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PLASTIC BASED CONCRETE BRICKS

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Abstract - Plastic waste is increasing day by day, especially in the form of use and throw like plastic bags for daily usage ,drinking water bottles, designed to be convenient, inexpensive and accessible. Plastic disposal, however, is difficult as plastic is non-biodegrable and has a lower recyclability rate than other types of materials such as glass ,metals and paper. Concrete blocks can be manufactured using plastic flakes as an alternative material aggregate. This study aimed to developed such blocks and tested them for compressive strength integrating four major factors. The cement to aggregate ratio, the water to cement ratio, the size of plastic flakes used and the proportion of plastic flake that replaced sand. Using a ratio of 1:3 cement to aggregate, where the aggregate mix comprised of 20% small and medium sized plastic flakes plus 80% sand and a water to cement ratio of 0.5, provided the optimal compressive strength to form a concrete block that can be used to construct a wall. This study aims of reducing pollution due to plastic waste and creating an alternative for fine aggregate to some percentage.

1. INTRODUCTION

The development of technology has brought many comforts to the ever increasing world population. Such progress, however, has also increased the demand for energy and, as a consequence, created massive environmental damage. A further danger to the environment is the growth of the consumer society, typified by convenience and disposability. The popularity of the plastic water bottle illustrates the escalating problems of consumption and waste. Out of the total waste produced 15-20 % is synthetic materials, including plastics, and 60% solid waste. However, only 30% of plastic can be disposed of by recycling, or by melting, incinerating and processing methods which emit environmentally destructive gasses into the atmosphere. Landfill is a popular method of waste disposal but this method comes at a high environmental cost. Landfill produces toxins that are released into the atmosphere or leach through the soil to contaminate ground and river water supplies and eventually the destruction of marine ecosystems In addition, composting is not possible because the plastic used in water containers can take up to 700 years to decompose. As the demand for plastics increases, especially in the form of packaging, the petro-chemical industry continues with its contribution towards the greenhouse effect which is considered a major attribute to global warming. The properties of plastic bottles made from PET (Polyethylene Terephthalate) have been studied extensively. PET is a lightweight polymer, with a relatively low density, at about 15-60 kg/m3. If PET plastic bottle flakes are mixed with, or used to replace, the aggregates of general construction materials, such as mixing with concrete or forming bricks, it can make the building material lower in weight and density. Thus, producing a light weight but strong material that can be used in general construction such as building a wall. Rapid growth of construction industries requires a lot of building materials that utilizes natural resources either in their production plant or as the materials itself. More recently the world concern about the demands for construction materials and the rate production of plastic that increases swiftly every year. In turn, both industries contribute in increasing the MSW. Since the rate of production is projected to double the value in every 10 years, a more sustainable and safer way is needed to be taken into action. Banning or minimizing plastic usage is not practicable to solve the problem as it is nearly impossible for different sectors to run efficiently without plastic. Mining of natural resources on the other hand is an energy waste process as only 900 million tons of raw materials is produced from 6000 million tons of waste generated. They may be differ in constitution of raw materials but posses the same in contributing to various environmental threats. Hence, utilizing plastic waste in brick production can solve both the MPW and demands for construction materials. Previous studies showed the possibility of using plastic waste in bricks application but the bricks produced are still lacking of durability as a safe construction materials. The aim of this paper is to review the application of plastic waste in bricks.

OBJECTIVES:

- To replace the plastic with some amount of fine aggregate.
- To increase the strength of the cement bricks by mixing it with definite proportions of plastic.
- To provide the low cost cement bricks in the market that may be affordable for common people.
- To make the high strength, low weight cement bricks.
- To increase the life of the cement bricks.
- To produce the energy efficient bricks than the common burnt bricks.

- To reduce natural resources in the manufacturing of cement bricks.
- To replace aggregates with waste materials.
- To minimize the cracks in the bricks by using plastic having better cohesion.

2. LITERATURE REVIEW:

- UTILISATION OF WASTE PLASTIC IN MANUFACTURING OF BRICKS AND PAVER BLOCKS
  Dinesh.S, Dinesh.A, Kirubakaran.K 2016
  Plastic waste which is increasing day by day becomes eyesore and in turn pollutes the environment, especially in high mountain villages where no garbage collection system exists. A large amount of plastic is being brought into the tourist trekking regions are discarded or burned which leads to the contamination of environment and air. Hence, these waste plastics are to be effectively utilised. 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 ondegradable pollutant. This alternatively saves the quanta of sand/clay that has to be taken away from the precious river beds/mines. The plastic waste is naturally available in surplus quantity and hence the cost factor comes down. Also Colouring agents can be added to the mixture to attain desired shades. Hence in this thesis, an attempt is made to study regard the properties of the brick which is manufactured using plastic wastes.

- MANUFACTURING AND TESTING OF PLASTIC SAND BRICKS:
  Mr.N.Thirugnanasambantham, P.TharunKumar, .R.Sujithra, R.Selvaraman, P.Bharathi April-2017
  Plastic sand brick possess more advantages which includes cost efficiency, resource efficiency, reduction in emission of greenhouse gases, etc., Plastic sand brick is also known as “Eco-Bricks” made of plastic waste which is otherwise harmful to all living organisms can be used for construction purposes. It increases the compressive strength when compared to fly ash bricks. By use of plastic sand bricks, the water absorption presence of alkalies was highly reduced. Owing to numerous advantages further research would improve quality and durability of plastic sand bricks.

- CEMENT SOIL BRICKS: MANISH KUMAR SAHU, LOKESH SINGH Nov – 2017
  In this paper the bricks are made by mixing cement with soil especially clay that resulted in, It offers good comfort conditions, comparable to brick and masonry buildings or ceramic blocks, offering no conditions for the proliferation of insects harmful to public health, meeting minimum living conditions. This material has good resistance and perfect waterproofing features, resisting weathering and humidity, facilitating conservation. The application of roughcast or plaster mortar is unnecessary due to the smooth finish of monolithic walls as a result of the perfection of pressed faces and material impermeability requiring only the application of a simple cement-based painting, further increasing its impermeability, as well as visual appearance, comfort, and hygiene. Low aggression to the environment, since it eliminates the firing process. Low transport costs when produced at the construction site. Low cost compared to conventional masonry.

- THE DEVELOPMENT OF CONCRETE BLOCK CONTAINING PET PLASTIC BOTTLE FLAKES:
  TanutWaroonkun,TanapongPuangpinyo&YuttanaTongtuam Oct-2017
  This paper presents the effects on the density and compressive strength of concrete blocks when fine aggregate is replaced by plastic bottle flakes. The fine sand aggregate was replaced in the mortar mix at varying percentage points and the data, on density and compressive strength, was recorded. The study results indicate that the concrete blocks, with plastic flake replacing sand in the mortar mix at a ratio of 20% by weight, can be used in the construction of a non-load-bearing wall. Many of the blocks in the study, however, had a compressive strength only slightly higher than the minimum standard value (2 MPa). This suggests that the blocks composition needs to be improved in order to bear greater compression.

- STRENGTH CHARACTERISTICS OF ECOFRIENDLY CEMENT BRICKS USING SOLID WASTE COMPOSITES:
  Mohammed Yaseen, Puttaraj M H , Ravitej M Bandlekar Jan-2018
  In the present study various trial mixes were made and moulded bricks were casted using the solid waste components like waste glass, waste plastic, fly ash, bed ash, and some percentage of cement in various proportions and its compressive strength, fallingtests, shapetest, water absorption. The study can be extended by using the solid waste fractions as coarse aggregate and using different plastics other than LDPE and HDPE and different fly ash ratio under different proportions. Further experimentation can be made by adding suitable admixtures the curing period can be decreased.

- EFFECT OF PRESSURE ON MAKING OF CEMENT BRICKS FROM PUMICE:
  Mufti Amir Sultan, Kusnadi, Muhammad TaufiqYudasaputra May-2018
  This paper expressed the results of the strength characteristics of cement brick pumice sand proportion of 1 PC : 4 Sand with load / pressure on the manufacturing process of 1.33 MPa, 2.67 MPa, 4 MPa, 5.33 MPa, 6.67 MPa has a compressive strength value

32.50 kg/cm^2, 61.16 kg/cm^2, 73.36 kg/cm^2, 81.17 kg/cm^2, 93.76 kg/cm^2. This shows that the greater the load/pressure at the time of manufacture the higher the strength of the brick cement produced. Cement bricks using pumice sand produce lighter weight than cement bricks of natural sand with the same load / pressure on the manufacturing process.

- PLASTIC IN BRICK APPLICATION:
  SitiNabilahAmir and NurZulaikhaYusof Aug-2018
  A variety of plastic waste has been used in many ways in bricks production. The compressive strength of the bricks produced comply the standard outlined, which is more than the acceptable range outlined. A suitable proportion between plastic waste and other materials used need to be optimized to meet the standard outlined for manufacturing of bricks. Further research and development is needed to improve the quality and durability of plastic bricks.

- STUDY OF PLASTIC BRICKS MADE FROM WASTE PLASTIC:
  RajarapuBhushaiah, Shaik Mohammad, D. SrinivasaRao Apr-2019
  Waste plastic, which is available everywhere, may be put to an effective use in brick. Plastic bricks can help reduce the environmental pollution, thereby making the environment clean and healthy. Plastic sand bricks reduce the usage of clay in making of bricks. Plastic sand bricks give an alternative option of bricks to the customers on affordable rates. Water absorption of plastic sand brick is zero percent. Compressive strength of plastic sand brick is 5.6 N/mm2 at the compressive load of 96KN. Theyconclude that the plastic sand bricks are useful for the construction industry when we compare with Fly Ash bricks and 3rd class clay bricks.

- UTILISATIONOF PLASTIC WASTE FOR MAKING PLASTIC BRICKS:
  R. S. Kognole, KiranShipkule, Manish Patil, LokeshPatil Jun-2019
  Due to increasing population, the demand of plastic materials and necessary requirement also increases. Brick is largest materials used in the construction industries and occupied in very large amount of materials of the project especially in residential projects. We use various types of plastic with various combinations to produce different type of bricks. We find the different properties of bricks by conducting various tests on it. Among them compression and water absorption test is most common test conducted on bricks by the various researches. But the use of such types of bricks is very limited in the industry. We need to convenience the people to use the such types of bricks and increase the use of it.

- RECYCLING WASTE PLASTIC BAGS AS A REPLACEMENT FOR CEMENT IN PRODUCTIO OF BUILDING BRICKS & CONCRETE BLOCKS:
  Abdel Tawab OF, Amin MR, Ibrahim MM, Abdel Wahab M March-2020

Recycling waste plastic is sustainable and can conserve natural resources. The percentage of recycled plastic can be increased by transforming waste plastic into mortar and concrete products suitable for housing and construction. In this study, melted plastic bags were used as a replacement for cement in the production of construction building bricks and concrete blocks. Using waste plastic in making bricks and blocks is advantageous due to its extreme versatility and ability to be tailored to meet specific technical needs and its light weight compared to other competing material which reduces fuel consumption during transportation. Also replacing cement with waste plastic will reduce environmental problems associated with the disposal of waste plastic as well as those associated with the cement industry. The results showed that the thermal conductivity depended upon the plastic content of the molded materials. Decreases in the thermal conductivity were observed with increases in the plastic content of both the bricks and concrete blocks. Increasing the plastic content from 33.33% to 66.67% (100%) in the bricks decreased the thermal conductivity from 1.70x10-3 watt/m.K to 1.43x10-3 Watt/m.K (16 %) while increasing the plastic content from 20% to 50% in the concrete blocks decreased the thermal conductivity from 1.61x10-3 watt/m.K to 1.50x10-3 Watt/m.K (7 %). The results also showed that bricks and concrete blocks with similar plastic contents (50%) have similar thermal conductivity values.

METHODOLOGY:

MATERIALS USED:

- CEMENT

The manufacturing of Cement was conducted by heating limestone (calcium carbonate) with small quantities of other materials (such as clay. Tests were carried out on various physical properties of cement and the results are shown in test data of materials. cement will act as a binding material.

- SAND

We are using M-Sand in the mix. Manufactured sand (M-Sand) is artificial sand produced from crushing hard stones into small sand sized angular shaped particles, washed and finely graded to be used as construction aggregate. It is a superior alternative to River Sand for construction purpose.

- WATER

Water is an important ingredient of bricks as it actively participates in the chemical reaction with cement. Since it help to form the strength giving cement gel reinforcement

and concrete inside thecentre hole of this brick and act as load bearing of column.

- GRAVEL

Gravel is classified by particle size range and includes size classes from granule to boulder-sized fragments. The gravel is categorized into granular gravel (2 to 4 mm or 0.079 to 0.157 in) and pebblegravel (4 to 64 mm or 0.2 to 2.5 in). ISO 14688 grades gravels as fine, medium, and coarse with ranges 2 mm to 6.3 mm to 20 mm to 63 mm. One cubic metre of gravel typically weighs about 1,800 kg.

- PET PLASTIC

Polyethylene terephthalate, commonly abbreviated PET, PETE, or the obsolete PETP or PET-P, is the most common thermoplastic polymer resin of the polyester family and is used in fibres for clothing, containers for liquids and foods, thermoforming for manufacturing, and in combination with glass fibre for engineering resins. It can be used in construction industry in bricks or other building components.

- Type of Concrete Mix

In the manufacture of concrete blocks, cement is mixed with aggregates, such as sand and gravel. Therefore, the main mix consisted of:

(1) Portland cement type 1,

(2) M-sand,

(3) Gravel flakes

(4) Water

(5)PET plastic

Cement to Aggregate Ratio

The ratio mix varies according to the purpose of concrete application. In the research work, with the addition of plastic flakes for structural work, the ratio of cement to aggregates (C/A) was approximately 1:3. In alternative block production, added M-soil to replace sand using a 1:6 ratio. Therefore, setting the cement to sand ratio should not be more than the ratio used in most factories, 1:6. If too little cement is used when mixed with plastic flakes, (which are not a common material for building walls), the cement and aggregates will not bond.

- Water to Cement Ratio

In addition to compressive strength tests of blocks that include aggregates of non-typical materials like plastic flakes, tests need to account for the variance in cement to water ratios. It was found that concrete with a water to cement ratio of 0.5 could bear better compression than a 0.6 ratio, if a 0.45 ratio is used, the compressive strength was better than a 0.55 ratio. Due to the specificity and size of the plastic flakes when mixed with other aggregates, increasing the proportion of water may improve the ability of the cement to mix with the sand and in turn adherence to the plastic flakes. Moreover, the amount of water will increase the weight and density of the blocks resulting in greater efficiency of heat transfer.

- Proportion of Plastic Flake Replacement

In thi research, the replacement of aggregates using plastics variation is 0-100%. The replacement ratio will be below 20%, which is the range where the concrete bears the compression well. Mazouk et al., Shalaby et al., Akçaözoğluet al, set the range of sand replacement at 50-100% and up to the replacement of 30%, the compressive strength of the blocks reduced gradually. With 30% or more, the compressive strength was greatly reduced since low density plastic flakes would replace higher density sand. The density of concrete blocks is a factor that affects the compressive strength. In these tests, replacement ranges include 0, 5, 10, 15, and 20% of the sand aggregate by weight.

- Mixing

Mixing of materials is essential for the production of uniform and strength for brick. The mixing has to be ensure that the mass becomes homogeneous, uniform in color and consistency. Generally, there are two types of mixing, Hand mixing and mechanical mixing. In this project, we adopted hand mixing. Until the entire plastic content required for making plastic brick of one mix proportion is added into it. then these plastic liquids thoroughly mixed by using trowel before it hardens. The mixture has very short setting bags are turned to molten state; the M sand is added to it. The sand added is mixed time. Hence mixing process should not consume more time.

- Moulding

After completion of proper mixing we place mix into required mould. In this projects we use the normal brick sizes (5*4*9 in). After 2 days remove the brick from the mould and then done curing.

- Curing

The test specimens after moulding were allowed to dry for a period of 24 hours. The specimens were kept in curing tank and allowed to cure for a period of 28 days.

Tests on Bricks

i. Compression strength test

The cube specimens was placed in compression testing machine and the load is to be applied without shockand increased continuously at a rate of approximately 140 kg/cm2 min untilthe resistance of the specimen to the increasing load breaks down and no greater load can be

restrained. The maximum load applied to the specimens is to be recorded and the appearance of the brick and any unusual features in the type of failure is noted.

Compressive strength = Maximum load

Area of the specimen =P/A

Where, P -Maximum load (kN)

A - Area of the specimen (mm2)

ii. Water absorption test

In this test, bricks 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, brick is weighed in wet condition. The difference between weights is the water absorbed by brick. The percentage of water absorption is then calculated. The less water absorbed by brick the greater its quality. Good quality brick doesn't absorb more than 20% water of its own weight .

Water absorption = {[W2 – W1] / W1} x 100

Where,

W1 = Weight of dry brick (kg)

W2 = Weight of wet brick (kg)

iii. Efflorescence test

The presence of alkalis in bricks is harmful where it forms a gray or white layer on brick surface by absorbing moisture. To find out the presence of alkalis in bricks, this test is performed. In this test, a brick is immersed in fresh water for 24 hours. Then, it is taken out from water and allowed to dry in shade. If the whitish layer is not visible on surface, it proofs that absence of alkalis in brick. If the whitish layer visible about 10% of brick surface, then the presence of alkalis is in acceptable range. If that is about 50% of surface, then it is moderate. If the alkali's presence is over 50%, then the brick is severely affected by alkalis.

iv. Hardness test

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

v. Fire resistance test

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

vi. Soundness test

The soundness test is also done in the field. After the manufacturing of the brick are allowed to dry in air for 2days.Then the bricks are made to hit each other the ring sound produced during the process, which denotes the quality of the brick that it is good. Good quality bricks produce the clear ringing sound. In our project both fly ash bricks and plastic sand bricks clear ringing sound produced.

3. CONCLUSIONS

Plastic waste which is available everywhere can be used effectively in brick making. By using plastic in bricks we can reduce the plastic waste in our environment and it also reduces environmental pollution. Plastic bricks reduces the usage of clay in bricks and they give an alternate option of bricks for much lesser cost. Water absorption of plastic sand bricks will be very less. The use of PET in plastic bricks has the potential to limit the amount of plastic being disposed of into the environment. Nowadays, PET is a good quality product and biodegrades extremely slowly, having a serious negative impact on the environment. Systematic use of the smaller sized PET aggregate in the construction industry could be a good solution to reducing this environmental impact.

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