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Effect of Waste PET Aggregate as Partial Replacement of Aggregate (Fine and Coarse) M30, M25, M20 in Concrete -An Experimental Investigation.

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A B S T R A C T

Plastic disposal is now a significant problem for the sustainability of the environment. Concrete construction assiduity is one of the major sector exercising natural coffers to produce concrete for erecting constructions styles Statistical Analysis The thing of this paper to decide ideal quality and impact of application of reused PET as fractional negotiation of fine & coarse total in common Portland bond. This exploration work presents an disquisition of compressive strength, of concrete by adding crushed pet bottles as partial relief of total in colorful probabilities. Ordinary Portland cement in Concrete and an attempt has been made to probe the strength parameters of concrete (Compressive Strength). For control concrete, IS system of blend design is espoused and considering this a base, blend design for relief system has been made. Five different relief situations videlicet0,2.5, 15, and17.5 are chosen for the study concern to relief system. Large range of curing ages starting from 3days, 7days and 28days are considered in the present study. Cells(150 × 150 × 150 mm) with varying rates of PET will be casted. Total no of cells casted would be 42. The result showed that the concrete instance containing PET at 5 by weight showed advanced compressive strength than other samples. The flexural strength of concrete samples containing PET total was below that of the control concrete.

Keywords — PET bottles, fine & Coarse aggregate relief, Split tensile, Compressive strength, Flexural strength

1. INTRODUCTION

The consumption of plastic has grown mainly each over the world in recent times and this has created huge amounts of plastic- grounded waste. Plastic waste is now a serious environmental trouble to the ultramodern expressway of living. Recycling plastic waste to produce new accoutrements like total in concrete could be one of the stylish results for laying of it, given away its profitable and ecological vantages. constitutionally, the use of waste accoutrements as total in concrete product will reduce the pressure on the exploitation of natural coffers. Plastic total (PA) is produced by mechanically divorcing and recycling plastic waste. A life circle dissection of mixed ménage plastics shows that mechanical recycling provides a advanced net positive environmental jolt than the reclamation of dynamism or land- stuffing. Nonidentical manners of plastic waste have been exercised as total, padding or grittiness in cement mortar and concrete after mechanical treatment. They carry polyethylene terephthalate (PET) bottles, polyvinyl chloride, PVC pipes, high viscosity polyethylene, HDPE, thermosetting plastics, mixed plastic waste, expanded polystyrene froth, polyurethane froth, polycarbonate, and glass corroborated plastic. PA is significantly lighter than natural total (NA) and thus its objectification lowers the consistence of the performing concrete. This property can be exercised to develop featherlight concrete. The use of shredded waste Dad in concrete can reduce the dead cargo of concrete, therefore lowering the earthquake threat of a structure, and it could be helpful in the project of an earthquake- resistant structure.

1.1 OBJECTIVES OF THE PRESENT INVESTIGATION

In this study, the main aim is to find out the variations that will occur on rheological, mechanical, and physical properties of SCC when shredded waste PET granules (WPET) are added in a partial replacement of coarse aggregates at different substitution levels, for water/binder (w/b) of 0.48. The objectives to be investigated are:

The main objects in the present-day investigation areas following:-

- To evaluate the mechanical properties of hardened concrete with effect of PET plastic aggregate. Compressive strength (σc), Flexural strength, Splitting tensile strength,
    - To evaluate strength quality of concrete by ultra sound pulse velocity.
    - Identifying the best suitable mix for the more desirable properties.

- Determining the optimum amount of Fine & coarse replacement by PET plastic aggregate.
- Cost comparison between normal mix and design mix.

1.2 LITERATURESURVEY

Grounded on the once experimenter following are the literature check done for the present disquisition:

Jo et al. (2008) The purpose of this study was to break some of the logical waste cases posed by plastics and concrete obliteration. To this end, we estimated the mechanical parcels of polymer concrete, in personal, polymer concrete made of unsaturated polyester resins from recycled polyethylene terephthalate (PET) plastic waste and recycled concrete summations. The energy and the defiances to acid and alkali composites of the polymer concrete were measured by varying the coarse and fine aggregate rate and resin content. Three main compliances followed the effects. First, we set up that the energy of polymer concrete made with a resin grounded on recycled PET and reclaimed aggregate raises with adding resin content; still, beyond a certain resin content, the energy doesn't revise appreciably. Second, the pressure – strain angles of polymer concretes with 100 natural total and 100 recycled total displayed non identical failure mechanisms of the compressed accoutrements. Third, with reference to acid defiance, the polymer concrete at a resin content of 9 was closely innocent by HCl, whereas the polymer concrete with 100 recycled total showed off penurious acid defiance. Unlike acid, alkali composites didn't feel to attack the polymer concrete with 100 recycled aggregate as observed from the cargo revise and the compressive energy.

Frigione (2010) An attempt to change in concrete the 5 by cargo of fine aggregate (natural sand) with an equal cargo of PET aggregates formed from the waste un- washed PET bottles(WPET), is offered. The WPET spots held a granulometry similar to that of the changed sand. slices with non- identical cement content and water/ cement rate were formed. Rheological characterization on fresh concrete and mechanical experiments at the ages of 28 and 365days were performed on the WPET/ concretes as well as on reference concretes containing only natural fine aggregate in order to probe the influence of the concession of WPET to the fine aggregate in concrete. It was set up that the WPET concretes flash similar malleability characteristics, compressive energy and splitting tensile energy hardly lesser that the reference concrete and a fairly improved severity.

Reis et al. (2012) The end of this exploration is to use non-biodegradable plastic summations made of polyethylene terephthalate (PET) waste from libation holders as partial relief of natural summations in polymer mortars and estimate the mechanical parcels. colorful weight fragments of beach 5, 10, 15, and 20 are replaced by the same weight of plastic. The main results of this study show the feasibility of the exercise of PET waste summations accoutrements as partial backups for summations in compound accoutrements. Despite of some downsides like a drop in flexural and compressive strength, the use of PET waste summations presents some advantages. Significant advancements in the flexural and compressive modulus of pliantness were observed. Also, the flexural and compressive durability increase with adding PET content. The present study presents an indispensable way of recovering PET, contributing to reduce waste terrain preservation.

Guru etal. (2014) This study investigates an operation area for Polyethylene Terephthalate (PET) bottle waste which has come an environmental case in recent decades as being a respectable portion of the grand plastic waste brunt. Two new accretive paraphernalia, videlicet slim Liquid Polyol PET (TLPP) and Viscous Polyol PET(VPP), were chemically derived from waste PET bottles and exercised to qualify the base asphalt singly for this end. The goods of TLPP and VPP on the asphalt and hot mix asphalt (HMA) amalgamation groupings were detected through usual experiments (Penetration, enervating Point, severity, Marshall Stability, Nicholson Stripping) and Super pave styles (Rotational viscosity, Dynamic Shear Rheo meter (DSR), Bending Beam Rheo meter (BBR)). Also, chemical structures were described by Scanning Electron Microscope (SEM) seasoned with Energy Dispersive Spectrometer (EDS) and Fourier Transform Infrared (FTIR) ways. Since TLPP and VPP were determined to meliorate the low temperature interpretation and fatigue defiance of the asphalt as well as the Marshall Stability and disrobing defiance of the HMA mixtures predicated on the effects of the applied experiments, the operation of PET waste as an asphalt expressway pavement substance offers an volition and a salutary expressway of discarding of this ecologically hazardous substance.

Islam et al. (2016) This study investigates the effect of plastic as an indispensable coarse total on colorful fresh and harden parcels of concrete. Polyethylene terephthalate(PET), a thermoplastic polymer, is considered as an indispensable total and replaced with natural coarse total, similar as slipup chips. The PET total is attained by shredding, melting and crushing the collected waste PET bottles. The primary focus of the work is to observe compressive strength and unit weight of PET total concrete (PAC) along with their plasticity in comparison with the natural total concrete(NAC). With the increase in PET relief rate and w/ c rate lower unit weights and compressive strengths are observed for PAC compare to NAC. Compressive strength for 20 PET replaced PAC at0.42 w/ c rate is30.3 MPa which is only 9 lower than the NAC. still, the sequel of plastic as an PAC has significantly high malleability as1.8 cm depression value is observed for 20 PET displaced PAC at0.42 w/ c rate. therefore, PET displaced concrete with low w c rate and high malleability can be exercised for structural concrete member.

Hameed (2019) In recent times, the use of recycled plastic aggregate (RPA) as an necessary grand substance has been considered to lower the environmental influence of both concrete and waste of plastics. Recycled plastic aggregate concrete (RPAC) is now known as a largely encouraging technology that can contribute to resource forcefulness in the construction sedulity. In this paper, the first experimental study of the groupings of concrete formed utilizing recycled Polyethylene terephthalate (PET) Flake aggregates is offered. Five clumps of concretes were formed with non- identical PET contents (1, 3, 7, 10) by the cargo of Portland cement. The sequel of RPA content on the compressive energy, flexural energy, ramifying tensile energy and hardened density of each package is studied. The effects showed off that the use of PET at 1 lead to boost the compressive energy in 58 assimilated to the reference package mad without waste). Flexural energy effects showed off that the use of PET at 1, 3 increases the valuations flexural energy in singly likening with reference package. Also, the rate 1 of PET gives the optimum value of blistering tensile energy with accumulation rate 130. The density valuations fluently ceased with adding the luck of PET content, the abating rate of density close to14 especially at 10 of PET.

Dawood (2021) This study was conducted to assess the effect of plastic box waste patches (PBWPs) on the mechanical characteristics of a concrete admixture if plastic box patches (PBPs) are used as a partial cover for beach in the admixture. Another purpose was to corroborate the effect of the waste on the flexural gest of corroborated concrete shafts (RCBs). In this exploration, four normal concrete fusions with a water/ cement rate of0.41 were examined. Three concrete fusions contained recycled plastic box waste spots by varying the luck of operation (2.5, 5, and 10) and one amalgamation without PBPs as reference amalgamation (RNC) for comparison. To probe the delicacy jolt of the waste on energy and mileage, three RCBs were tried with confines of 150 × 200 × 1400 mm, containing non-identical portions of the waste with in the concrete amalgamation. Several experiments were performed to descry the disparity between the mechanical groupings of a amalgamation containing plastic waste and the reference amalgamation. Cracking exploration, weight- divagation behaviour, severity pointers, initial stiffness, and secant stiffness were the RCB test variables. The concrete amalgamation with PBWPs extensively meliorated concrete groupings. effects indicated that depending on the measure of plastic spots displaced by fine aggregate, plastic may have an sequel on energy. still, the test effects demonstrated that the partial relief of 5PBWPs by cargo in the amalgamation swelled. the compressive energy roughly30.2. Incorporating PBWPs into the concrete amalgamation did not significantly revise the failure mode of RCBs assimilated with that of NC shafts. still, the first check weight showed off bettered effects in the crossbred shaft (shaft with two mixtures of non -identical chances of PBWPs). The substantiated concrete amalgamation, which contained 5 plastic spots, displayed 5 a slight boost during the ultimate failure weight with an accumulation of1.82. also, the effects of the concrete shaft test showed off a showy improvement in severity, especially in the crossbred shaft; a fragile boost in the initial stiffness; and a slight drop in the secant stiffness.

Kangavar et al. (2022) On this study Waste management is an area of significant global concern. The waste materials of reuse of waste (such as: plastics, glass, wood, etc.) in concrete manufacturing has been studied for potential cost savings, improvements in quality, and reduction of environmental impact leading to sustainability. This study examination the performance of concrete containing recycled polyethylene terephthalate (PET) waste in granular form to replace the fine aggregate. A series of concrete specimens for Grade 32 concrete mix were cast using PET granules as partial replacement to fine aggregates in the mixture (0%, 10%, 30%, and 50% replacement by volume of fine aggregate). Important properties materials in the experimental such as workability (slump), density, compressive strength, elastic modulus, tensile strength, flexural strength, and crack mouth opening displacement (CMOD) were evaluated together with the microstructural observations. The experimental trial results show that volumetric replacement of fine aggregates with 10% recycled PET granules positively impacted the characteristics of the concrete.

Saha et. al. (2023) Plastic waste operation 56 is one of the major global expostulations at present-day. 30 Recycling single exercised plastic waste as partial relief of natural aggregates in concrete may reduce cases descrying mismanagement of plastic waste and unsustainable utilization of natural resources as aggregates. This generality has been explored in multitudinous inquiries and positive effects are attained, but 25 it has not been materialized at a voluminous scale due to the query descrying profitable viability. The present-day study therefore focuses on the profitable aspects of utilizing Polyethylene predicated fine aggregates and Polyethylene Terephthalate predicated coarse aggregates as partial relief(10, 20, 30 and 40) of natural fine and coarse aggregates singly and simultaneously, with special emphasis given away on environmental and gregarious cost. A substance flux illustration utilizing STAN is first developed to calculate plastic waste generation. An artificial check 14 has been conducted to estimate product cost of plastic aggregates, while gregarious cost as WTP is determined through CVM system. The result shows that the grand cost of concrete disparagements with boost of relief luck and cost reduction varies between0.65 and7.58 analogize to usual concrete depending on the luck and type of relief without compromising energy. consequently, alongside being monstrously salutary to fiefdom and society in tours of reduction of leachate and greenhouse gas-plastic toxin, demand of tip area, mosquito borne conditions, erosion, sedimentation, land loss etc. the generality of recycling plastic waste as partial relief of natural aggregates in concrete has been substantiated to be economically doable and salutary too.

Peng et al. (2023) To present study the combined effect of steel and waste PET fibers on the properties of recycled aggregate concrete (RAC), steel-waste PET hybrid fiber reinforced recycled aggregate concretes (HFRACs) were produced. Slump and mechanical strength tests trial on the specimen were performed. The interaction between fiber contents and each performance index was performed by response surface methodology (RSM), and the optimal steel and waste PET fiber contents were obtained by maximum strength indicator simultaneously. The trial results obtained that the contents of two types of fibers had a significant negative impact on workability and positive effect on mechanical strength except the compressive strength which was not significantly studied by the PET fiber content. The slump and compressive strength of HFRAC can be guess by linear equations with the contents of steel and waste PET fibers, while the splitting tensile strength and flexural strength can be predicted by quadratic polynomial equations. Waste PET fiber properly consolidate with steel fiber can improve the mechanical properties of RAC, which with illustrates steel-waste PET HFRAC has the potential to be green sustainable concrete.

Azad and Karim (2023) In this presents study results of tests trial done on workability, mechanical properties, first cracking impact and ultimate load impact of high strength concrete (HSC) contained polyethylene terephthalate (PET) waste fiber. Different PET fibers with regard the length (10 mm, 20 and 40 mm) were added to concrete by 0.50, 0.75, 1.00, 1.25 and 1.50% (by volume). Density, ultrasonic pulse velocity, compressive strength, splitting tensile strength, flexural strength, first crack impact (N1) and ultimate load impact (N2) tests trial were conducted on sixteen HSC mixes. Results indicate a slight change in ultrasonic pulse velocity, while addition of PET fiber with 10 mm, 20 mm and 40 mm length reduced compressive strength by a maximum value of 15.74, 14.37 and 10.28% respectively compared to control concrete. Regardless to the fiber length and fraction volume, fiber content improves splitting tensile and flexural strengths by a maximum of 63.3% and 24.7% respectively. Striking results were recorded against impact strength property, in which improvement in N1 recorded up to 300% and N2 up to 833% depending on fiber length and fraction volume. It is concluded that PET waste fiber can improving important properties of HSC and it is recommended to be added to concrete by up to 1.5% by volume. Regression analysis was made to develop equations for calculating N1 and N2, and these properties were found to depend essentially on compressive strength of plain concrete and PET fiber parameters.

1.3 Material used & Methodology

1.3.1 MATERIAL USED

1.3.1.1 CEMENTOPC53GRADE

Ordinary Portland Cement (OPC) ConformingtoIS12269:1983(53Grade) was used for the experimental work. The properties of material used for making concrete mix is determined in laboratory as per relevant codes of practice. Differentmaterials used in tests were OPC, coarse aggregates, fine aggregates, rice and waste PET, Physical and chemical properties.

1.3.1.2 FINE AGGREGATE

In this experiment, two different sizes of fine aggregates 3, and 5 mm in diameter, and coarse aggregate with maximum size of 10 mm in diameter were adopted. In order to discover the graduation of coarse and fine aggregates, IS 383:1970 sieve analysis was done to every size,according to IS 1607 (1977)standard.

1.3.1.3 COARSE AGGREGATE

The sand used for the work was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The fine aggregated belonged to grading zone III.Aggregates constitute the bulk of a concrete mixture and give dimensional stability to concrete. The aggregates provide about 75% of the body of the concrete and hence its influence is extremely important.Locally available coarse aggregate having the maximum size of 20 mm was used in this work. The aggregates were tested as per IS: 383-1970.

1.3.1.4 WASTE PET AGGREGATE

PET is commonly used for carbonated beverage, water bottles and many food products. PET provides very good alcohol andessential oil barrier properties, generally good chemical resistance and a high degree of impact resistance and tensile strength.

To study the properties of PET.

To provide a most economical concrete.

Using the wastes in useful manner.

To reduce the cost of the construction.

1.3.1.5 SILLICA FUME

Silica fume, also known as micro silica, (IS code 15388:) is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It's an ultrafine powder re-collected as a by- output of the silicon and ferrosilicon admixture product and consists of global snippets with an moderate flyspeck circumference of 150 nm. It is a pozzolanic material that added to cement to enhance the concreteproperties. In this study, the percentage of silica fume added was 10 % of weight ofcement.

1.3.1.6 WATER MIXING

Water: In this experiment, we used normal tap water which is free from organic subsistence and impurities whose pH value is 6.86.

1.4 MIX DESIGN PROPORTIONING

M30 grade of mix design has been prepared as per IS 10262 : 2009 guidelines Method. 10% of Nano-silica by its weight was replaced with cement in all the mixes and Rivers sand was replaced by PET bottle waste(0, 2.5, 5, 7.5, 10, 12.5, 15, and 17.5 %) by its weight. For this Experiment we have use water-cementation as 0.48.

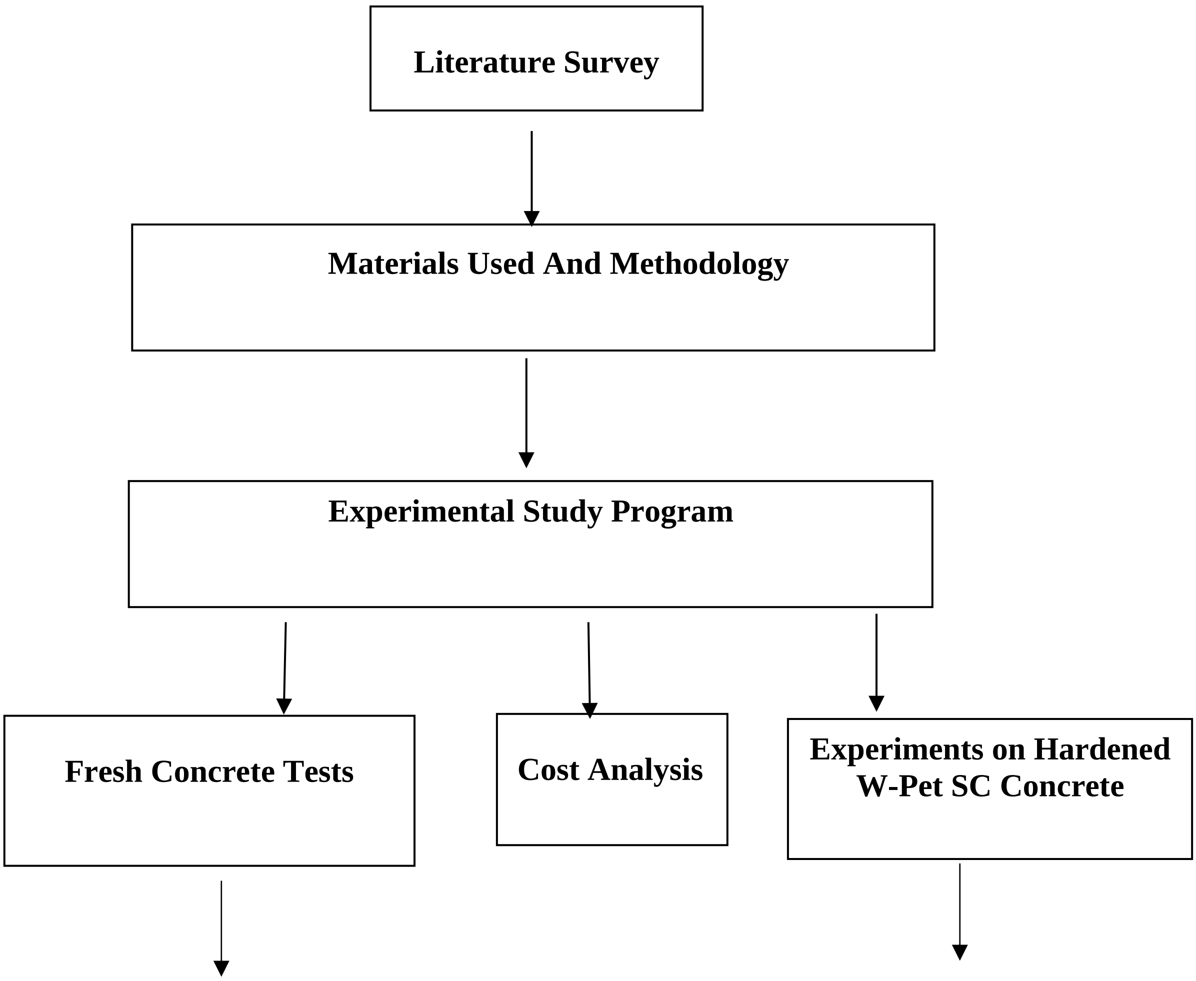
Mixdesignisthedeterminationoftheamountsoftheconstituentmaterialsofconcrete mixes (cement, water, aggregates, Nano silica) in order toget the expected mechanical and physical properties (σ_c, permeability, durability, workability,etc.). Themixdesign isillustratedinTable1.4The concrete mix design was done by using IS 10262 for M-30-20 grade of concrete.

Table 1.4 the mixture proportions used in laboratory for Experimentation are shown in table

Mix	**%**	**W/c ratio**	**Water (Kg/m3)**	**Cement (Kg/m3)**	**Fine aggregates (Kg/m3)**	**Coarse aggregates (Kg/m3)**	**Pet bottles Plastic (Kg/m3)**
Control	0	0.48	192	400	726.64	1136.55	-
Plastic	2.5	0.48	192	400	708.48	1136.55	18.16
	5	0.48	192	400	690.31	1136.55	36.33
	7.5	0.48	192	400	672.15	1136.55	54.49
	10	0.48	192	400	653.98	1136.55	72.66
	12.5	0.48	192	400	635.81	1136.55	90.83
	15	0.48	192	400	617.64	1136.55	108.99
	17.5	0.48	192	400	599.48	1136.55	127.16

1.5 EXPERIMENTAL PROGRAM

The application of plastic waste as annatural aggregate replacement in concrete is a more or less recent conception. One of the first significant reviews on the use of waste plastic in concrete concentrated on the advantages and fiscal benefits of similar use, beside their physical and mechanical properties. And more over use of plastic as aggregate gives a result for the problems encountered with the quarrying of natural aggregate. On the other hand, plastic pollution is presently on of the biggest environment concerns.



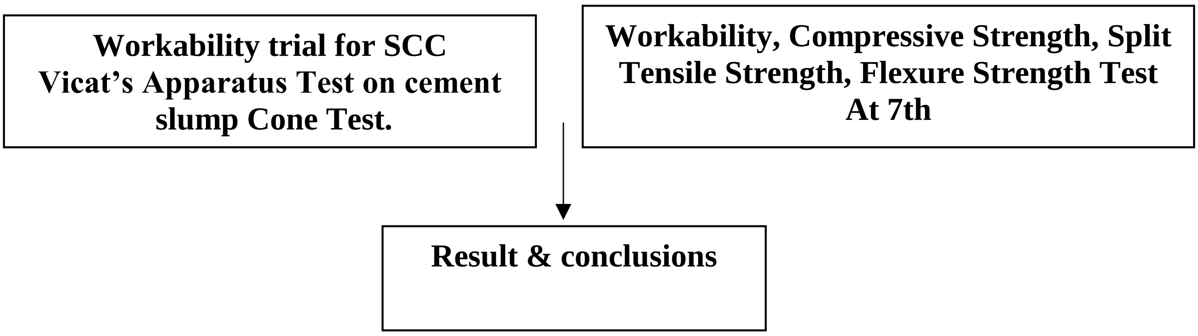


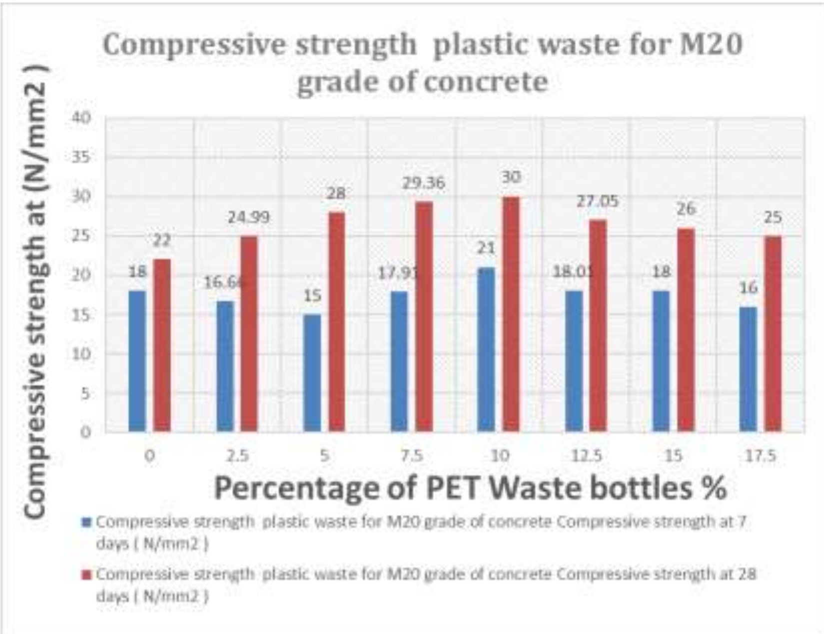
Fig. 1.5.Flow chart used in present study

1.5.1 FRESH CONCRETE TESTS

In accordance with the goals of the thesis,Eight different mixes were casted with five different replacement percentages namely 0, 2.5, 5, 7.5, 10, 12.5, 15, and 17.5 % of Waste plastic PET bottles for w/b ratios of 0.48, using self-compacting concrete. The main goal was to determine the effects of plastic PET aggregates added on the fresh, physical and mechanical properties of SCC. For this reason, several trial have been made:

1. Workability trial for SCC (slump flow, V-funnel, L-box)
2. Compressive strength
3. Splitting tensile strength
4. Ultrasonic pulse velocity
5. Flexural toughness
6. Degradation test, with two different temperatures 100 °C and 200 °C (Influence of temperature on σc, σs, UPV, micro-cracks, and density of concrete).Finally, this chapter illustrates the materials used in the mixtures, the standard codes that are used in the experimental study, and the ways how the using of tools, machines, and test method have been done.

The strength ,7and28forControlconcreteare also represented graphically infigure 1.8.2.2



Graph. 1.8.2.2 Compressive Strength of Control concrete in N/mm2

Table1.8.2.2(A):CompressiveStrengthofPET ConcreteStrengthofControlconcreteinN/mm2

	Compressive strength plastic waste for M20 grade of concrete		
S.NO.	Percentage of PET Waste bottles %	Compressive strength at 7 days (N/mm2)	Compressive strength at 28 days (N/mm2)
1	0	18	22
2	2.5	16.66	24.99
3	5	15	28
4	7.5	17.91	29.36
5	10	21	30
6	12.5	18.01	27.05
7	15	18	26
8	17.5	16	25

As per experimental program and results shown in table no. 1.8.2.2 (A) and graph no. 1.8.2.2 and we can replace aggregatesbyPETupto0, 2.5, 5, 7.5, 10, 12.5, 15, and 17.5 % BecausethecompressivestrengthofM20 Grade of concretereplacementofaggregateiscomparativelyequaltocontrolmixdesign. If aggregate is replaced by PET more than 15% the loss in compressive strength is comparatively. It is only15%acceptable mix proportion PET Waste

1.8.3.1 EFFECTOFAGE ONFLEXURAL STRENGTH

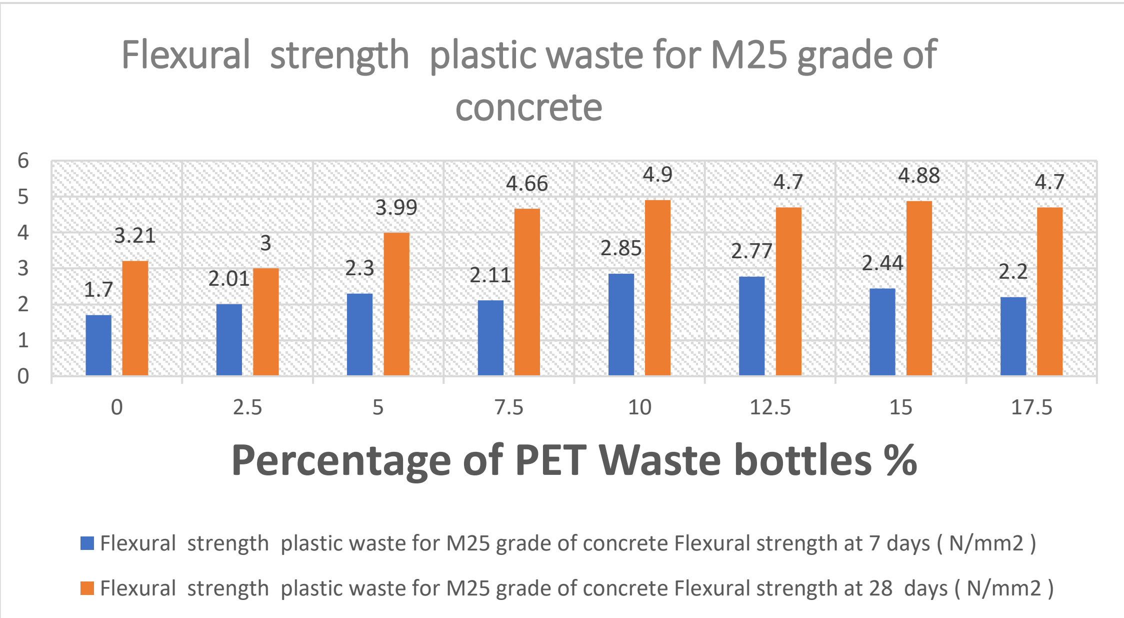
The28daysstrengthobtainedforM30GradeControlconcreteis4.9N/mm2.Thestrengthresultsreportedintablearepresentedintheformofgraphicalvariations, wheretheFlexural strengthisplotted againstthe%ofAggregatereplacement.

Table1.8.3.1Flexural StrengthofControlconcreteinN/mm

Grade of concrete	7Days	28Days
M25	2.85	4.9

The strength attained at different ages namely, 7 and 28 for Control concrete are also represented graphically in figure 1.8.3.1

Graph1.8.3.1Flexural Strength of Controlconcretein N/mm2



From the figure, it is clear that as the age advances, the strength of Control concrete increases. The rate of increase of strength is higher at curing period upto 28 days. However the strength gain continues at as lower rate after28 days.

Table 1.8.3.1 (A) Flexural Strength of Control concrete in N/mm2

	Flexural strength plastic waste for M25 grade of concrete		
S.NO.	Percentage of PET Waste bottles %	Flexural strength at 7 days (N/mm2)	Flexural strength at 28 days (N/mm2)
1	0	1.7	3.21
2	2.5	2.01	3
3	5	2.3	3.99
4	7.5	2.11	4.66
5	10	2.85	4.9
6	12.5	2.77	4.7
7	15	2.44	4.88
8	17.5	2.2	4.7

As per experimental program and results shown in table no. 1.8.3.1(A) and graph no. 1.8.3.1 and we can replace aggregatesbyPETupto0, 2.5, 5, 7.5, 10, 12.5, 15, and 17.5 % Because the FlexuralstrengthofM25 Grade of concretereplacementofaggregateiscomparativelyequaltocontrolmixdesign. If aggregate is replaced by PET more than 10% the loss in Flexural strength is comparatively. It is only 10 % acceptable mix proportion PET Waste.

EFFECT OF AGE ON FLEXURAL STRENGTH

The28daysstrengthobtainedforM30GradeControlconcreteis 4.91N/mm2.Thestrengthresultsreportedintablearepresentedintheformofgraphicalvariations, where theFlexural strength against the % of Aggregate replacement.

Table1.8.3.2Flexural StrengthofControlconcreteinN/mm2

Grade of concrete	**7Days**	**28Days**
M20	2.7	4.91

Graph1.8.3.2Flexural StrengthofControlconcreteinN/mm2

The strength achieved at different ages namely, 7 and 28 for Control concrete are also represented graphically in figure 1.8.3.2

Table1.8.3.2 (A)Flexural StrengthofControlconcreteinN/mm2

	Flexural strength plastic waste for M20 grade of concrete		
S.NO.	Percentage of PET Waste bottles %	Flexural strength at 7 days (N/mm2)	Flexural strength at 28 days (N/mm2)
1	0	1.8	3.33
2	2.5	2	3.01
3	5	2.3	4
4	7.5	2.9	3.85
5	10	2.7	4.91
6	12.5	2.5	3
7	15	2.3	3.85
8	17.5	2.99	4.44

As per experimental program and results shown in table no. 1.8.3.2(A) and graph no. 1.8.3.2 and we can replace aggregatesbyPETupto0, 2.5, 5, 7.5, 10, 12.5, 15, and 17.5 % BecausetheFlexuralstrengthofM20 Grade of concretereplacementofaggregateiscomparativelyequaltocontrolmixdesign. If aggregate is replaced by PET more than 10% the loss in Flexural strength is comparatively. It is only 10 % acceptable mix proportion PET Waste.

1.8.4.1 EFFECT OF AGE ON SPLIT TENSILE STRENGTH

The28daysstrengthobtainedforM30GradeControlconcreteis5.4N/mm2.Thestrengthresultsreportedintablearepresentedintheformofgraphicalvariations, wheretheSplit tensilestrengthisplotted againstthe%ofAggregatereplacement.

Table1.8.4.1Split Tensile StrengthofControlconcreteinN/mm2

Grade of concrete	7Days	28Days
M25	3.8	5.4

Thestrengthachievedatdifferentagesnamely,7and28forControlconcreteare alsorepresentedgraphicallyinfigure 1.8.4.1

Table1.8.4.1Split Tensile Strength of Control concreteinN/mm2

	Split tensile strength plastic waste for M25 grade of concrete		
S.NO.	Percentage of PET Waste bottles %	Dayas7 strength at 7 days (N/mm2)	Days 28 strength at 28 days (N/mm2)
1	0	3.2	5
2	2.5	3.41	4.88
3	5	3.4	4.77
4	7.5	3.11	4.9
5	10	3.8	5.4
6	12.5	3.55	4.45
7	15	3.2	4.88
8	17.5	3.01	4.911

Graph1.8.4.1 (A)Split Tensile StrengthofControlconcreteinN/mm2

As per experimental program and results shown in table no. 1.8.4.1 and graph no. 1.8.4.1(A)and we can replace aggregatesbyPETupto0, 2.5, 5, 7.5, 10, 12.5, 15, and 17.5 % BecausetheSplit tensilestrengthofM25 Grade of concretereplacementofaggregateiscomparativelyequaltocontrolmixdesign. If aggregate is replaced by PET more than 10% the loss in Split tensile strength is comparatively. It is only 10 % acceptable mix proportion PET Waste.

1.8.4.2 EFFECTOFAGE ONSPLIT TENSILE STRENGTH

The28daysstrengthobtainedforM30GradeControlconcreteis 5.881N/mm2.Thestrengthresultsreportedintablearepresentedintheformofgraphicalvariations, wheretheSplit tensilestrengthisplotted againstthe%ofAggregatereplacement.

Table5.3.3Split Tensile StrengthofControlconcreteinN/mm2

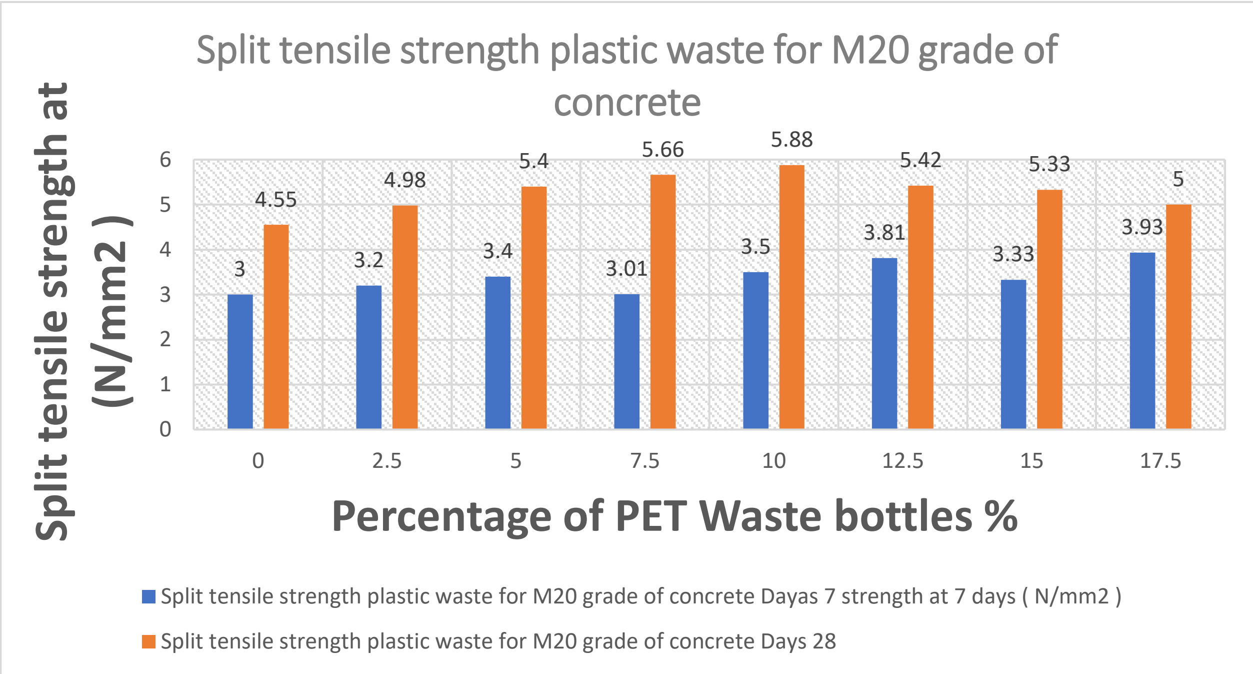
Grade of concrete	7Days	28Days
M20	3.5	5.88

Thestrengthachievedatdifferentagesnamely,7and28forControlconcreteare alsorepresentedgraphicallyinfigure1.8.4.2

Table1.8.4.2 (A)Split Tensile StrengthofControlconcreteinN/mm2

	Split tensile strength plastic waste for M20 grade of concrete		
S.NO.	Percentage of PET Waste bottles %	Dayas7 strength at 7 days (N/mm2)	Days 28 strength at 7 days (N/mm2)
1	0	3	4.55
2	2.5	3.2	4.98
3	5	3.4	5.4
4	7.5	3.01	5.66
5	10	3.5	5.88
6	12.5	3.81	5.42
7	15	3.33	5.33
8	17.5	3.93	5

from the Graph, it is clear that as the age advances, the strength of Control concrete increases. Therate of increase of strength is higher at curing period upto28 days. How ever the strength gain continues at as lower rate after28 days.



Graph1.8.4.2 (B) Split Tensile Strength of Control concretein N/mm2

As per experimental program and results shown in table no. 1.8.4.2 and graph no. 1.8.4.2 (A)and we can replace aggregates by PET up to 0, 2.5, 5, 7.5, 10, 12.5, 15, and 17.5 % Because the Split tensile strength of M20 Grade of concrete replacement of aggregate is comparatively equal to control mix design. If aggregate is replaced by PET more than 10% the loss in Split tensile strength is comparatively. It is only 10 % acceptable mix proportion PET Waste.

1.9 Cost Estimation Between Conventional Concrete &Pet Waste Mixed Concrete

1.9.1 Cost Analysis

The cost estimation has been done separately for every mix proportion that being used in this work. The rate applied to the all the used materials to estimate cost is from current 2023 market price. Quantity estimation of all materials which are batched is done as per 1 cubic meter such that total quantity of each material can be calculated separately, and so on rates of each material as per market price are applied as per kilogram. Rate analysis shows that as the percentage of PET WASTE material increases, the cost goes on decreases. Reduction in cost can be achieved easily without affecting strength of concrete.

Table 1.9.1 Standard Cost of materials

Materials	Quantity	Price (₹)
Water	1000 liters	400
Cement	50 Kg	340
Sand	1 Cu. Feet	55
Coarse Aggregate	1 Cu. Feet	80
W-PET Bottles	-	0

On the present investigation W-PET in the strength of the concrete upon replacement of sand & aggregate with different percentages of W-PET plastic. Analysis of the cost efficiency and the waste reduction be done to measure the benefits in terms of cost and reduction of waste plastic.

The cost of PET bottle waste varies with the season. In the peak season the cost goes up to 1 Rs/bottle whereas during off season it costs 2 Rs/ kg. The waste bottles for this project have been provided free of cost by the disposable unit of Municipal Corporation of the city. This is so because most municipal corporations use bottles for landfill purposes and they would give away the bottles readily.

Table 1.9.2 Quantity Estimate of Concrete (kg/m3).

Mix	PET WASTE %	PET WASTE	Cement	Sand	Aggregate	Total quantity
	(Kg)	(Kg)	(Kg)	(Kg)	(Kg)	(Kg) in 1 m3
Mix 3	5	53.21	400	673.04	1011.18	2137.43
Mix 3	5	33.64	400	639.4	1064.39	2137.43
Mix 7	15	159.65	400	673.04	904.74	2137.43
Mix 7	15	100.92	400	572.12	1064.39	2137.43

Table 1.9.3 Price list for different material for one kg

S. No.	Name of Material	Unit	Rate (Rs)
1	Pet Waste Fine	Kg	₹ 0.00
2	Pet Waste Coarse	Kg	₹ 0.00
3	Cement	Kg	₹ 6.80
4	Sand	Kg	₹ 1.10
5	Aggregate	Kg	₹ 1.60

Table 1.9.4 Estimating the cost of material in ₹ with the help of abstract sheet

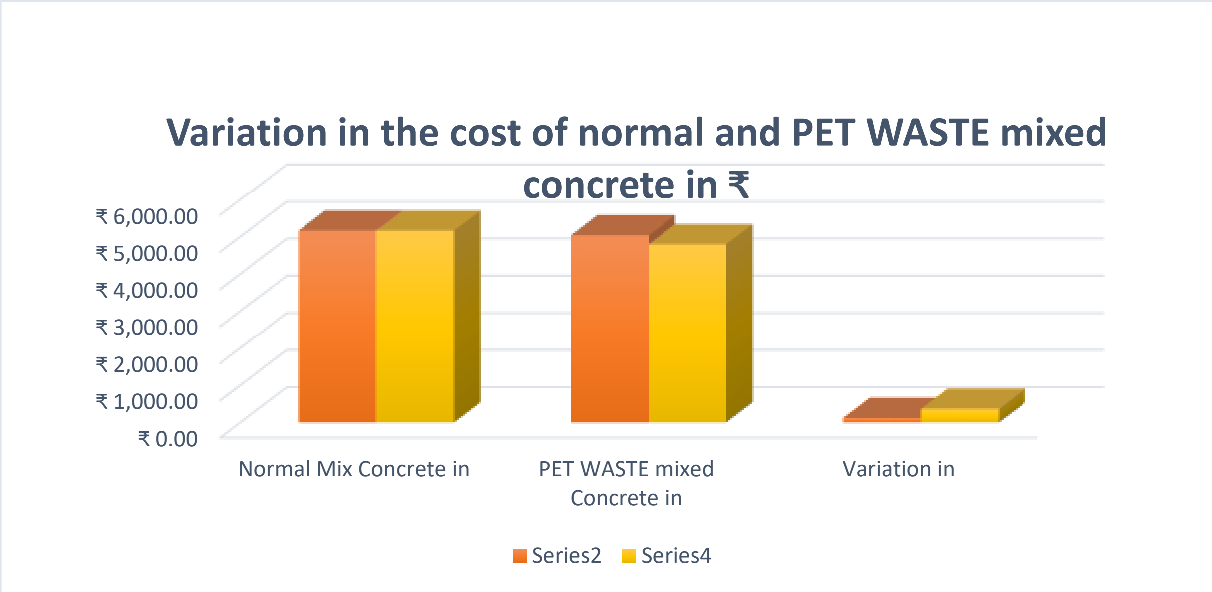
S. No.	Items	Quantity	Unit	Rate	Amount
1	PET WASTE FINE	33.64	Kg	₹ 0.00	₹ 0.00
2	PET WASTE COARSE	53.21	Kg	₹ 0.00	₹ 0.00
3	Cement	400	Kg	₹ 6.80	₹ 2720.00
4	Sand	639.4	Kg	₹ 1.10	₹ 703.34
5	Aggregate	1011.18	Kg	₹ 1.60	₹ 1617.89
Total					₹ 5041.23

Table 1.9.5 Estimating the cost of material in ₹ with the help of abstract sheet

S. No.	Items	Quantity	Unit	Rate	Amount
1	Cement	400	Kg	₹ 6.80	₹ 2720.00
2	Sand	673.04	Kg	₹ 1.10	₹ 740.34
3	Aggregate	1064.39	Kg	₹ 1.60	₹ 1703.02
Total					₹ 5163.37

Table 1.9.6 Variation in the cost of normal concrete and Waste-PET mixed concrete

Mix	Normal Mix Concrete in	PET WASTE mixed Concrete in	Variation in
Mix 3	₹ 5163.37	₹ 5041.23	₹ 122.14
Mix 7	₹ 5163.37	₹ 4796.92	₹ 366.45



Graph 1.9 Variation in the cost of normal and Pet Waste mixed concrete in ₹The cost is low to the normal mix for M-30 grade of concrete and it is increase when increases of proportion of Waste-PET material in the design mix. The difference between normal mix and design mix is ₹366.45. It is saved in per meter cubic of concrete.

CONCLUSIONANDSCOPEFORFURTHERSTUDY

The behaviour of fresh and hardened properties of concrete almost depend upon shape and the size of the PET bottles aggregate

1. The gradual increase is seen in the compressive strength of Waste-PET bottles mixed concrete at 7 days and 28 days of curing with 10% addition to12.5% Waste-PET bottles in after that it starts reducing the compressive strength with an increase Waste-PET bottles addition and the mix which gives the maximum compressive strength is Mix 5.
2. The split tensile strength of Waste-PET bottles mixed concrete is 10% to 12.5% addition, but it begins to decrease with an increase in Waste-PET bottles addition, and the mix with the highest compressive strength is Mix 5.
3. The Flexural strength of Waste-PET bottles mixed concrete is 12.5% to 15% Waste-PET bottles addition, but it begins to decrease with an increase in 15% Waste-PET bottles addition, and the mix with the highest flexural strength is Mix 6.
4. After estimation of normal concrete (M-30) and the Waste-PET bottles mixed concrete is found that per m3 concrete save ₹366.45.
5. In this present investigation approx. ₹ 26.01=7.1% amount of is saved As compare to normal concrete.

RECOMMENDATIONSFORFUTURESTUDIES

1. Studying the durability properties of WPET-SCC concrete such as water permeability, rapid chloride permeability, creep, plastic shrinkage and drying shrinkage, resistance to freezing and thawing, and degradation test at elevated temperatures.
2. Studying possibilities of increasing the strength of WPET-SCC concrete orc ompensating the strength loss when different replacement levels of WPET with coarse aggregate are incorporated in concrete. Such possibilities include reducing the w/c ratio and the use of superplasticizers and the use of different pozzolanic materials with WPET.

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