Waste Plastic and Mortar in Solid Blocks

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Abstract: Plastic has become one of the vastly used materials for various applications all over the world because it is flexible, robust, rigid and non bio degradable. Due to its vast use, its disposal thereafter has created challenges across the world. It threatens the environment and significantly contributes to the climate change phenomenon. Many methods and techniques have been and are being explored and implemented for its disposal. These techniques revolve around recycling or re use. Most researchers find that re use is a better approach as it does not require additional energy and is cheaper. As such, the waste plastic bottles are being re used in a variety of applications, especially building construction. In this study, the waste plastic bottles awaiting disposal, were filled with another waste material namely mortar powder collected from a building demolition site and embedded into conventional solid blocks in variable numbers and positions to determine its influence on the compressive strength of the block. The results have shown that these two waste materials when reused together can result in higher compressive strength besides giving a direction for their disposal. Ultimately, this leads to improvement in the environment.

Index Terms – Waste plastics bottles, Mortar powder, number, position, solid blocks, compressive strength.

I. INTRODUCTION

The use of plastic is nothing short of a revolution as it finds its use in applications in all walks of life across the globe. The consumption of plastic in India alone is expected to reach around 205 lakh tones by 2020. Consequent to its vast use, plastic is one of the most disposed materials in the world. More than 100 million plastic bottles are used every day worldwide, and about 1500 bottles end up as waste in landfills or are thrown in ocean every second and its rate is alarmingly increasing due to its consumption. This is causing environmental imbalance as well as climate change. The situation forced to explore ways for its disposal or reuse. Many approaches have been developed in this direction, but the target is very well short of its achievement. It has been attempted to use the waste plastic bottles as innovative materials in building, as it happens to be a vast industry. Focusing on this, a concept of solid blocks made with plastic bottles in filled with used mortar powder has been introduced. When these bottles are used, they have great insulating capability. The walls constructed with these bottles, can absorb abrupt shock loads; being non-brittle they produce much less construction waste compared to conventional blocks. It is also reported that compared to brick and concrete block walls, concrete blocks with plastic bottle walls cost 75% less. Being lighter, plastic bottle walls can be better against earthquakes. Due to the compaction of filling material in the bottles, they are 20 times more load resistant than conventional blocks. The objective of this project is to investigate the characteristics of this product and the benefits obtained by using it in building. It also intends to compare the characteristics of concrete block with plastic bottles filled with demolished waste in the form of mortar powder and placed in different numbers and positions.

II. MATERIALS & METHODOLOGY

The materials were used in the study are, Used mortar powder, Waste Plastic bottles, Cement, M-sand and Water. These materials were tested for their basic properties and the results are indicated in Table 1.

Table 1: Properties of Materials used

Plastic	
Color	White or light cream
Material Density of plastic	1.33220 gm/cm3
Melting point	255 to 265 ˚C
Solubility	Insoluble in water
Cement	
Consistency	35%
Initial setting time	30 Minutes
Final setting time	600 Minutes

Fineness	8.16%
Specific Gravity	3.43
Demolition Waste Mortar Powder	
Sieve analysis	C_u=0.056 ,C_c =2.16 D_{10}=0.136,D_{60}=2.4,D_{30}=0.84
Specific gravity	2.56
Moisture content	8.19%

III. EXPERIMENTAL WORK

The waste plastic bottles were collected having volume 250 ml, 600 ml and 750 ml. The bottles were washed, dried and filled with used cement mortar powder collected from a building demolition site. To prepare solid blocks, an assembly of three moulds with conventional dimension 16*8*8 inches each was fabricated using mild steel sheet. The bottles with the in fill in three layers; were prepared with each layer compacted by tapping on a level platform. The bottles were arranged in different combinations and patterns in the conventional solid blocks to find the varying compressive strength.

3.1 Preparation of plastic bottle brick filled cylinders

The cylindrical specimens of size of the 150 mm in diameter and 300 mm in length were prepared in 1:3 proportion by weight with water cement ratio of 0.6. The moulds were oiled with medium viscosity oil before the mortar powder was filled in. The mortar powder was filled in three layers each approximately 100 mm high. After the first layer a 750 ml mortar powder filled plastic bottle brick was inserted into the middle of the mould. Each layer was rammed 25 times with evenly distributed strokes. The cylinders were removed from the moulds after 24 hours and water cured for 28 days**.** The solid blocks and the cylindrical specimens were subjected to compressive strength and indirect tensile strength test respectively. The test results are presented in Tables 2 to 6 and Fig. 1.

Table 2: Compressive Strength of Solid Block Embedded with 250 ml Bottle Blocks in filled with Mortar Powder in Different Alignments

Sl. No.	Pattern	No. of bottles	Vol. of bottle (ml)	Wt. of block (kg)	Compressive Strength of block (N/mm^2)
1	1 Layer Horizontal	4	250	32.5	18.45
2	2 Layer Horizontal	8	250	35	15.38
3	1 Layer vertical	8	250	36	19.99
4	Inclined at 45^0	6	250	33.5	9.23

Table 3: Compressive Strength of Solid Block Embedded with 600 ml & 250 ml Bottle Blocks in filled with Mortar Powder

Sl. No.	Pattern	No. of bottles	Vol. of bottle (ml)	Wt. of block (kg)	Compressive Strength of block (N/mm^2)
1	1 Layer Horizontal	2 1	600 250	36	14.14
2	2 Layer Horizontal	4 2	600 250	35	9.23
3	Inclined 45^0	4	600	34.5	10.77

Table 4: Compressive Strength of Solid Block Embedded with 750 ml & 250 ml Bottle Blocks in filled with Mortar Powder

Sl. No.	Pattern	No. of bottles	Vol. of bottle (ml)	Wt. of block (kg)	Compressive Strength of block (N/mm^2)
1	1 Layer Horizontal	2 1	750	36	22.76
2	2 Layer Horizontal	2 3	750	34	18.45

Table 5: Compressive Strength of Cylinder Embedded with 750 ml Bottle Blocks in filled with Mortar Powder

Sl. No.	Vol. of Bottle(Ml)	Weight of Cylinder(Kg)	Compression Strength (N/mm^2)
1	750	11.5	0.62

Table 6: Tensile Strength of 750 ml bottle cylinder in filled with Mortar Powder

Sl. No.	Vol. of Bottle (ml)	Weight of Cylinder (Kg)	Tensile Strength (N/mm^2)
1	750	11.9	0.049

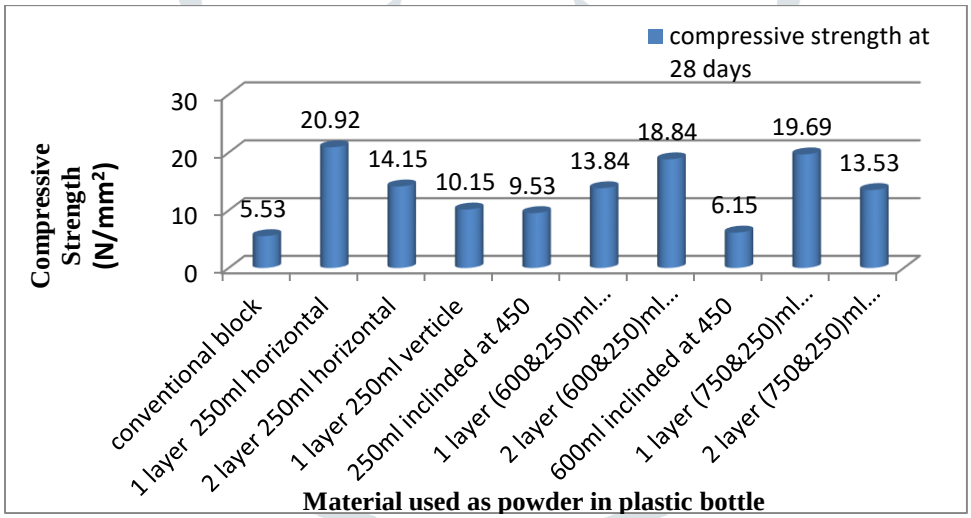

Fig 1: Comparison of Compression Strength of Conventional Block and Block Embedded with Crushed mortar Filled Bottles

IV. COST ESTIMATION

Cost of making a single bottle brick is calculated and compared with the cost of a single brick.
Cost of waste plastic bottle: Cost of waste plastic bottle= Rs. 12/kg

- 250 ml bottle
  Wt. of a250 ml plastic bottle = 11gms.
  No. of bottles in 1 Kg. = (1000÷11) ~ 91
  Cost of 1(250 ml) bottle = 12 ÷ 90 = Rs 0.13
- 600 ml bottle
  Wt. of a 600 ml PET bottle = 26 gms.
  No. of bottles in 1 Kg. = (1000÷26) ~ 39
  Cost of 1 (600 ml) bottle = 12 ÷ 39 = Rs 0.30
- 750 ml bottle
  Wt. of a 750 ml bottle = 34 gms.
  No. of bottles in 1 Kg. = (1000÷34) ~ 30
  Cost of 1 (750 ml) bottle = 12 ÷ 30 = Rs 0.40

Cost of demolition waste

2500 kg = Rs. 200 for transport within 2-5 km distance

Cost of demolition waste per kg = Rs 0.08

- **Crushed mortar filled with 250 ml bottle**

  Cost of 250ml bottle filled with crushed mortar
  Wt. of crushed mortar filled bottle = 470 grm
  Empty wt. of bottle =11grm
  Mortar filled in bottle = 459 grm
  Cost of mortar filled in bottle = 0.459X0.08 = Rs0.036
  Mortar cost + bottle cost = 0.036+0.13 = Rs 0.166
  Total cost of 250ml crushed mortar bottle = Rs 0.166

- **Crushed mortar filled with 600 ml bottle**

  Cost of 600ml bottle filled with crushed mortar
  Wt. of crushed mortar filled bottle = 1194 grm
  Empty wt. of bottle =26 grm
  Mortar filled in bottle =1168 grm
  Cost of mortar filled in bottle =1.168X0.08 = Rs 0.094
  Mortar cost + bottle cost = 0.094+0.30 = Rs 0.40
  Total cost of 600 ml crushed mortar bottle = Rs 0.40

- **Crushed mortar filled with 750 ml bottle**

  Cost of 750 ml bottle filled with crushed mortar
  Wt. of crushed mortar filled bottle = 1382 grm
  Empty wt. of bottle =34 grm
  Mortar filled in bottle =1348 grm
  Cost of mortar filled in bottle =1.348X0.08 = Rs 0.11
  Mortar cost + bottle cost = 0.11+0.40 = Rs 0.51
  Total cost of 600 ml crushed mortar bottle = Rs 0.51

- **Cost of one solid block**

  Aggregate 13kg = 13 X 0.40 = Rs5.2
  M sand 13kg = 13X0.40 = Rs5.2
  Cement 2.5kg = 2.5 X 7 = Rs17.5
  Labor charge = Rs 4.0 = Rs 4.0

  Total Rs. 31.90

Table 7: Cost Estimation of 09 Blocks with Different Alignment

Sl. No.	Volume of bottles (ml)	Alignment of bottles	No. of bottles	Cost of bottles (Rs)	Total cost of bottles (Rs)	Cost of one solid block without bottles (Rs)	Total cost of block with bottles (Rs)
1	250ml	1layer horizontal	4	0.166	0.67	31.9	32.57
2	250ml	2layer horizontal	8	0.166	1.33	31.9	33.23
3	250ml	vertical	8	0.166	1.33	31.9	33.23
4	250ml	inclined	6	0.166	0.10	31.9	32.00
5	600ml 250ml	1layer horizontal	2 1	0.40 0.166	0.80 0.166	31.9	32.87
6	600ml 250ml	2 layer horizontal	4 2	0.40 0.166	1.60 0.332	31.9	33.83
7	600ml	Inclined at 45^0	4	0.40	1.60	31.9	33.50
8	750ml 250ml	1layer horizontal	2 1	0.51 0.166	1.02 0.166	31.9	33.09
9	750ml 250ml	2layer horizontal	2 3	0.51 0.166	1.02 0.498	31.9	33.42

V. CONCLUSION

The 1 layer 250 ml horizontal, 2 layer 650 ml & 250 ml, and 1 layer with 750 ml & 250 ml combinations resulted in highest average compressive strength of over 19 N/mm^2 while 2 layer 250 ml, 1 layer 600 ml & 250 ml and 2 layer 750 ml & 250 ml combinations resulted in second highest compressive strength of about 13.**5 N/mm^2** . the compressive strength for 600 ml bottles inclined at 450 was 6.15 N/mm^2 which is higher than that of the plain conventional solid block. Thus, all the combinations tested resulted in higher compressive strength and hence may be used in practice.

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