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AN APPROACH TO REDUCE CARBON-FOOTPRINT BY USING THE NON-BIODEGRADABLE PET BOTTLES AS AN ALTERNATIVE MATERIAL IN MASONRY UNITS

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***Abstract*—** As per the study, a massive production scaling of about 350 million tons in the world, contributes alone to 'Plastic'. According to the statistics given by CPCB (Central Pollution Control Board), India alone produces about 3.3 million metric tons of Plastic waste every day. A global material study states that around 79% of the Plastic produced in the world, enters the environment as waste. Out of which, only a minimal of 9% waste produced is being recycled. With this as a major consideration, it is our aim to effectively use the non-biodegradable plastic waste in construction industry. To be specific, this plastic waste can be used into concrete blocks as a whole that helps in percentage reduction of volume of concrete. Therefore, it can be used to replace the conventional burnt brick masonry units and to study and estimate the reduction of carbon-footprint emission.

***Keywords*—PET bottles, Carbon-footprint, Sensor, Arduino**

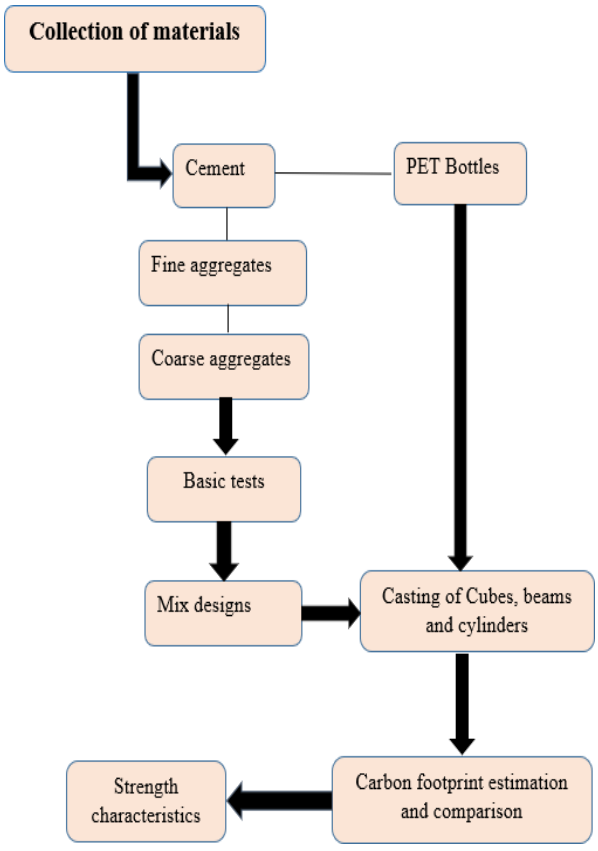
I. INTRODUCTION

A global material balance study on plastic points out that 79% of the total plastic produced in the world enters our environment as waste. Out of which only 9% of total plastic waste in the world is recycled.

It is evident that plastics bring many social benefits and offer future technological advances. But is inevitable that it is contributing largely towards the production of 'non-biodegradable waste' and takes around 20 to 500 years to decompose depending on the material and structure. However, concerns about usage and disposal are diverse and it includes the accumulation of waste in landfills and natural habitats, physical problems in wildlife resulting from ingestion and entanglement in plastic, leaching action of plastic to emit chemicals to wildlife and humans.

However, perhaps the most important concern is the volume of current usage is not sustainable. The solution to this includes plastic waste reduction, increased reusing capacity, strategies to reuse non-biodegradable plastic waste in construction. Such measures will be most effective through the combined actions of the Public, Production Industries, Engineers and Environment.

II. METHODOLOGY



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2.1 Materials

Collection of Material

Sl. No.	Materials used	Source
1	Cement	JK Cement PPC 43 grade
2	Fine aggregate	River sand
3	Coarse aggregate	20mm downsize
4	PET bottles	Waste plastic dump yards (Auto-Nagar)


Preparation of required moulds

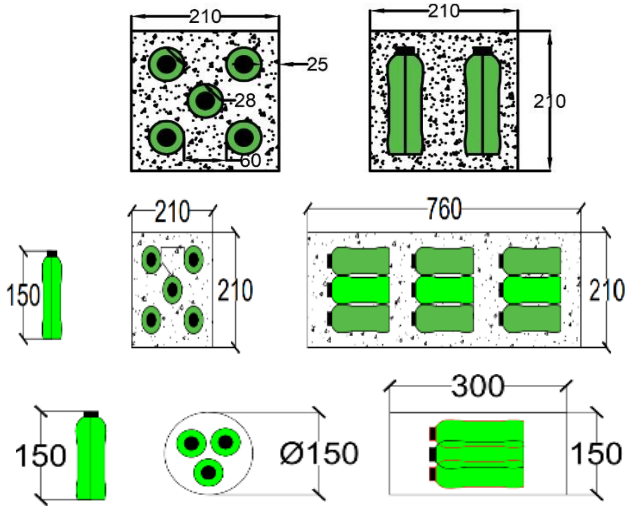
Sl. no.	Particular	Dimension
1	Cube	210 x 210 x 210 mm
2	Beam	210 x 210 x 710 mm
3	Cylinder	150Ø x 300 mm



Working Procedure

Based on the Problem Definition, in order to study the proper disposal of PET bottles waste and to reduce the Carbon Footprint in the environment, The PET bottles are inserted in Concrete as a Whole and are casted in the form of Cube, Beam and Cylinder are tested for Compression strength, Flexural strength and Tensile strength and is compared with the Conventional block.

i. Initially the basic tests on coarse aggregates, Fine aggregates and Cement are carried out in laboratory and test results are obtained.
ii. The moulds of sizes 210mm x 210mm x 210mm cube for Compression testing, 210mm x 210mm x 760mm Beam for Flexural strength test and 300mm x 150mmØ Cylinder for Split tensile strength test are prepared accordingly without changing the aspect ratio to ensure that the collected bottles are completely immersed in the concrete with suitable cover and spacing.
iii. Bottles of same sizes are taken and placed hollow into the moulds, and concrete of specific mix design is laid.
iv. After 24 hours, the specimens are subjected to curing for 7 and 28 days and tested for compression, spilt tensile and flexure.
v. Since, the volume of concrete in the block is reduced, the overall carbon foot-print can be estimated and around 15 – 20% carbon emission can be reduced.



Casting of specimens

i. The cubes, beams and cylinders are casted as per the mix design ratio obtained (**1: 1.4: 2.5**).
ii. PET bottles are placed vertically and are completely immersed into the concrete maintaining a minimum cover of 25mm and spacing between the bottles to be 28mm.
iii. The concrete is poured into the moulds along with immersed PET bottles and is placed on the vibrator machine to expel the air voids.
iv. The casted specimens are then kept for 24hours drying under normal atmospheric temperature and then remolding is done.



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Curing of specimens

The casted specimens are kept for curing for 7 and 28 days.

III. RESULT AND DISCUSSION

Tabulations of Total specimens casted

Sl. No.	Specimen	Type of bottle and duration		Placing of bottles		Total no. of specimens casted
				Vertical	Horizontal	
1.	Cube	Bisleri	7	✓	✓	6
			28	✓	✓	6
		Mountain dew	7	✓	✓	6
			28	✓	✓	6
2.	Conventional Concrete block	Mountain dew	7	-	-	3
			28	-	-	3
3.	Cylinder	Mountain dew	7	✓	✓	6
			28	✓	✓	6
4.	Beam	Mountain dew	7	✓	✓	6
			28	✓	✓	6

Compressive strength test

The compression strength test is carried out for cubes consisting two types of bottles viz. Bisleri and Mountain Dew PET bottles, which is tested for 7- and 28-days curing. The bottles are placed vertically as well as horizontally and the following test results are being illustrated in the following graphs below

Sl. No.	Type of bottle used	Testing	Placing of bottles	Load (P) kN	Stress (σ) N/mm2
1.	Bisleri	7 days	Vertical	186.67	4.22
			Horizontal	113.30	2.56
		28 days	Vertical	366.47	8.31
			Horizontal	177.72	4.03
2.	Mountain dew	7 days	Vertical	230	5.21
			Horizontal	177.6	4
		28 days	Vertical	487.5	11.03
			Horizontal	416.74	9.45
3.	Conventional block	7 days	-	532.72	12.08
		28 days	-	1166.67	26.45

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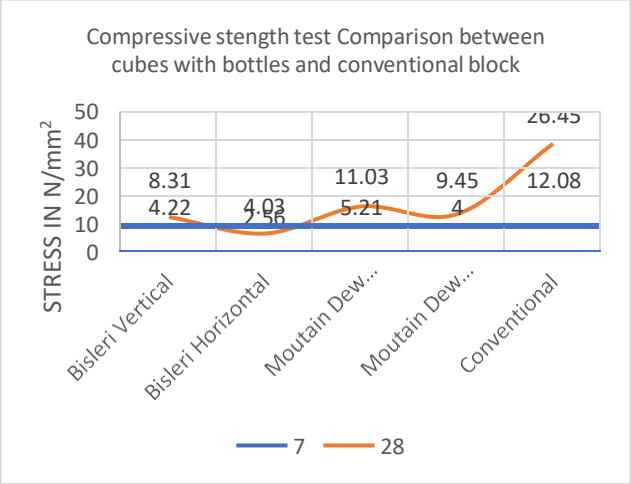
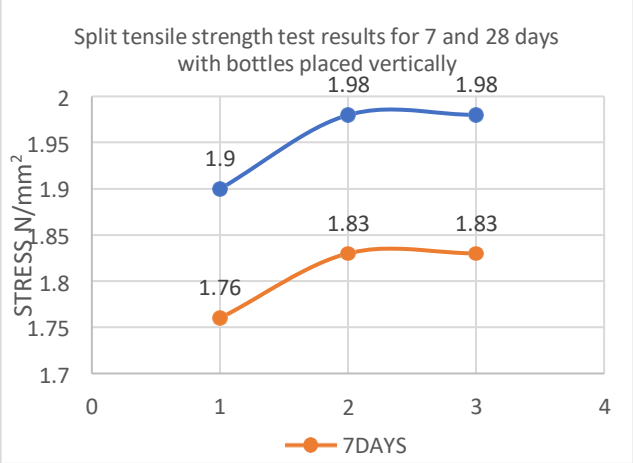


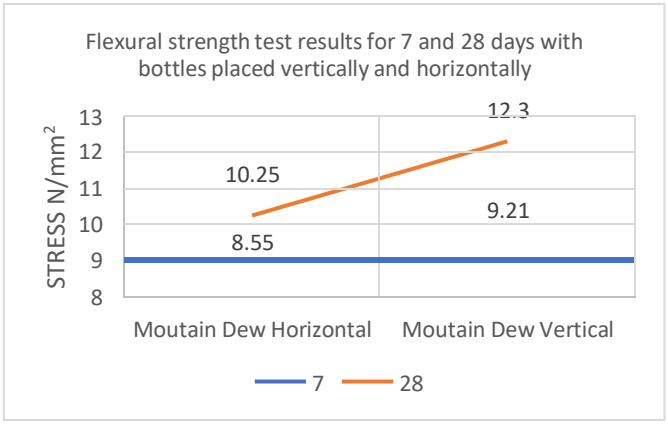
The Compressive strength test results obtained for specimens having vertically placed bottles has achieved greater strength compared to specimens having bottles placed horizontally.

Split tensile test



The Spilt tensile strength test results obtained after curing are 1.80 N/mm^2 and 1.95 N/mm^2 respectively.

Flexural strength results



The Flexural strength test results obtained after curing with bottles placed vertically achieves greater strength compared to beams tested after curing with bottles placed horizontally.

Carbon-footprint estimation

Size of PET bottles used in 1m^3 of Concrete	Estimated Reduction in CO_2 after casting the blocks in 1m^3 of Concrete	Reduction of Carbon-footprint in Percentage	Global emission of carbon footprint in percentage
250ml	251.43kg	13.3%	65%
500ml	212.42kg	26.75%	74%
1000ml	134.85kg	53.5%	81%0m

By using 250ml bottles, it is estimated to reduce 13.3% carbon-footprint. Likewise, if 500ml and 1000ml bottles are used, it is estimated to reduce 26.75% and 53.5% carbon-footprint.

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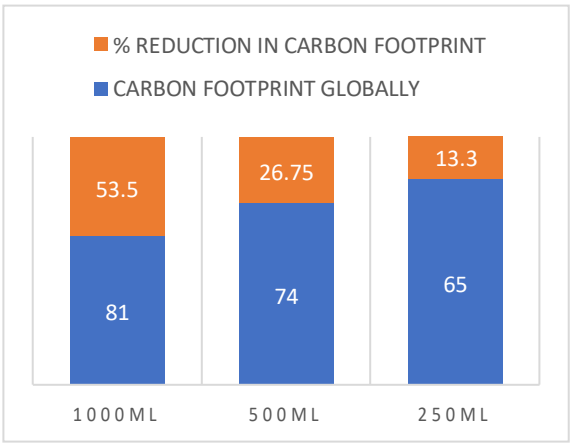
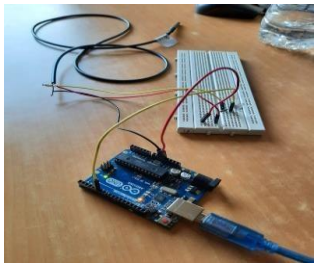
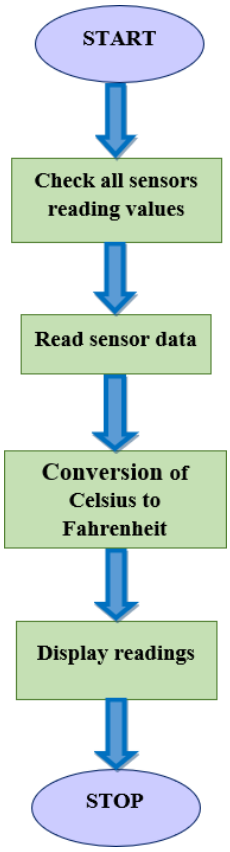


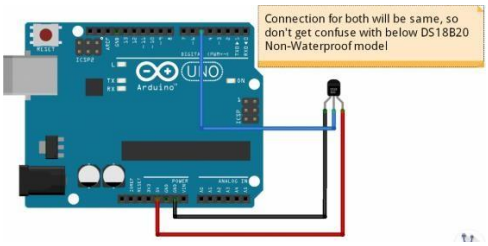


Sl. No	Materials	Estimated CO2
1	PET bottles(500ml)	82.2gm CO2/per bottle
2	PET Recycling bottles	1.538kg Co2 / kg
3	Cement	576 kg CO2/ton
4	Sand	5.51kg CO_2 /ton
5	Coarse aggregate	332 kg CO_2 / m^3
6	Brunt Clay bricks	195 g CO_2 / kg
7	1 m3 concrete	290 kg CO_2 / m^3



Test results obtained using sensors

Circuit diagram



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```
#include <OneWire.h>
#include <DallasTemperature.h>

#define ONE_WIRE_BUS 5

OneWire oneWire(ONE_WIRE_BUS);

DallasTemperature sensors(&oneWire);

 float Celcius=0;
 float Fahrenheit=0;
void setup(void)
{

  Serial.begin(9600);
  sensors.begin();
}

void loop(void)
{
  sensors.requestTemperatures();
  Celcius=sensors.getTempCByIndex(0);
  Fahrenheit=sensors.toFahrenheit(Celcius);
  Serial.print(" C  ");
  Serial.print(Celcius);
  Serial.print(" F  ");
  Serial.println(Fahrenheit);
  delay(1000);
}
```

```
C   C  25.06 F  77.11
C  25.00 F  77.00
C  25.00 F  77.00
C  25.00 F  77.00
C  25.00 F  77.00
C  25.00 F  77.00
C  25.06 F  77.11
C  25.00 F  77.00
C  25.06 F  77.11
C  25.06 F  77.11
C  25.00 F  77.00
C  25.06 F  77.11
C  25.00 F  77.00
C  25.06 F  77.11
C  25.00 F  77.00
```

```
C  24.31 F  75.76
C  24.31 F  75.76
C  24.31 F  75.76
C  24.31 F  75.76
C  24.31 F  75.76
C  24.37 F  75.87
C  24.37 F  75.87
C  24.37 F  75.87
C  24.44 F  75.99
C  24.44 F  75.99
C  24.44 F  75.99
C  24.50 F  76.10
C  24.50 F  76.10
C  24.50 F  76.10
C  24.56 F  76.21
C  24.56 F  76.21
C  24.62 F  76.32
```

i. It was observed that the temperature within the cube remains the same as the atmospheric tmeprature.
ii. Therefore, it can be concluded that this work can be enhanced by adopting IoT's that can help us monitor other physical parameters in detail.

IV.CONCLUSION

1. **Compression test results**
   i. The Compressive strength test results obtained after curing of Cubes having Bisleri bottles indicates that the specimen tested for bottles placed vertically has obtained greater strength compared to specimens tested for bottles placed horizontally viz. 4.22 N/mm^2 and 2.56 N/mm^2.
   ii. The Compressive strength test results obtained after curing of Cubes having Mountain Dew bottles indicates that the specimen tested for bottles placed vertically has obtained greater strength compared to specimens tested for bottles placed horizontally viz. 5.21N/mm^2 and 4N/mm^2.
   iii. Therefore, it can be concluded that bottles placed vertically has obtained greater strength.
   iv. The Cubes casted with Mountain Dew bottles have achieved higher strength compared to Bisleri bottles.
   v. Therefore, bottles having greater density achieve greater strength.
2. **Comparison with conventional block**
   i. The Compressive strength test results after 28 days curing for cubes having Mountain dew bottles in comparison with the conventional concrete block are 11.03 N/mm^2 and 26.45 N/mm^2 respectively.
   ii. The cubes casted by placing mountain dew bottles have achieved the strength of 11.03 N/mm^2 which is comparatively more than the common clay building bricks which possess the strength of 3.5 N/mm^2 as per IS 1077:1992. Hence can be used as a non – structural masonry unit.
3. **Flexural strength test**
   i. The Flexural strength test results obtained after curing with bottles placed vertically achieves greater strength compared to beams tested after curing with bottles placed horizontally.
4. **Split tensile test**
   i. The Spilt tensile strength test results obtained after curing are 1.80 N/mm^2 and 1.95 N/mm^2 respectively.
5. **Reduction in carbon footprint**
   i. Reduction in Carbon footprint is estimated to be 13.3%, 26.75% and 53.5% for 250ml, 500ml and 1000ml bottles respectively.
   ii. By using 5 PET bottles in cube, reduction in carbon footprint is estimated to be 2.32 kg of CO_2 which is around 13.3% reduction of carbon.
   iii. By using 20 PET bottles in beam, reduction in carbon footprint is estimated to be 8.42 kg of CO_2 which is nearly 40% reduction of carbon.

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iv. By using 3 PET bottles in cylinder, reduction in carbon footprint is estimated to be 1.33 kg of CO_2 which is around 8.9% reduction of carbon.

6. Monitoring temperature using sensors

i. It was observed that the temperature within the cube remains the same as the atmospheric tmeprature.

ii. Therefore, it can be concluded that this work can be enhanced by adopting IoT's that can help us monitor other physical parameters in detail.

V. REFERENCES

[1] ***Md. Sazzadul Haque et. al., [2021]*** *"Effectiveness of waste plastic bottles as construction material in Rohingya displacement camps" (ELSEVIER).*

[2] ***Nur Hanis Zukernain et. al., [2021]*** *"Utilization of plastic waste as aggregates in construction materials: A review" (ELESVEIR).*

[3] ***J. Thorneycroft et. al., [2018]*** *"Performance of structural concrete with recycled plastic waste as a partial replacement for sand" (ELSEVEIR).*

[4] ***N. Mohan Priya et.al. [2018]*** *"Replacement of bricks with plastic bottles in construction" (IRJET).*

[5] ***Jin Ho Bae et. al., [2022]*** *"Evaluation of physiochemical properties and environmental impact of environmentally amicable Portland cement/ metakaolin bricks exposed to humid or CO2 curing condition" (ELSEVEIR).*

[6] ***Tengfang Xu et. al., [2013]*** *"Reducing carbon footprint in cement material making: characterizing cost of conserved energy and reduced carbon emissions." (ELSEVEIR).*

[7] ***Ernst Worrel et. al., [2001]*** *"Carbon Dioxide emission from the global cement industry." (ANNU. REV. ENERGY ENVIRON).*

[8] ***Himani Maheshwari et. al., [2017]*** *"Carbon foot-print of brick production in fixed chimney bull's trench kilns in India", Indian Journal of Science and Technology, Vol 10(16).*

[9] ***C. Scuro et. al., [2020]*** *"IoT for masonry structural health monitoring" (ELSEVIER).*

[10] M.S. Shetty, Concrete Technology - Theory and Practice Published by S. Chand and Company, New Delhi.

[11] Neville A.M. "Properties of Concrete"-4th Ed., Published by Longman.

[12] Kumar Mehta. P and Paulo J.M. Monteiro, "Concrete-Microstructure, Property and Materials", 4th Edition, Published by McGraw Hill Education, 2014.

Indian standard codes

[1] ***IS 456:2000*** *- "Indian Standard Code of practice for plain and reinforced Cement Concrete", Bureau of Indian Standards, New Delhi.*

[2] ***IS 10262:2019*** *- "Indian Standard Code of practice for Concrete Mix Proportioning Guidelines", Bureau of Indian Standards, New Delhi.*

[3] ***IS 383:2016*** *- "Indian Standard Code of practice for Coarse and Fine aggregate – Concrete Specification", Bureau of Indian Standards, New Delhi.*