UTILIZATION OF WASTE PLASTIC HDPE WITH FILLER MATERIALS (FLYASH AND BOTTOM ASH / CERAMIC WASTE) AS ALTERNATIVES TO NATURAL COARSE AGGREGATES; STRENGTH PROPERTIES

D.N. Weerasinghe [1,], D.P.H.K. Wickramasinghe [1,], R.M.K.M. Rathnayake [1, *], R.U. Halwatura

[1] Department of Civil Engineering, University of Moratuwa, Moratuwa

The increasing costs of construction materials and the rapid depletion of natural aggregates have highlighted the urgent need for sustainable alternatives in the construction industry. In this context, plastic waste, particularly high-density polyethylene (HDPE), has become a significant environmental challenge due to the global surge in plastic production and disposal. This study investigates the feasibility of using synthetic coarse aggregates derived from post-consumer HDPE plastic waste, combined with various filler materials, as an environmentally friendly substitute for natural aggregates in concrete.

The research focuses on developing two types of synthetic aggregates, one consisting of HDPE mixed with fly ash and bottom ash and the other comprising HDPE combined with ceramic waste powder. The synthetic aggregates were created by varying the proportions of HDPE and filler materials, followed by extensive testing of the resulting plastic aggregate cubes for compressive strength and shrinkage. The results revealed that the optimal mix for the first type of aggregate consisted of 60% HDPE, 15% fly ash, and 25% bottom ash, while the second type achieved the best performance with a blend of 80% HDPE and 20% ceramic waste. These compositions demonstrated the highest compressive strength, making them the most effective synthetic aggregate blends for potential use in construction.

Subsequent to developing these optimal mixes, concrete cubes of different grades (15, 20, 25, and 30) were cast using both natural aggregates and a full (100%) replacement with the developed plastic aggregates. The findings of the study indicate that concrete made with synthetic plastic aggregates exhibited lower compressive strength and density compared to traditional concrete. However, these materials also resulted in significantly reduced production costs. Notably, replacing conventional natural aggregates with synthetic aggregates in higher-grade concrete mixes led to substantial cost savings, with reductions in production expenses ranging from 20% to 24% per footing in a sample building.

The research underscores the potential of incorporating synthetic coarse aggregates made from HDPE plastic waste, along with fly ash, bottom ash, and ceramic waste, as a sustainable and economically viable alternative to natural aggregates in concrete construction. The use of such synthetic aggregates not only addresses environmental concerns related to plastic waste but also offers a cost-effective solution that does not compromise the structural integrity of the concrete. These findings contribute to the growing body of knowledge on sustainable construction practices, presenting a promising pathway for the industry to reduce its environmental footprint while maintaining economic efficiency.

Keywords: Compressive strength, Cost reduction, Sustainability, Synthetic aggregates

[*] Correspondence: rangika@uom.lk

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1 BACKGROUND

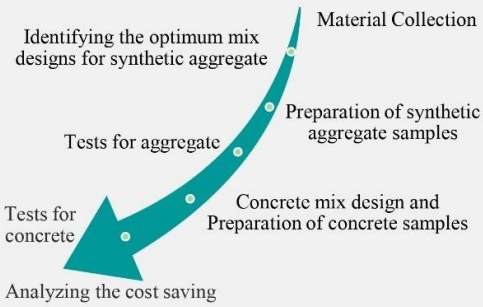
- Depletion of Natural Resources due to Extensive Extraction
- Environmental Pollution due to plastic consumption
- Escalating cost and demand of natural aggregates

Solution?

HDPE + Filler material → Synthetic aggregate

Fly ash/ Bottom Ash Ceramic waste

2 METHODOLOGY



Shredded HDPE

A Cast aggregate cube sample

Synthetic Aggregate Sample

3 RESULTS

Proportion for synthetic aggregates based on compressive strength

Alt 01	HDPE : Fly Ash: Bottom Ash	=	60 : 15: 25
Alt 02	HDPE : Ceramic waste	=	80: 20

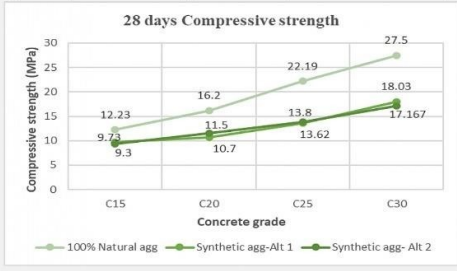
SEM analysis

Grade 25 concrete with synthetic agg- Alt 1

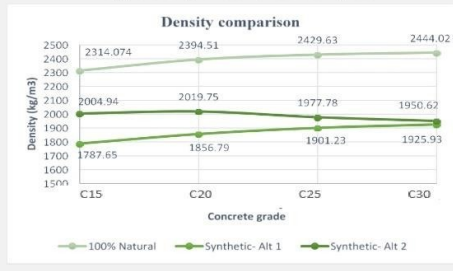
Specific Gravity and Water Absorption tests

	Specific Gravity	Water absorption
Natural Aggregate	2.72	0.49%
Alt 01- HDPE: Fly ash/Bottom ash	1.21	0.97%
Alt 02- HDPE: Ceramic waste	1.186	0.64%

Avg. Compressive strength at 28 days of Concrete samples

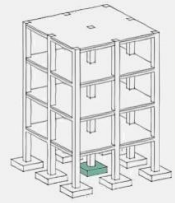


Avg. density of concrete samples



Cost saving per unit volume of concrete

Percentage cost saving	C 15	C 20	C 25	C 30
Concrete with Alt 01	8.51%	7.51%	8.05%	7.85%
Concrete with Alt 02	7.34%	6.41%	6.99%	6.85%



The cost reductions per footing ranged from 20% to 24%