	Bending Strength in kg	Compression Strength
Poly ethylene	10 20 25 30	325 340 350 400	250 270 290 325
Poly propylene	10 20 25	350 370 385	280 290 310
Poly styrene	10 20 25	200 210 215	155 165 170
Polyethylene Foam	10 20 25	310 325 335	250 265 290
L Polyethylene Foam	10 20 25	340 360 365	270 290 310
Limited Plastics	10 20 25	360 385 400	290 310 335

Table 2 Type of plastic and variation in bending strength

S. No.	Description	MORTH 2001 Specification	Result	IS Code
1.)	Impact test	Max 30	4.30%	IS 2386 part 4
2.)	Hardness test by Los Angele's	Max 30	20.13%	IS 2386 part 5
3.)	Flakiness index	Max 30	23.62%	IS 1211 - 1978
4.)	Elongation index	Max 30	29.16%	IS 1211 – 1978
5.)	Water absorption test	Max 2	0.206%	IS 0383 - 1970

Table 3 Physical properties of aggregate

3.2 Methodology

Note : Since because of pandemic we are not able to carry out any tests.

So we are putting here the different case studies given by different authors.

The Author's name is **Aditya Joshi** Published in October 2018.

In order to find the plastic paver blocks that they possess high compressive strength with various mix proportions are made and they are tested using compressive testing machine. The mix proportion were in the ratio of (1:1, 1:2, 1:3, 1:4) These are the ratio which represent the plastic, aggregate respectively.

- In first step we should collect the waste plastic bags and the polyethylene bags are sorted out and remaining are disposed safely.
- Next the collected waste bags are cleaned with water and dried to remove the water present in it after this the plastics are burned out.

- The drum is placed over the above setup and it is heated to remove the moisture present in it. Then the plastic bags are added to the drum one by one and the aggregate is added to the plastic when it turns into hot liquid.
- The aggregate 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.

This mixture is then poured in to the mould and they are compacted using steel rod and surface is finished using trowel.

Chapter 4

Result and Discussion

Note : Since Because of Pandemic we are unable to carry out any tests.

So we are going to consider of few case studies. And the name of the author is Aditya Joshi.

4.1. Compressive test: The apparatus shall comprise of compression testing machine which shall be equipped with two steel bearing blocks for holding the specimen. It is desirable that the blocks have a minimum hardness of 60 (HRC) and a minimum thickness of 25 mm. The block on top through which load is transmitted to the specimen shall be spherically seated. The block below on which the specimen is placed shall be rigidly fitted. When the bearing area of the steel blocks is not sufficient to cover the bearing area of the paver block specimen, two steel bearing plates meeting the requirements shall be placed between the steel plates fitted on the machine and the specimen.

S. No.	Dimension of block (mm)	Plastic& Aggregate Ratio	Maximum load in KN (P)	Compressive strength (N/mm^2)
1)	100 X60X100	1:1	130	5.01
2)	100 X60X100	1:2	200	7.7
3)	100 X60X100	1:3	300	11.5
4)	100 X60X100	1:4	150	5.77

Table no. 4 Compressive strength of different ratio for plastic

S. No.	Dimension of block (mm)	Plastic& Aggregate Ratio	Maximum load in KN (P)	Compressive strength (N/mm^2)
1)	100 X60X100	1:1	70	2.69
2)	100 X60X100	1:2	150	5.77
3)	100 X60X100	1:3	185	7.12
4)	100 X60X100	1:4	240	9.23

Table no. 5 Compressive strength of different ratio for 14 days

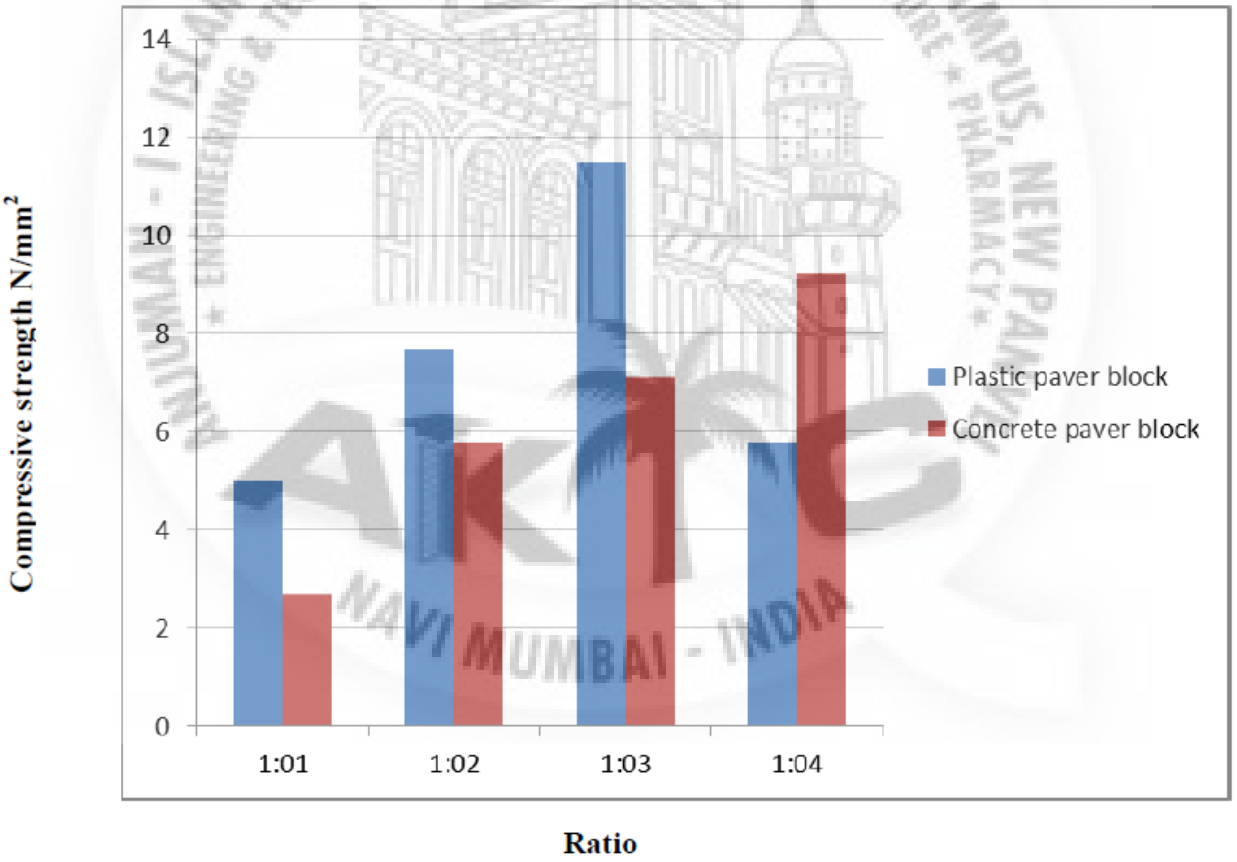

Fig 1. Comparison of plastic paver blocks and concrete paver blocks

4.2. Water Absorption

The test specimen shall be completely immersed in water at room temperature for 24 ± 2 h. The specimen then shall be removed from the water and allowed to drain for 1min by placing them on a 10mm or coarser wire mesh. Visible water on the specimens shall be removed with a damp cloth. The specimen shall be immediately weighed and the weight for each specimen noted in N to the nearest 0.01 N.

S. No.	Plastic & Agg. Ratio	Weight of dry blocks W_1 (Kg)	Weight of wet blocks W_1 (Kg)	Water absorption (%)
1)	1:1	2.62	2.68	0.06
2)	1:2	2.99	3.04	0.05
3)	1:3	2.92	2.96	0.04
4)	1:4	2.97	3.01	0.04

Table no. 6 Water absorption of paver blocks

4.3. Fire Resistence of blocks :

The Plastic is highly susceptible to fire but in case of Plastic Aggregate Paver blocks the presence of aggregate imparts insulation. There is no change in the structural properties of block of paver up to 1300 C above which visible cracks are seen and the blocks deteriorate with increase in temperature.

4.4 . Cost Estimate

Labour cost: Labours required

1) Head mason – 1/10 No´s
2) Labour – 3 No´s
3) Bristi – ½ No´s

Head Mason rate – 800 Rs/day
Labour rate- 400 Rs/day

One labour can manufacture 300 blocks

So, Labour cost per unit block = 1480/900 = 1.5 Rs/brick

Material cost:

1.) **Plastic** - Nil
2.) **Aggregate** – 2.5 Rs/Kg

Aggregate required for 1 block = 2.5 kg

Cost of aggregate = 2.5 X 2.5 = 6.25Rs/block

Transportation cost:

Aggregate

Density of aggregate = 1660 kg/m3
Volume of truck = 14.5 m3
Rate for 1 trip of truck = 4000 Rs
Cost of transport of aggregate =4000/23200 = 0.17 Rs/Kg
Cost of aggregate = 0.17 X 2.7 = 0.4 Rs/block

Plastic

Quantity of plastic filled in a truck = 3000 kg
Cost of transport of plastic = 4000/3000 = 1.3 Rs/kg
Cost of plastic = 1.3 X0.57 = 0.7 Rs/kg

Total cost of block:

Cost of block = 1.5 + 6.25 + 0.4 + 0.7= 8.85Rs/block
Profit 10 % of 8.85=.885Rs/block
Total manufacturing cost of block = 9.7Rs/block

Chapter 5

Conclusion

The generation of waste plastics is increasing day by day. The major polymers, namely polyethylene, polypropylene, and polystyrene show adhesion property in their molten state. Hence, the use of waste plastic for plastic blocks is one of the best methods for easy disposal of waste plastics.

Plastic blocks are made with the help of plastic waste which is otherwise harmful for all living beings. Not only in India but globally the disposal of plastic has become an issue of major concern. In order to deal with this problem new concept of Plastic blocks came into existence. Material which is considered as waste can be utilized in making material for construction. Every year thousands of animals die due to effect of plastic hence if this plastic will be used in making something useful it would be beneficial in preserving our wildlife as well as marine life. These blocks are very cheaper in cost therefore the dream of helter of the poor people can be fulfilled by using these blocks. Drawback of these blocks is that they cannot be decomposed after use. It is also weakening the ozone layer by releasing harmful gases but these problems can be reduced by making plastic. which can decompose. Recycling of the plastic can also contribute or reduce the negative effect of Plastic blocks.

A plastic paver block gives high result as compare to concrete paver blocks with aggregate use. Overall Plastic blocks is a cost efficient and resource efficient building material which can be used to deal with the various environmental problems as well for the reduction in the cast of construction. We can conclude that using the concept of Plastic blocks is cost effective, energy efficient and commercially feasible. Using PET bottles is also Bio-climatic and thus we can say it is a Green construction.

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