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Construction of Paving Blocks by using Plastic Waste

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Abstract:- Countless plastics have been gathered from a variety of locations, including commercial and open places. When making plastic paver blocks, high density polyethylene plastic is gathered, cleaned, and utilised in place of aggregate. The central governing body of India said that more than 30.5 lakh tone of plastic garbage was generated in 2018–2019 and 34 lakh tone of waste in 2019–2020 and 2020–21. Waste for 2021 is not computed Over the past decade, India's production of plastic waste has increased by an average of more than double that amount, 21.8 % annually. Projects like Plastic Paver Block help reduce plastic waste in various ratios with aggregate. Since plastic degrades far more slowly than other types of waste, the initiative is beneficial in finding practical ways to reduce plastic waste on the planet. According to a study on them, plastic paver blocks are a better choice than conventional cement paver blocks.

I. INTRODUCTION

Paver block pavement is adaptable, aesthetically pleasing, practical, affordable, and requires little to no care provided it is made and installed properly. Although there are two primary areas of concern, most of the concrete block paving constructed in India has also operated satisfactorily: infrequent failure brought on by extreme surface wear and variability in block strength. Natural resource depletion worldwide is accompanied by a significant increase in waste produced by industry and human occupancy. Sustainable development for the building industry entails the use of unusual and new materials as well as the recycling of waste materials in order to make up for the shortage of natural resources and explore alternative means of environmental preservation.

The local region provided the plastic garbage that was utilised in this project. The amount of plastic garbage dumped in India each year is currently at 56 lakh tonnes **[1].** The environment is polluted by the rubbish placed there. Consequently, it has direct and indirect effects on both people and animals. Therefore, it's important to dispose of plastic garbage correctly in accordance with the rules set forth by our government. Use of concrete paver block in road pavements is more common nowadays. Concrete paver block is a better option in road construction when compared to the conventional road which is made by bitumen and gravel **[2].** Paver block is versatile, aesthetically attractive, functional, and cost effective and requires little or no maintenance if correctly manufactured and laid **[3].** They stay solid and, unlike thermoplastics cannot be re-melted. Based on the advantages of thermoplastics over thermoset Plastics, it is preferably used in production of paver blocks **[4-5].** Brick is one of the most common masonry units used as building material. Due to the demand, different types of waste have been investigated to be incorporated into the bricks **[6].** 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 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 **[7].** The nearness of the saturated zone to the land surface and the manner of fluctuation of this zone has direct effect on the geotechnical properties of the soil. These in turn influence the stability of engineering structures such as houses, bridges, dams, and roads **[8-9]**. Natural resources such as limestone used in the manufacture of cement are constantly being depleted globally while generation of wastes especially plastic is on the increase on a daily basis thereby creating an imbalance in the sustainability of our dear environment. The construction sector is therefore in need of non-conventional and innovative materials, whose availability is not a challenge in order to replace the diminishing of natural resource **[10-11]**. Plastic is very common material that is now widely used by everyone in the world. Waste plastic is used to make plastic paver blocks. The separating area's environment and air are contaminated due to the large amount of plastic waste being disposed of or burned there. Sand is manually placed into heated garbage plastic that is also operated mechanically.

Recyclable plastic plays a major role in this period as it is compact & light in the weight. The big problem with plastic is its decomposition. Plastics are made from polymer chemicals and are not biodegradable. The use of eco-friendly and lightweight building material has grown in popularity in the building industry. Consumption of plastic materials from 5 million tonnes in the 1950s to 100 million in the 2000.

II. EXPERIMENTAL METHODS

A. *Materials*

In view of the proposed experimental study, the materials used are:

- Cement
- Sand
- Aggregates
- Plastic
- Mould

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a) Cement
Portland concrete in the typical sense is utilised throughout the project. Because blocks must gain strong strength very soon to allow for early delivery without significant breakages, the strength class should be 42,5 or above. Where the experiments were conducted, the cement was available.

Fig. 1: Cement

S.NO	Properties	Result	IS-Required
1	Specific gravity	2.5	-
2	Initial Setting Time	30 mins	As per IS4031-1986 max 30 min
3	Final Setting Time	600 mins	As per IS4031-1986 max 600 min

Table 1: Property Tests on Cement

b) Sand
Considering that crusher sand is less expensive than regular sand, it was utilised throughout the whole project. On-site supplies of sand were made available for use throughout building and testing.

Fig. 2: Sand

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c) Aggregates

The project uses coarse aggregates. The aggregates were offered on the property where the tests and construction were done. Particle size, grading, particle shape, and hardness all work together to determine how well aggregates perform during the moulding process and in the hardened block.

Fig. 3: Aggregates

Coarse Aggregate	**Size**
Fine gravel	4mm - 8mm
Medium gravel	8mm - 16mm
Coarse gravel	16mm - 64mm
Cobbles	64mm - 256mm
Boulders	>256mm

Table 2: Size of Coarse Aggregate.

S.NO	**Properties**	**Result**
1	Specific gravity	2.70
2	Water absorption	0.53
3	Bulk density	1406 kg/m³

Table 3: Property Tests on Coarse Aggregate

a) Plastic

This project made use of LDPE plastic (low density polyethylene). a synthetic material that can be moulded into shape while still being soft and is then hardened to take the form of a solid or slightly elastic material. Plastic was collected from the nearby landfill. Plastic bags are used for the project.

Fig. 4: Plastic

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S.NO	Properties	Result
1.	Specific gravity	1.5
2.	Water absorption	0.18

Table 4: Property Tests on Plastic

b) Mould
Mould used in this project are PVC plastic dumbbell shaped mould for construction of concrete paver blocks and iron casted mould for construction of plastic paver blocks. The mould was provided on site where the tests and construction were carried out.

Fig. 5: PVC plastic mould.

Fig. 6: Pre casted iron mould

Size:
350*250 – PVC plastic mould.
350*250- Pre casted iron mould.

III. EQUIPMENTS USED

The equipment used while performing these tests can be described as below:

A. IMPACT TESTING APPARATUS
An impact testing device that adheres to the following standards and is of general form

- An inside measurement steel cup that is cylindrical with: 50 mm of depth, a minimum thickness of 6.3 mm, and a diameter of 102 mm.
- A case-hardened, cylindrical, lower end of a metal hammer with a weight between 13.5 and 14.0 kg, a diameter of 100.0 mm, and a length of 5 cm. The upper end should also have a 2 mm chamfer. For the bottom (cylindrical) portion of the hammer to be above and concentric with the cup, it must freely travel between vertical guides.
- A way to raise the hammer to a height of 380.0 mm and then let it fall freely between the vertical guides onto the test sample in the cup. a way to change the height of the fall by no more than 5 mm.

B. Los Angeles Abrasion Testing Apparatus

- A hollow steel cylinder with a diameter of 700 mm on the inside and a length of 500 mm on the inside will make up the Los Angeles abrasion testing device. It will be closed at both ends. The cylinder must be mounted on stub shafts that are attached to the ends of the cylinders but do not extend inside of them. It must also be fixed in a way that allows for horizontal rotation of the cylinder around its axis .
- The cylinder must have a hole for the entry of the test sample.
- One element of the cylinder's interior surface must be attached with a detachable steel shelf that extends its whole length and projects radially 88 mm into the cylinder. The shelf must be mounted using bolts or another method that has been approved so that it is sturdy and rigid.

C. Compression Testing Machine
The ability of a material or structure to support loads on its surface without cracking or deflecting is known as compressive strength. When a material is compressed, its size tends to decrease, and when it is stretched, its size elongates.

- Load Frame:- A load frame is typically made up of two powerful supports for the machine. Some compact machines only have one support.
- Load Cell:- A force transducer or equivalent device for measuring the load is needed for a load cell. Usually, a quality system or regulatory regulations call for periodic calibration.
- Cross head:- A cross head that can move up or down is controlled. Usually, a steady pace is used. Hydraulic servos are employed.
- Output device:- A method of distributing test findings is offered. Older machines occasionally contain dial gauges or displays. A computer display for analysis and printing is a feature of many modern devices.

D. Vibrating table
Vibrating table was provided on site where the tests and construction were carried out. It is used to compact concrete in mould and remove air voids present in concrete.

E. Melting Barrel
1 barrel of melting (an oil drum cut in half, 80cm wide and 50cm high). To keep the fire confined to the area beneath the barrel, if at all possible, employ a shield. Simple oil drums should be split in half, and three rebar legs should be attached to create the melting barrel. The ideal barrel height and width, with the legs attached, are 50 cm and 80 cm, respectively. Try

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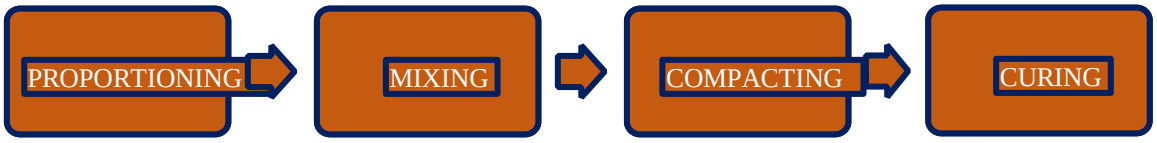
to make the burner large enough to contain a substantial volume of liquid plastic while keeping it from being too tall to make mixing difficult. If the legs can be sunk into the ground, the barrel will be more stable for mixing.

IV. METHODOLOGY

A. *Manufacture of Concrete Paving Blocks*

The steps below are part of the process used to make cement concrete pavement blocks:

- Measuring
- Mixing
- Compacting
- Curing



a) Proportioning
For cement concrete paving blocks, a concrete mixture of 1:2:4 (cement: sand: stone chips) by volume with a water to cement ratio of 0.62 may be used. Before mixing, the cement to mixed aggregates volume ratio in the concrete mix should not be higher than 1:6. The aggregated aggregates' fineness modules should fall between 3.6 and 4.0.

b) Mixing
In a concrete mixer, all the raw components are added, and the mixer is turned for 15 minutes. After 30 minutes, the prepared mixture is removed from the mixer and consumed.

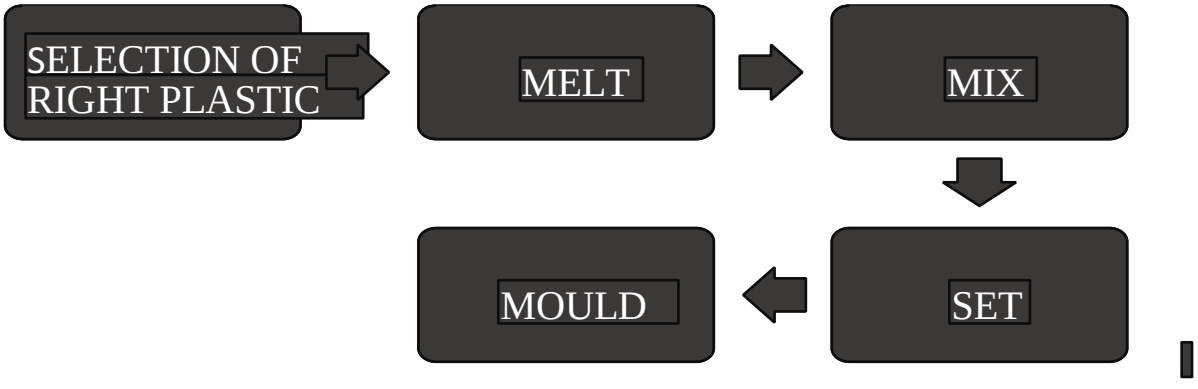
c) Compaction
Using a vibrating table, the concrete mixture can be compacted into the necessary sizes and forms of moulds. Ideally, vibration should last between 3 and 12 seconds, however this must be tested experimentally in the plant. Thicker blocks and blocks with acute angles make it more difficult to accomplish good compaction. Because of this, it is uncommon to produce concrete pavers with a thickness of more than 80 mm. The vibration's frequency and amplitude must be tailored to the materials being utilised and the number of blocks being moulded in a cycle.

d) Curing
The quality of concrete pavers is enhanced by water curing, as it is with all concrete products. But it is not feasible to spray or immerse freshly-moulded pavers in water or apply a substantial amount of water to them afterwards.

B. *Manufacturing of plastic paving blocks*

- **Procedure**

The sand content of the mixture affects the floor tile's strength. The best composition, according to laboratory testing, is 3 parts sand to 1 part LDPE (3:1 sand to plastic), however it is highly advised that you experiment with other ratios. To determine what works best for you, start with a 50:50 sand: plastic ratio and then increase the ratio of sand to 60:40 and 70:30. For floor paving tiles to be utilised in a residential compound, a 75:25 mixture works well. The plastic acts as a bonding agent to keep the sand together, therefore typically the tiles have more sand than plastic.



a) Select the right plastic
It is necessary to just choose the right kind of plastic. This is due to the physical characteristics and varying melting and burning temperatures of various varieties of plastic. With LDPE, the procedure as described here performs nicely. LDPE is typically used to make water bags, non-woven plastic shopping bags, and plastic film. Use of other plastics should be avoided since they could be detrimental to your health. Make sure most of your plastic garbage is clean. Get rid of everything that is not LDPE (including other plastics). Leave something out if you're unsure of its LDPE composition.

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b) Melt
Light a small fire under the metal drum and gently heat it. Add the plastic waste. As it warms up it will reduce in size. Light the plastic at the top using a small flame to help it melt down. Make sure the fire does not get too hot. Keep adding plastic gently at the side of the melted plastic until it melts down to a black liquid. Keep adding plastic until you have around a 20cm depth of melted plastic. Do not stand directly over the melting barrel; try to avoid breathing any gases from the fire; and take care as tools can get hot.

c) Mix
A steady black liquid will form once thorough mixing continues after all the plastic has melted. Even at very high temperatures, LDPE lumps can occasionally persist. Since lumps impact the material's strength, stirring and heating must go on until all of them are eliminated and a homogeneous paste is produced. It can take up to 20 minutes to complete this. Avoid allowing the liquid to become so hot that it violently burns; if this occurs, the substance will be useless for construction. It is acceptable for a small amount of the liquid to catch fire. Sand should be added until the proper consistency is reached, and then the mixture should be continuously mixed until the plastic, which serves as a binder, is thoroughly incorporated, and resembles grey cement.

d) Mould
Make sure the mould is ready by making sure it is very clean, well-oiled, and free of any fragments of plastic from prior mouldings. Use the metal-shafted spade to quickly remove the mixture, then use the trowel to quickly place it into the mould. Wearing gloves is recommended because the combination is quite hot. To ensure there are no air holes, press and stir the contents into the mould.

e) Set
Wait a few minutes for the heated fluid in the mould to cool before shaking the mould vigorously to free the edges (a rocking motion works well). Continue attempting to lift the mould. Remove the mould and depart when the mixture has sufficiently solidified to prevent the slab from collapsing. Its ought should solidify in about two hours. Try experimenting with different sand and LDPE amounts. The various amounts can be utilised to create different types of slabs, tiles, or bricks.

V. TESTS PERFORMED

A. *TESTS ON AGGREGATES*

a) Test for Aggregate Impact Value
- **Objective:** Using this test procedure, coarse aggregate's aggregate impact value is determined.

b) Test for Aggregate Abrasion value
- **Objective:** Using a Los Angeles machine, the following test procedures are used to determine the abrasion value of coarse aggregate.

B. *TESTING OF PAVING BLOCKS*

a) Test for Compressive Strength:
One of the significant and practical characteristics of concrete is its compressive strength. Compression testing equipment was used to make the determination. The test techniques are outlined in Annex D of IS 15658: 2006. Two steel bearing blocks for holing the specimen are part of the compression testing machine. Between the steel plates, the specimen was put. The specimens' dimensions and plan area were established in accordance with the instructions in Annex B. The specimen was set on the testing device once it had dried. Up until the specimen's collapse, the load was introduced progressively. N represents the greatest load that was applied to the specimen.

b) Test for Water Absorption:
To better understand the characteristics of the plastic block, a water absorption test was performed on the cast specimen. Following the drying process, the specimen was submerged in a water tank and left there for 24 hours. The blocks must then be taken out of the water and allowed to drain for a minute on a wire mesh made of 10 mm or coarser. Any visible surface water must then be wiped away with a damp towel, and both the soaked and surface-dry blocks must then be weighed right away. All blocks must be dried in a vented oven at 100 to 115 C for at least 24 hours after being weighed, or until two subsequent weigh-ins spaced by two hours show an increment of loss of no more than 0.2% of the preceding weigh-in.

c) Oven Test
Since the paver block is made of plastic it is required to know its heat resistance. Hence plastic paver block is placed in oven for 2 hours.

VI. CALCULATIONS & RESULTS

Observations Table 5

GRADING SELECTED	SAMPLE 1	SAMPLE 2	SAMPLE 3
Total weight of the collected dry sample taken = W1 g	340g	345g	350
Weight of the portion passing through 2.36 mm sieve = W_2 g	50g	53g	55g
Aggregate Impact Value = (W2/W1) * 100	14.70%	15.36%	15.71%

Table 5: Impact Value Test

Mean aggregate impact value =15%
Result:-The aggregate Impact value of the provided sample of coarse aggregate is 15%.

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Observation Table 6

GRADING SELECTED	SAMPLE 1	SAMPLE 2	SAMPLE 3
Original Weight = W1	5000g	5000g	5000g
Weight Of Aggregates Retained On 1.7mm Sieve = W2	1994g	2010g	2005g
Percentage wear = (W2/W1) * 100	39.88%	40.2%	40.10%

Table 6: Los Angeles abrasion value

Result:-The aggregate Abrasion Value of the provided sample of coarse aggregate is 39.84%.

strength test value of plastic paving blocks

S.NO	TRAILS	COMPRESSIVE STRENGTH N/mm^2		
		3 DAYS	7 DAYS	14 DAYS
1	**Trail 1**	**12**	**13**	**15**
2	**Trail 2**	**11**	**14**	**15**
3	**Trail 3**	**13**	**15**	**16**

Table 7: Compressive Strength of Plastic Paver At 3, 7 And 14 Days

S.NO	TRAILS	COMPRESSIVE STRENGTH N/mm^2		
		3 DAYS	7 DAYS	14 DAYS
1	Trail 1	14	15	16
2	Trail 2	13	14	14
3	Trail 3	14	15	15

Table 8: Compressive Strength of Plastic Paver at 3, 7 And 14 Days

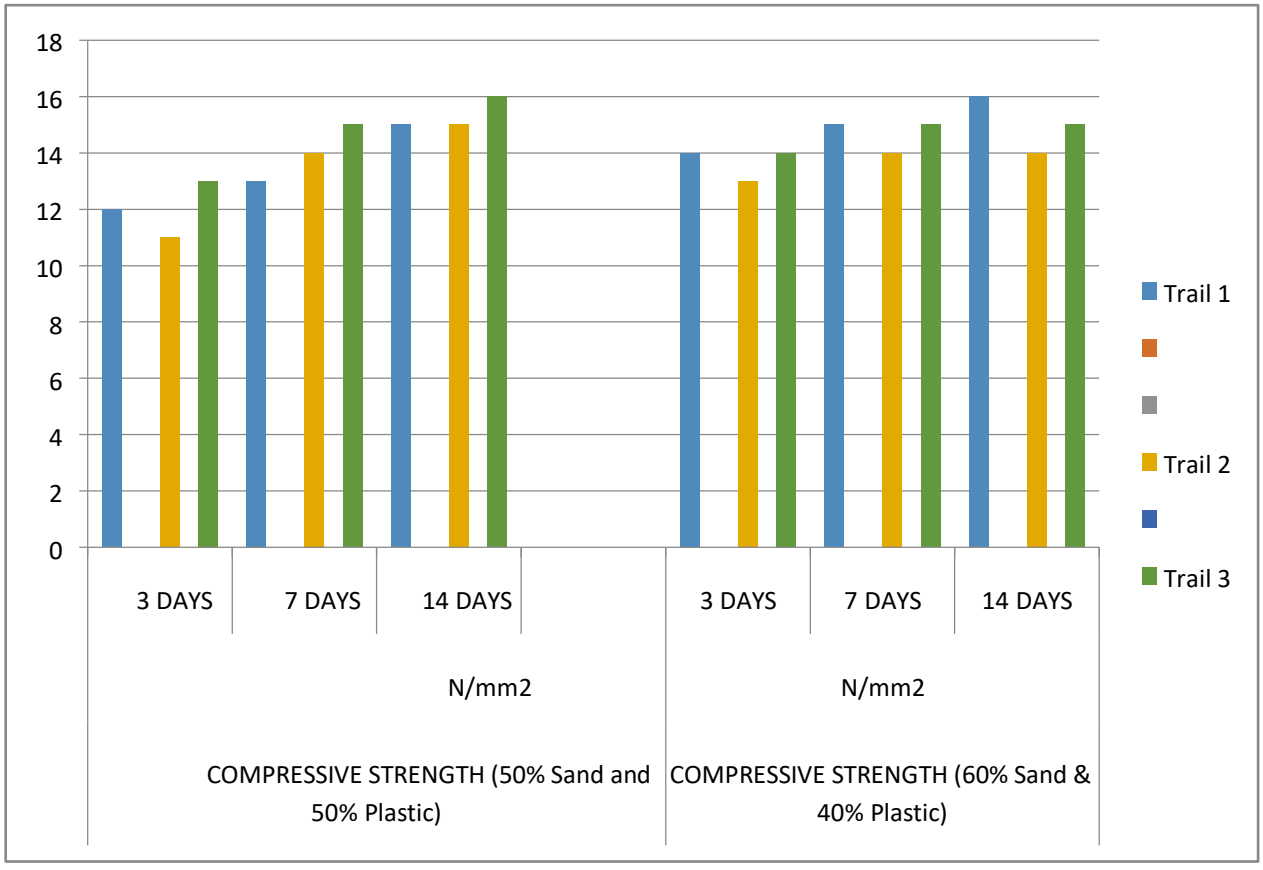

Fig. 7: WATER ABSORPTION TEST

S.NO	SPECIMEN	DRY WEIGHT Kg	WET WEIGHT Kg	%age OF WEIGHT ABSORPTION
1	A	4.1	4.141	1
2	B	4.25	4.265	0.9
3	C	4.3	4.35	1.42

Table 9: Observation Table 6.4

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SPECIMENS	Temperature (°C)	Remarks
Specimen 1	50	No change
	100	No change
	150	Melts
Specimen 2	50	No change
	100	No change
	150	Melts
Specimen 3	50	No change
	100	No change
	150	Melts

Table 10: Oven Test Result

VII. CONCLUSION

The following conclusions were drawn from the experimental investigation.

- The utilization of waste plastic in production of paver block has productive way of disposal of plastic waste.
- The cost of paver block is reduced when compared to that of concrete paver block.
- Paver block made using plastic waste, coarse aggregate and fine aggregates have shown better result.
- It also shows good heat resistance.
- Though the compressive strength is low when compared to the concrete paver block it can be used in gardens, pedestrian path, and cycle way etc. It can be used in non-traffic and light traffic road.
- Construction costs will be decreased, and this will assist to avoid the common methods of disposing of waste plastics, such as land filling and incineration, both of which have an environmental impact.
- The use of polymers in paving blocks decreases weight by up to 15%.
- It also decreases manufacturing time when compared to concrete paver blocks.

REFERENCES

[1.] B. Shanmugavalli, K. Gowtham, et.al, "Reuse of plastic waste in paver block, International journal of engineering research and technology", Vol. 6 ISSUE 02, FEB 2017, ISSN: 2278-0181.

[2.] R. Mahadevi, S. Abirami, et.al, "An experimental investigation on concrete paver block by using PVC plastic material", International Research Journal of Engineering and Technology (IRJET), Volume: 5, Issue: 03, [March– 2018].

[3.] Mohan, D.M.S., J. Vignesh, P. Iyyanpa, and C. Suresh. 2018. "Utilization of Plastic Bags in Pavement Blocks". International Journal of Pure and Applied Mathematics. 119(15): 1407-1415.

[4.] Dinesh, S., A. Dinesh, and K. Kirubakaran. 2016. "Utilisation of Waste Plastic in Manufacturing of Bricks and Paver Blocks". International Journal of Applied Engineering Research. 11(3): 364 – 368.

[5.] Ganesh, T., P. Satish, P. Pramod, and R.K. Hemraj. 2014. "Recycled Plastic used in Concrete Paver Block". International Journal of Research in Engineering and Technology. 3(9): 2319-2323.

[6.] Manish kumar sahu, Lokesh singh, "Critical review on types of bricks type 14: plastic sand bricks", International Journal of Mechanical and Production Engineering, Volume- 5, Issue-11, Nov.-2017, ISSN: 2320-2092.

[7.] Dinesh.A , Kirubakaran.K et.al, (2016), "Utilization of waste plastic in manufacturing of bricks and paver blocks", International Journal of Applied Engineering Research Vol. 11 No3 , ISSN 0973-4562.

[8.] Ostwal, T. and M.V. Chitawadagi. 2004. "Experimental Investigations on Strength, Durability, Sustainability and Economic Characteristics of Geo-Polymer Concrete Block". International Journal of Research Engineering and Technology. 3(6): 234-241.

[9.] Raghatate, D. and M. Atul. 2016. "Use of Plastic in a Concrete to Improve its properties". International Journal of Advance engineering Research and Studies. 78(2): 67-75.

[10.] Ankit, A. and V.D. Urmil. 2013. "Utilization of E-Waste and Plastic Waste in Concrete". International Journal of Students Research in Technology & Management. 1(4): 398-406.

[11.] Huda, S. and H. Hanzar. 2016. "Plastic Roads: A Recent Advancement in Waste Management". International Journal of Engineering Research and Technology (IJERT). 5(9): 145-152.