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"Mechanical Characteristics of Concrete with Partial Replacement of Sand by Waste PET Bottle Fibers"

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ABSTRACT: This study investigates the feasibility of using waste **Polyethylene Terephthalate (PET) bottle fibers** as a partial substitute for fine aggregate in concrete and evaluates their influence on the mechanical properties of concrete. The improper disposal of plastic waste has become a serious environmental concern due to its non-biodegradable nature. PET bottles, which are extensively used for packaging drinking water and carbonated beverages, contribute significantly to plastic pollution. To address this issue and reduce the consumption of natural sand, the construction industry is exploring sustainable and economical alternative materials.

In this research, waste PET bottle fibers were incorporated into **Ordinary Portland Cement (OPC)** concrete as a partial replacement for fine aggregate. Since complete replacement of natural sand with PET fibers is impractical, replacement levels of **1%, 2%, 2.5%, 3%, and 5%** were investigated. Prior to concrete preparation, the physical and mechanical properties of the constituent materials were determined. The cement exhibited a normal consistency of **31%**, soundness of **3 mm**, initial and final setting times of **65 minutes** and **280 minutes**, compressive strength of **59.38 N/mm²**, and a specific gravity of **3.15**. The water absorption and specific gravity values were **1.40%** and **2.63** for fine aggregate, and **1.19%** and **2.69** for coarse aggregate, respectively. Sieve analysis was carried out to determine the particle size distribution and fineness modulus of the aggregates.

An **M20 grade concrete mix** with a **water-cement ratio of 0.50** was designed for the investigation. Concrete cubes measuring **150 × 150 × 150 mm** and beams of **75 × 75 × 300 mm** were cast, cured, and tested after **7 and 28 days**. The performance of concrete containing varying percentages of PET fibers was compared with a conventional control mix without PET replacement. Compressive strength and flexural strength tests were conducted to evaluate the structural performance of the specimens.

The experimental findings indicated that replacing fine aggregate with **2%–2.5% PET bottle fibers** resulted in improved compressive and flexural strengths compared to conventional concrete. However, higher replacement levels led to a reduction in strength. The results suggest that a limited percentage of PET bottle fibers can effectively enhance concrete performance while promoting the recycling of plastic waste and reducing dependence on natural fine aggregate. Therefore, the use of PET bottle fibers as a partial replacement for sand represents an environmentally friendly and sustainable approach for concrete production.

Keywords: PET bottle fibers, plastic waste recycling, fine aggregate replacement, compressive strength, flexural strength, workability, water absorption, bulk density, M20 concrete, sustainable concrete.

INTODUCTION: Concrete is widely used materials in the world. Based on global uses it is placed at second position after water. Concrete is a composite material consists of fine aggregate and coarse aggregate bonded together with cement paste that hardens with time. It requires workability, strength and durability that cannot be obtained with techniques and materials adopted for producing conventional cement concrete. Fine aggregate is important construction materials, which is widely used in construction works. Nowadays the cost of concrete is increasing since the cost of fine aggregates increasing. To reduce the requirements and cost of concrete some alternatives materials are needed to replace the fine aggregates. River sand is one of the constituents used in the production of the conventional concrete has become highly expensive and scarcity. In the backdrop of such a bleak atmosphere, there is large demand for alternative materials from the industrial and household waste. The waste plastic pet bottle can be used as an alternative material for replacement of the sand. The rapid urbanization and industrialization all over the world has resulted in large deposition of waste polymer materials. The world's annual consumption of plastic materials has increased from around 5 million tons in the 1950s to nearly 300 million tons in 2015 (Plastic: the fact 2015). Plastic waste materials consist of surplus, obsolete, broken, old plastic furniture, different household plastic materials, equipment, anti-static packaging materials and devices made of plastic. These polymer wastes are almost non-degradable in the natural environment even after a long period of exposure. inclusion of polymer waste in concrete can be a proper utilization of this valuable property. Thus, utilization of waste polymer material in making concrete/mortar can be a good solution to this environmental hazard. Very few information is available regarding recycling of polyurethane formaldehyde (PUF) based polymer wastes and its use as construction materials. Kathmandu alone uses around 4,700,000 to 4,800,000 plastic bags daily. In Nepal, 16 percent of urban waste is comprised of plastic, which is 2.7 tons of daily plastic garbage production (The Kathmandu post 5th June 2018). When you look at the global level the data is staggering. Researchers claim humans have produced 9.1 billion tons of plastic so far, and much of it ends up in nature causing harm to both living beings and the environment. The safe use of plastic waste is very important because plastics are normally stable and not biodegradable. The aim of this research is to investigate the effect of two types of waste plastic on strength of concrete. Plastics are polymers, a very large molecule made up of smaller units called monomers which are joined together in a chain by a process called polymerization. The polymers generally contain carbon and hydrogen with, sometimes, other elementssuch as oxygen, nitrogen, chlorine or fluorine (UNEP, 2009). Plastics have become anintegral part of our lives. The number of plastics consumed annually has been growingsteadily. Its low density, strength, user-friendly designs, fabrication capabilities, longlife, lightweight, and low cost are the factors behind such phenomenal growth.Plastics have been used in packaging, automotive and industrial applications, medicaldelivery systems, artificial implants, other healthcare applications, water desalination,land/soil conservation, flood prevention, preservation and distribution of food,housing, communication materials, security systems, and other uses. With such largeand varying applications, plastics contribute to an ever-increasing volume in the solidwaste stream. The world's annual consumption of plastic materials has increased fromaround 5 million tons in the 1950s to nearly100 million tons in 2001.Quantities ofwaste plastic have been rising rapidly during the recent decades due to the highincrease in industrialization and the considerable improvement in the standards ofliving, but unfortunately, the majority of these waste quantities are not being recycledbut rather abandoned causing certain serious problems such as the waste of naturalresources and environmental pollution.

TYPES AND USES OF PLASTIC

Type of plastic	Description	Some uses for Virgin plastic	Some uses for Recycled plastic
Polyethylene terephthalate (PET)	Clear tough plastic, maybe used as a fiber	Soft drink and mineral Water bottles	clear film for packaging, carpet fibers, fleecy jackets
Low density polyethylene (LDPE)	Soft, flexible plastic, milky white, unless a pigment is added	Lids of ice-cream containers, garbage bags, and garbage bins	Film for builders, industry, packaging And plant nurseries
High density Polyethylene (HDPE)	Very common plastic, usually white or colored	Crinkly shopping bags, freezer bags, and milk	Compost bins, Detergent bottles, crates, and mobile rubbish bins
UnplasticizedPolyvinyl chloride (UPVC)	Hard rigid plastic, may be clear	Clear cordial and juice bottles, plumbing pipes and fittings	Detergent bottles, tiles, and plumbing Pipe fittings
Plasticized Polyvinyl chloride (PPVC)	Flexible, clear, elastic Plastic	Garden hose, shoe soles, blood bags and tubing	Hose inner core, and Industrial flooring
Polypropylene (PP)	Hard, but flexible plastic	Ice-cream containers, potato crisp bags, stools and chairs	Compost bins, kerb side recycling crates, and worm factories
Polystyrene (PS)	Rigid, brittle plastic. Maybe clear, glassy	cheap, transparent kitchen ware, light fittings, bottles, toys, and food containers	Clothes pegs, coat hangers, and video/CD boxes
Polyester (EPS)	Foamed, lightweight, energy absorbing , andthermal insulation	Hot drink cups, and takeaway food containers	spools, rulers, and video/CD boxes
Polyamides (PA)	Nylons fibers,	toothbrush bristles, and fishing	

AIMANDOBJECTIVES

To evaluate the possibility of using plastic pet bottle fibre as partial replacement of sand in concrete. Specific objectives of this work include:

1) To study the effect of replacing sand with plastic pet bottle fibre on workability, compressive strength and flexural strength of concrete.
2) To study the effect of replacing sand with plastic pet bottle fibre on weight of concrete.
3) To find the optimum percentage of replacement of sand using plastic pet fibre.

LITERATURE REVIEW:

Maqbool Younus et al (2019) studied Experimental investigation on the properties of concrete with plastic pet (bottle) fiber as partial replacement of fine aggregates with the varying percentage (1%, 2%, 2.5%, 3% and 5%) of the Plastic PET bottles. In this research we can found that the compressive strength of the concrete increase with increase in plastic fiber up to 2% added of the Plastic fiber, there after the Compressive strength reduces with increase of the addition of the plastic fiber. Whereas the Flexural strength of the Concrete increases with increases as percentage increase up to 2.5%. Thereafter it reduces with increase of the addition of the plastic fiber.

Elango A and Ashok Kumar [2018]Concrete containingflexiblefine particles wasused in a study. They used crushed aggregates, river sand, and OPC 53 grade. Plastic wasutilised in place of fine aggregates in proportions of 10%, 20%, and 30%. On theirconcrete samples, they test mechanical and durability attributes. They discovered a dropin concrete strength. However, it was discovered that the concrete has good resistance toacid assaults and increased flexibility. As a result, they determined that flexible aggregateconcrete can be employed in places where compressive strength is less important thandurability.

Lhakpa Wangmo Thingh Tamanget [2017] Plastics in Concrete as Coarse Aggregatewas the subjectof a test.They investigated the mechanical characteristics of concretewith plasticparticles.They employ plasticaggregates in threedifferentproportions:10%, 15%, and 20%. They discovered a slight drop in strength and recommended a 15percentreplacementasthebestresult.

B Jaivignesh and A Sofi in [2017] Study of Concrete Properties using Plastic Waste asAggregate was completed. They used plastic in the place of fine and coarse aggregates inproportions of 10%, 15%, and 20%. Steel fibre was also added to the concrete. Theirfindings point to a drop in strength, but they recommend using it instead to save wasteanduseenvironmentallyacceptableproducts.

MB Hossain et. al. in[2016] did research on the use of waste plastic as a componentingredient in concrete. They are used to replace coarse aggregates in proportions of 5%,10%, and 20%. They discovered that the concrete was lighter. However, the compressivestrength of the concrete was lower than that of traditional concrete. They also discoveredthat the concrete with 10% plastic particles had a strength that is virtually identical tonormalconcrete.Asaconsequence,the best outcomewas10%plasticaggregates.

Amalu.R.Get. al. in [2016] The use of waste plastic as fine aggregate in concrete wasinvestigated. They employ plastic to replace fine aggregates in proportions of 10%, 15%,20%,and25%.Theydiscoveredadropinconcretestrength,buttheyencouragetheuseof plastic in non-structural concrete because it has a better workability and produces lesswaste.

Manhal A Jibrael and Farah Peter in [2016] The Strength and Behaviour of ConcreteContaining Waste Plastic is being investigated. Plastic bottles and plastic bags are used toreplace fine aggregates in concrete in proportions ranging from 0% to 5%. They came tothe conclusion that using plastic in concrete for non-structural uses is not a good ideabecauseitaffects strengthinbothcircumstances.

B.Harini and K.V.Ramana [2015] Experiments on the strength properties of M30 gradeconcrete with various plastic percentage proportions were carried out. By volume, thevarious plastic proportions are 5 percent, 6 percent, 8%, 10%, 15%, and 20%. When theplastic to aggregate ratiois raised, the compressive strength decreases.Which mix hadthe lowest compressive strength, and which mix had silica fume of 5%, 10%, and 15% byweight partially replaced cement. The strength properties were examined once more, andit was discovered that when 10% of the cement was substituted with silica fume, theconcentrationofsilicafume was 15%greaterthaninthe referencemix.

S. Vanitha et al. in [2015] conducted research on the utilisation of waste plastic inconcrete blocks Paver blocks and solid blocks with dimensions of 200 mm X 150 mm X60 mm and 200 mm X 100mm X 65 mm were cast in M20 concrete and tested forstrength after 7, 14, and 28 days. Plastic was substituted for aggregates in proportions of2%, 4%, 6%, 8%, and 10%, respectively. They discovered that replacing 4% of theaggregates with plastic aggregates yielded the best results for paver blocks. In the case ofsolidblocks,thereisalso2%plastic.

T.Subramani and V.K.Pugal in [2015] Plastic trash was used as coarse particles inconcreteintrials.Theypreparedtheconcretebyreplacing5percent,10%,and15%oftheaggregatesintheconcretewithplastic.They discoveredthatreplacing10%ofaggregates with plastic yielded the best outcomes. Concrete's strength deteriorates as itsplastic componentrises.

Daniel Yaw Osei in [2014] Experiments on plastic aggregate in concrete were carriedout. He used plastic to substitute 25 percent, 50 percent, 75 percent, and 100 percent ofthe coarse aggregates in 1:2:4 concrete. He discovered that both the strength and densityof the concrete had decreased. They suggested that replacement of aggregates more than36% is not suitable for structural concrete. They also suggested plastic as a medium forproductionoflightweightconcrete.

Brahim Safi [2013] investigated the use of plastic trash as a fine aggregate in self-compacting mortars. The researchers came to the conclusion that thisform of plastictrashcan beusedsuccessfully asfineaggregateinself-compactingmortars(orconcrete). The presence of these wastes improves fluidity greatly. For mortar containing 20 percentto 50 percent plastic trash, the reduction in compressive strength was between 15 and 33percent.

R.V.Silva [2012] had investigated the durability of concrete incorporating paste waste asaggregate and the effectof curing conditions on the durability of the concrete. He cameto the conclusion that as the number of coarser, flakier, and irregularly shaped plasticaggregatesincreases,workabilitydiminishes.Asallconcretespecimensdriedinprogressivelydriersettings,thedifferencebetweenthesevaluesexpanded,withreductionsrangingfrom11.1percentto28.3percentofcoarserplasticaggregatespecimenscured.

Semiha Akcaozoglu [2011] has evaluated the influence of Granulated Blast FurnaceSlag, Fly ash on light weight mortars and determined that the addition of fly ash loweredcompressive strength, flexural strength, and tensile strength when compared to cementspecimens.GranulatedBlastFurnaceSlagandflyashbothenhancedspecimencarbonation depths. As a result, while utilising these mineral admixtures, carbonationreductionprocedures mustbeperformed.

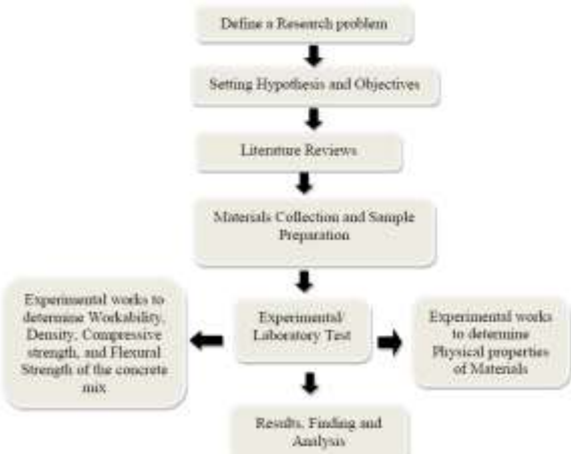
Simiha Akcozoglu [2009] had conducted research using PET plastic and concluded thatthe use of shredded PET granules reduces the unit weight of concrete, resulting in areduction in the dead weight of the building, which will help to reduce the seismic risk ofthe structure because earthquakeforcesare linerlyproportionaltodeadweight.

M. Etxeberria et. al. [2007] They looked at how recycled coarse aggregates and themanufacturing method affected the characteristics of recycled aggregate concrete. Fourdifferent recycled aggregate concretes were created, each containing 0%, 25%, 50%, and100% recycled coarse aggregates. The four concretes' mix proportions were designed toattain the same compressive strengths. To manage their fresh concrete characteristics,effective w/c ratio, and lower strength variability, recycled aggregates were used in a wetbut not saturated state. Due to the volume of cement required, it was determined thatrecycled aggregate concrete with low–medium compressive strength was required. Theimpactoftheorderinwhichmaterialsareutilisedinconcretemanufacturingonimprovingitssplittingtensilestrengthwasinvestigated. Thereducedmodulusof elasticity of recycled coarse aggregate concretes compared to standard concretes wasmeasured,confirmingvarious researchers'numericalpredictions.

P.F. Castro et. al. [2005] They evaluate the usefulness of the rebound test and ultrasonicpulse velocity in determining the strength variations of concrete structural elements usingconfidenceintervals, colour "contour" graphs, and the ANOVA technique. The reportalso includes a set of criteria for analysing concrete variability. The quality of structuralelements is determined by the concrete manufacturing process, which includes mixing,transport, placement, compaction, and cure. Nondestructive tests, at construction site, areusually used for assessing concrete strength into the structure. However, non-destructivetestsmayalsobeusedforassessingtheconcretehomogeneityintothestructuralelement

RESEARCH METHODOLOGY

RESEARCH DESIGN



DETAILS OF SPECIMENS

Table: Various specimen type prepared

S.N.	Specimen Type	No. of specimen Prepared with % replacement of Sand						Total no of specimen prepared From each type
		0%	1%	2%	2.5%	3%	5%	
1	Cube(150x150x150)	4	4	4	4	4	4	24
2	Beam(75x75x300)	4	4	4	4	4	4	24
	Total no. of specimen prepared							48

MATERIAL USED

Table : Materials used.

Basic materials	**Specifications**
Cement	Ordinary Portland cement 53 Grade from Ultratech Cement was used.
Sand	The fine aggregate was sand from River Sand Belkhu having a specific gravity 2.63.
Gravel	Maximum size of 20 mm, specific gravity of 2.69 was used as coarse aggregate.
Waste Plastic Pet Bottles	Recycled waste plastic PET Bottles with a percentage 1%, 2%, 2.5%, 3% and 5% replacement of sand was used.
Water	Fresh water was used for mixing process and curing.

Properties of PET Bottles Fiber

The plastic aggregates were produced mainly from waste PET bottles the plastic bottles were crushed and cut into small pieces using a crushing machine or by manually. The plastic aggregates were washed properly to make them clean and to ensure that no other dust particles were present there. Polyethylene terephthalate (PET) is thermoplastic polyester with tensile and flexural modulus of elasticity of about 2.9 and 2.4MPa respectively tensile strength up to 60MPa and excellent chemical resistance. It is a semi-crystalline polymer, with a melting point of about
260°C and a glass transition temperature ranging from 70 to 80°C, in relation to the amount of crystalline region enclosed in the amorphous phase.

Figure: Waste Plastic Pet Bottles Fiber **Figure: Waste plastic pet bottle**

Table :M20 grade of concretes

Particulars	Design values for different percentage of Plastic Pet bottle fiber						Remarks
	0%	1%	2%	2.5%	3%	5%	
Characteristic strength, F_{ck} (MPa)	20	20	20	20	20	20	Cement used = Ultratech OPC Cement S=3.6 Sp. Gravity of cement=3.15 For moderate Exposure w/c=0.50 Maximum nominal size of aggregate=20mm (crushed)Minimum cement content=260kg/m^{3}Wokability =30- 60mm Degree of supervision = Good sp. Gravity of sand =2.63 sp. Gravity of coarse agg. =2.69 sand passing through 600µmsieve=63.00% (grading zone III) free moisture for sand= nil free moisture for coarse agg.= nil
Target Strength For mix proportion $F'_{ck}=F_{ck}+1.65s$(MPa)	25.94	25.94	25.94	25.94	25.94	25.94	
Water cement Ratio Considering D curve	0.50	0.50	0.50	0.50	0.50	0.50	
Selected water Cement ratio	0.50	0.50	0.50	0.50	0.50	0.50	
Water content(kg/m^3)	195	1.95	195	195	195	195	
Cement Content	390	3	3	390	390	390	

(kg/m^3)		90	90			
Plastic pet Bottles fiber (kg/m^3)	-	5.74	11.48	14.35	17.22	28.70
Sand content(kg/m^3)	574	568.26	562.52	559.65	556.78	545.30
Coarse Aggregate content (kg/m^3)	1138	1138	1138	1138	1138	1138
Mix Proportions:						
Water	0.50	0.50	0.50	0.50	0.50	0.50
cement	1	1	1	1	1	1
Plastic pet Bottles fiber	-	0.014	0.029	0.036	0.044	0.073
Sand	1.47	1.46	1.44	1.43	1.425	1.40
Coarse Aggregate	2.92	2.92	2.92	2.92	2.92	2.92

Table : Design values of mixes according to Indian Standard Guidelines.

Particulars	Design Values for the different percentage of Plastic PET bottle fibers					
	0%	1%	2%	2.5%	3%	5%
Concrete grade	M20	M20	M20	M20	M20	M20
Characteristic Strength (MPa)	20	20	20	20	20	20
TargetCompressive Strength (MPa)	25.94	25.94	25.94	25.94	25.94	25.94
Mix Proportions:						
Water	0.50	0.50	0.50	0.50	0.50	0.50
Cement	1.00	1.00	1.00	1.00	1.00	1.00
Plastic PET Fibers	0	0.014	0.029	0.036	0.044	0.735

Sand	1.47	1.46	1.44	1.43	1.425	1.40
Coarse Aggregates	2.92	2.92	2.92	2.92	2.92	2.92

WORKABILITY TESTS

Table : Slump value of Fresh Concrete

Sand Replacement	**Slump value**
0%	35
1%	45
2%	50
2.5%	60
3%	65
5%	75

Bulk Density/ Unit Weight

Table : Bulk Density/ Unit Weight of 28 days cured concrete at different percentage of Sand Replacement

Sand Rep	S.N.	Length(mm)	Breadth(mm)	Depth(mm)	Volume(cm^3)	Weight after 28 days of curing (gm)	Bulk Density (Kg/m	Unit weight (KN/ m^3)
0	1	150	150	150	3375	8404	2490	24.90
	2	150	150	150	3375	8303	2460	24.60
1	1	150	150	150	3375	8353	2475	24.75
	2	150	150	150	3375	8269	2450	24.50
2	1	150	150	150	3375	8235	2440	24.40
	2	150	150	150	3375	8303	2460	24.60
2.5	1	150	150	150	3375	8168	2420	24.20
	2	150	150	150	3375	8259	2447	24.47
3	1	150	150	150	3375	8201	2430	24.30
	2	150	150	150	3375	8100	2400	24.00
5	1	150	150	150	3375	7931	2350	23.50
	2	150	150	150	3375	8100	2400	24.00

Water Absorption

Table : Water Absorption of 28 days cured concrete at different percentage of Sand Replacement.

Sand Replacement (%)	S.N.	Weight before curing (gm)	Weight of cube after28 days of curing (gm)	Difference in Weight(gm)	Water Absorption (%)
0	1	8362	8404	42	0.50
	2	8263	8303	40	0.48
1	1	8313	8353	40	0.48
	2	8231	8269	38	0.46

2	1	8200	8235	35	0.42
	2	8265	8303	38	0.46
2.5	1	8135	8168	33	0.40
	2	8223	8259	36	0.44
3	1	8170	8201	31	0.38
	2	8066	8100	34	0.42
5	1	7899	7931	32	0.40
	2	8071	8100	29	0.36

Compressive strength

Table : Compressive strength of the 7 days cured concrete at different percentage of sand Replacement

Sand Replacement (%)	S.N	Length (mm)	Breadth (mm)	Depth (mm)	Area (cm^2)	Failure load (KN)	Compressive Strength (N/mm^2)
0%	1	150	150	150	225	320	14.22
	2	150	150	150	225	340	15.11
1%	1	150	150	150	225	380	16.89
	2	150	150	150	225	360	16.00
2%	1	150	150	150	225	395	17.56
	2	150	150	150	225	385	17.11
2.5%	1	150	150	150	225	370	16.44
	2	150	150	150	225	360	16.00
3%	1	150	150	150	225	330	14.66
	2	150	150	150	225	310	13.78
5%	1	150	150	150	225	270	12.00
	2	150	150	150	225	290	12.89

Table : Compressive strength of the 28 days cured concrete at different percentage of sand Replacement

Sand Replacement (%)	S. N	Length (mm)	Breadth (mm)	Depth (mm)	Area (cm^2)	Weight after28 day of curing (gm)	Failure load (KN)	Compressive Strength (N/mm^2)
0%	1	150	150	150	225	8404	560	24.88
	2	150	150	150	225	8303	580	25.77
1%	1	150	150	150	225	8353	630	28.00
	2	150	150	150	225	8269	640	28.44
2%	1	150	150	150	225	8235	660	29.33
	2	150	150	150	225	8303	650	28.89
2.5%	1	150	150	150	225	8168	620	27.56
	2	150	150	150	225	8259	630	28.00
3%	1	150	150	150	225	8201	520	23.11
	2	150	150	150	225	8100	540	24.00
5%	1	150	150	150	225	7931	480	21.33
	2	150	150	150	225	8100	490	21.77

Flexural Strength

Table : Flexural strength of the 7 days cured concrete at different percentage of sand Replacement

Sand Replacement	S.N	Length (mm)	Length Between Support (mm)	Breadth (mm)	Depth (mm)	Load At Failure (N)	Flexural Strength (N/mm^2)
0%	1	300	200	75	75	2500	1.77
1%	2	300	200	75	75	2600	1.84
2%	3	300	200	75	75	3000	2.13
2.5%	4	300	200	75	75	3200	2.27
3%	5	300	200	75	75	2900	2.06
5%	6	300	200	75	75	2700	1.92

Table : Flexural strength of the 28 days cured concrete at different percentage of sand Replacement

Sand Replacement	S.NO	Length (mm)	Length Between Support (mm)	Breadth (mm)	Depth (mm)	LoadAt Failure (N)	Flexural Strength (N/mm^2)
0%	1	300	200	75	75	5000	3.55
1%	2	300	200	75	75	5200	3.69
2%	3	300	200	75	75	5600	3.98
2.5%	4	300	200	75	75	5800	4.12
3%	5	300	200	75	75	5500	3.91
5%	6	300	200	75	75	5100	3.63

RESULT AND DISSCUSSION

WORKABILITY OF THE MIXES

Table: Slump value of concrete containing different percentage of Plastic pet bottle fiber.

Sand Replacement	Slump values	Percentage change in slump as compared to control sample
0%	35mm	0%
1%	45mm	28.57%
2%	50mm	42.85%
2.5%	60mm	71.43%
3%	65mm	85.71%
5%	75mm	114.29%

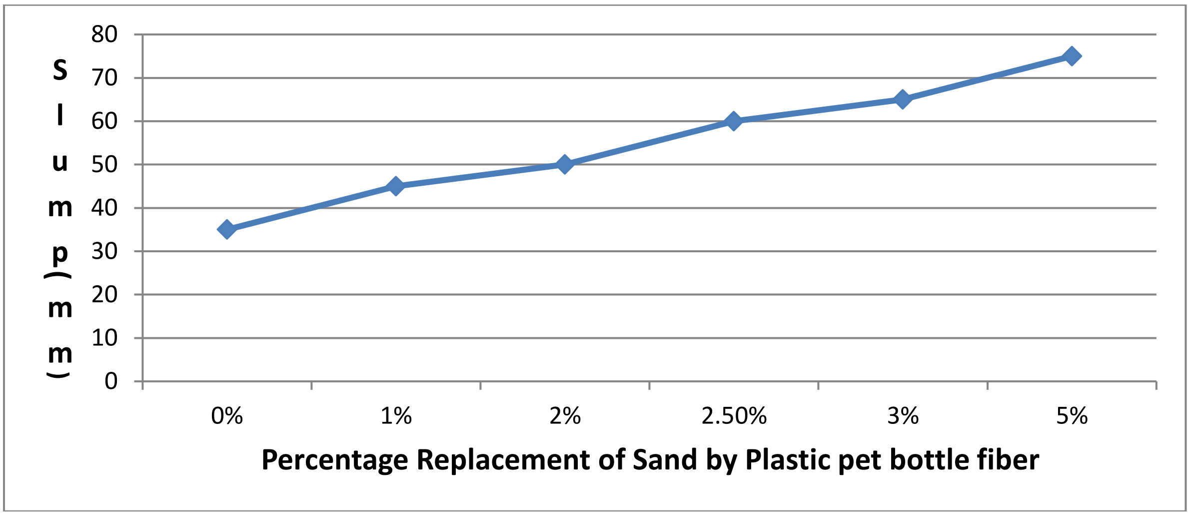


Figure : variation of slump of concrete containing different percentage of Plastic pet bottle fiber

BULK DENSITY/ UNIT WEIGHT OF THE MIXES

Table : Average Bulk Density/Unit Weight Results

Sand Replacement	S.N.	Bulk Density (Kg/m^3)	Unit weight (KN/m^3)	Aver	Aver	Standard Deviation of Bulk	Percent change in bulk density / unit weight as
0	1	2490	24.90	2475	24.75	0.21	0
	2	2460	24.60				
1	1	2475	24.75	2462	24.62	0.17	-0.53%
	2	2450	24.50				
2	1	2440	24.40	2450	24.50	0.17	-0.93%
	2	2460	24.60				
2.5	1	2420	24.20	2434	24.34	0.19	-1.65%
	2	2447	24.47				
3	1	2430	24.30	2415	24.15	0..21	-2.42%
	2	2400	24.00				
5	1	2350	23.50	2375	23.75	0.35	-4.04%
	2	2400	24.00				

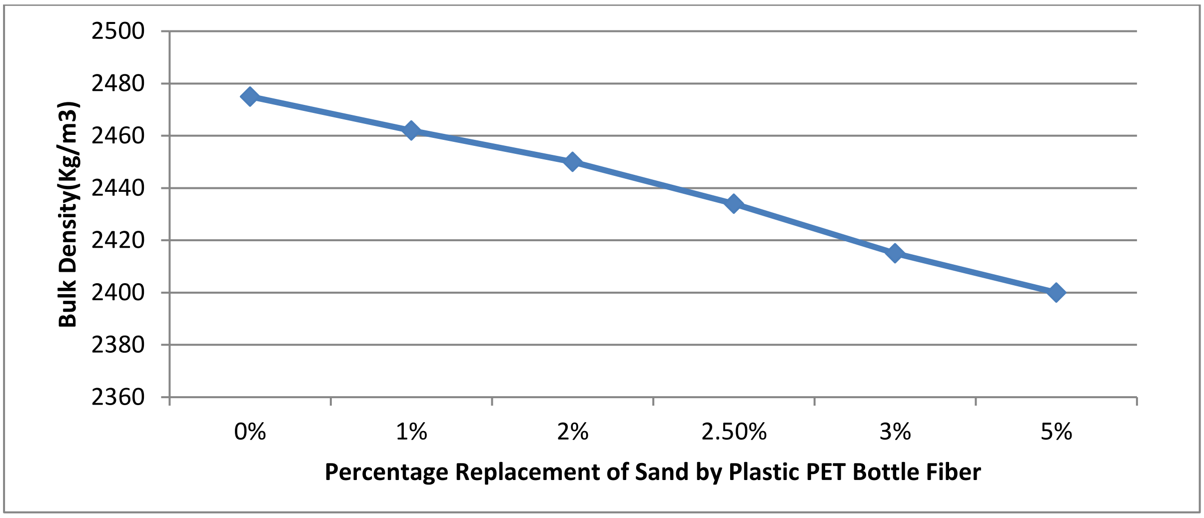


Figure : Variation of Bulk Density of Concrete containing different percentage of Plastic Pet Bottle Fiber.

WATER ABSORPTION OF THE MIXES

Table : Average water Absorption

Sand Replacement (%)	S.N.	Water Absorption (%)	Average Water Absorption (%)	Standard Deviation on Water Absorption	Percent change in Water Absorption compared to control sample
0	1	0.50	0.49	0.14	0
	2	0.48			
1	1	0.48	0.47	0.14	-4.08%
	2	0.46			
2	1	0.42	0.44	0.28	-10.2%
	2	0.46			
2.5	1	0.40	0.42	0.28	-14.28%
	2	0.44			
3	1	0.38	0.40	0.28	-18.36%
	2	0.42			
5	1	0.40	0.38	0.28	-22.44%
	2	0.36			

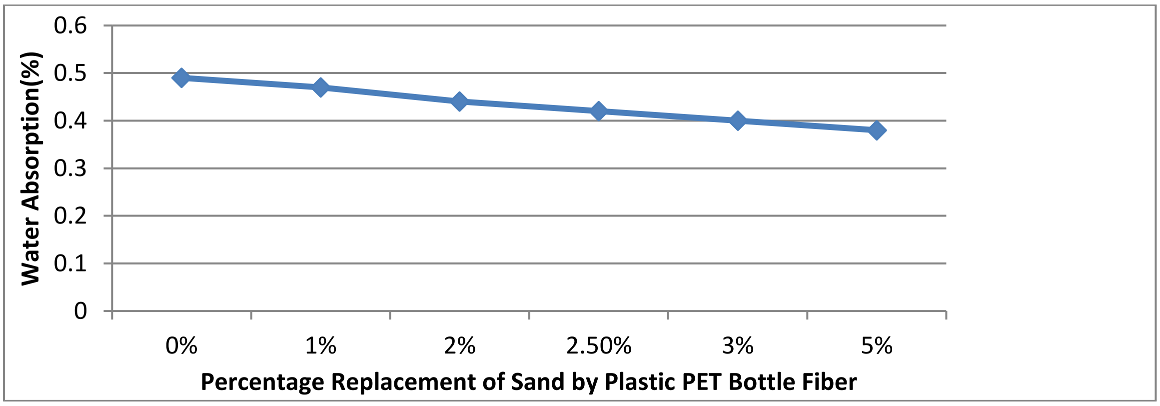


Figure: Variation of water Absorption of concrete containing different percentage of plastic pet bottle fiber

COMPRESSIVE STRENGTH TEST

Table :Variation of seven-day compressive strength

S. N	Percentage addition of Plastic PET Bottle Fiber	Failure load (KN)	Average Failure Load(KN)	The Average compressive strength of seven days (Mpa)	Percentage change in compressive strength
1	0%	320	330	14.67	0.00
2		340			
3	1%	380	370	16.44	12.06%
4		360			
5	2%	395	390	17.33	18.13%
6		385			
7	2.5%	370	365	16.22	10.56%
8		360			
9	3%	330	320	14.22	-3.07
10		310			
11	5%	270	280	12.44	-15.20
12		290			

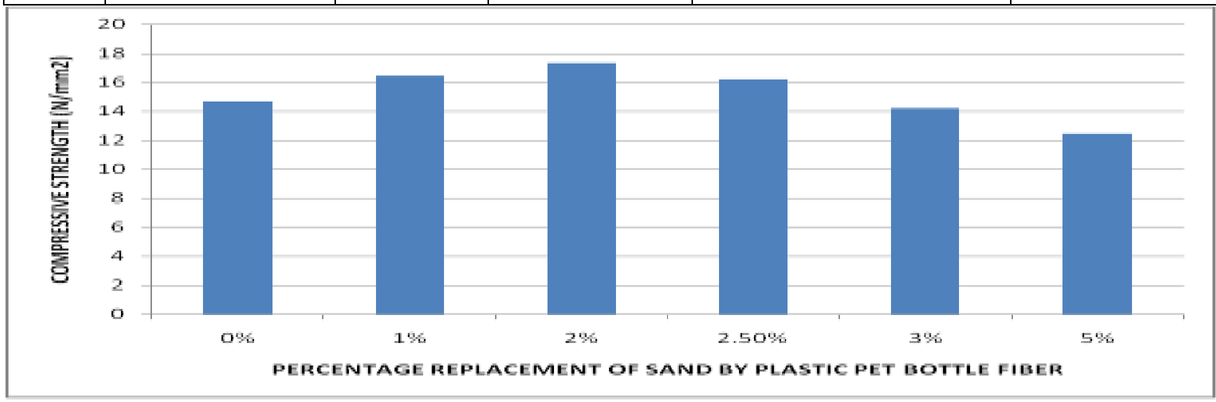


Fig. : 7 day compressive strength versus percentage replacement of sand by plastic pet bottle fiber.

Table : Variation of 28 day Compressive Strength Test.

S. N	Percentage addition of fiber	Failure load (KN)	Average Failure load (KN)	Compressive strength of 28 days (Mpa)	Percentage change in Compressive strength as compared to control sample(%)
1	0%	560	570	25.33	0.00
		580			
2	1%	630	635	28.22	11.41%
		640			
3	2%	660	655	29.11	14.92%
		650			
4	2.5%	620	625	27.78	9.67%
		630			
5	3%	520	530	23.56	-6.98%
		540			
6	5%	480	485	21.55	-14.92%
		490			

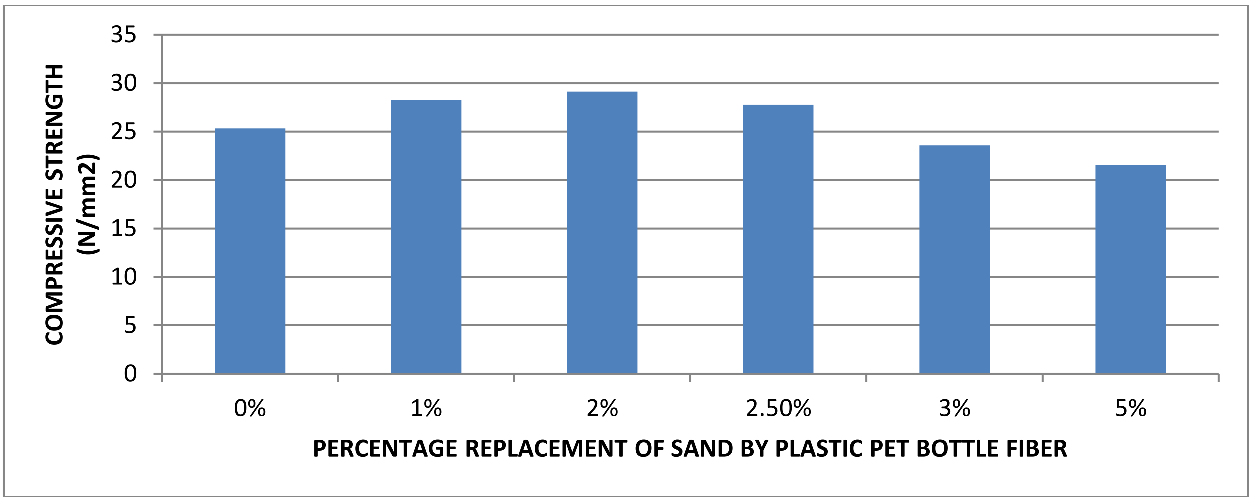


Figure : 28 day compressive strength v/s percentage replacement of sand by Plastic Pet Bottle Fiber.

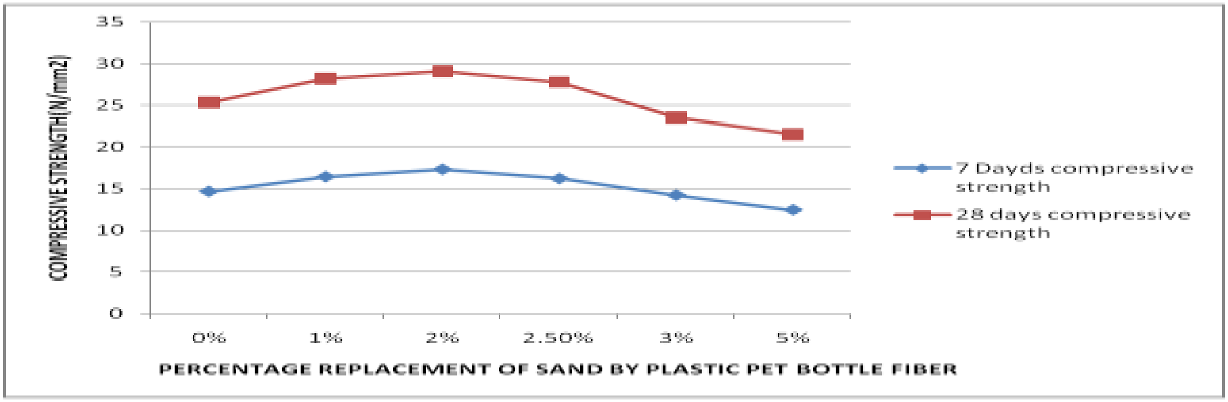


Figure : Comparison between 7 day and 28 day compressive strength v/s percentage replacement of sand by Plastic Pet Bottle Fiber

FLEXURAL STRENGTH (MODULUS OF RUPTURE) TEST

Table : Variation of seven-day Flexural strength

S. N	%PET Added	Breaking Load(N)	Average Breaking Load(N)	Flexural Strength (N/mm^2)	Percentage Change in Flexural strength as compared tocontrol sample
1	0 %	2000 2050	2025	1.44	0
2	1 %	2150 2200	2175	1.55	7.63%
3	2 %	2300 2320	2310	1.64	13.89%
4	2.5 %	2450 2420	2435	1.73	20.13%
5	3 %	2400 2380	2390	1.70	18.05%
6	5 %	2300 2350	2325	1.65	14.58%

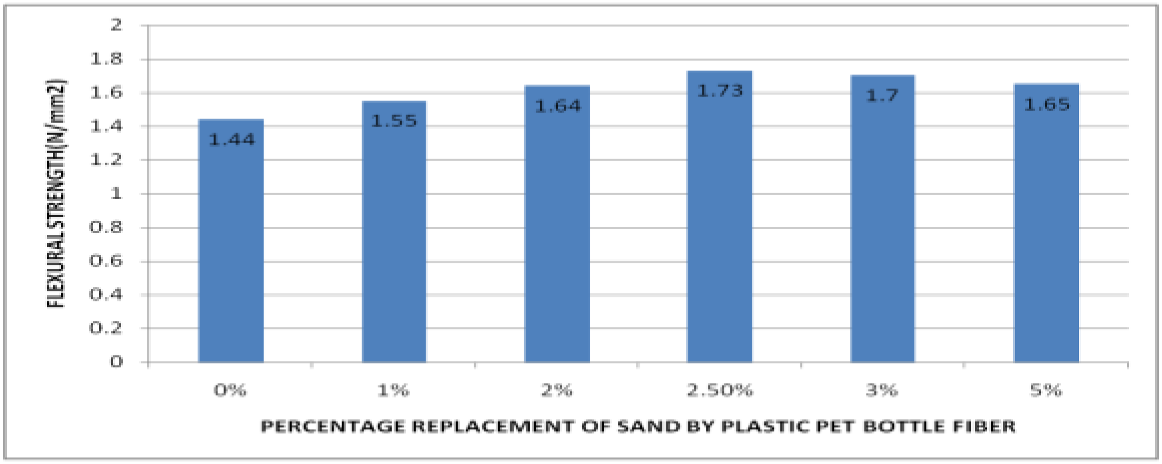


Figure: Variation of Flexural strength of concrete at 7 days

Table: Variation of flexural strength test at 28 days

S. N	%PET Added	Breaking Load(N)	Average Breaking Load(N)	Flexural Strength (N/mm^2)	Percentage change in Flexural strength as compared to control sample
1	0%	4500	4575	3.25	0
		4650			
2	1%	5000	5100	3.62	11.38%
		5200			
3	2%	5500	5475	3.89	19.69%
		5450			
4	2.5%	5600	5700	4.05	24.61%
		5800			
5	3%	5500	5550	3.95	21.54%
		5600			
6	5%	5300	5350	3.80	16.92%
		5400			

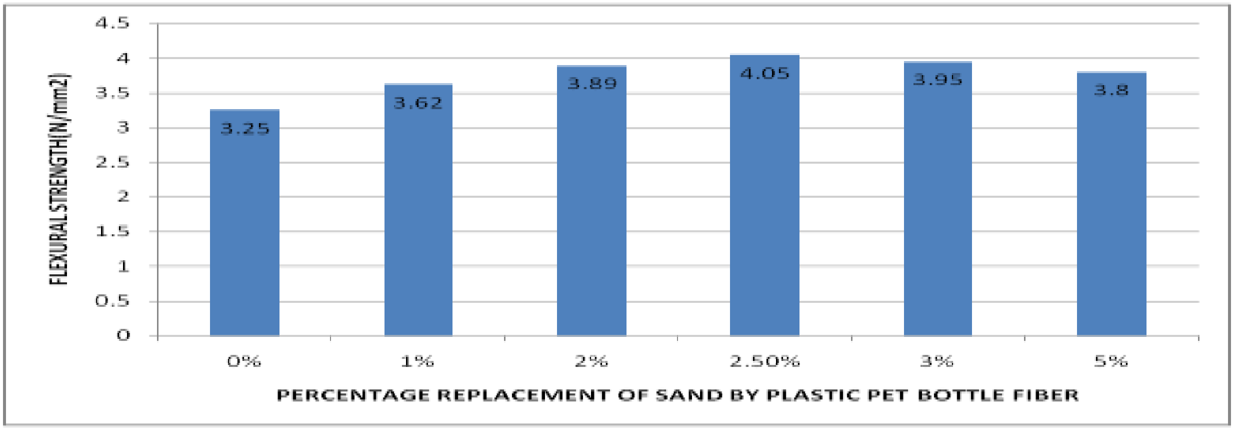


Figure: Variation of Flexural strength of concrete at 28 days

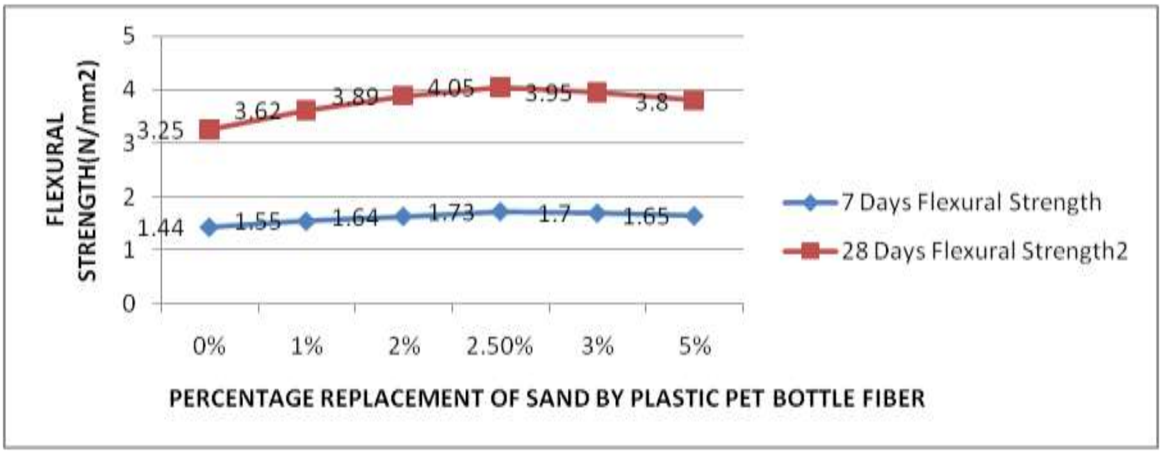


Figure: Comparison between 7- and 28-day Flexural strength of concrete v/s percentage replacement of sand by Plastic Pet Bottle Fiber

CONCLUSION AND RECOMMENDATION

CONCLUSION

1) The mix proportions of concrete containing cement, sand and coarse aggregates considering M20 grade was determined as 1:1.47:2.92.
2) The degree of workability of concrete varied between 35mm to 75mm. This showed that the increase in workability with the increase in percent replacement of sand by plastic pet bottle fiber.
3) The concrete with Plastic PET bottle fiber increases the flow properties of concrete and reduces the weight of concrete and thus Concrete with plastic pet bottle fiber can be made into lightweight concrete based on unit weight.
4) The maximum compressive strength was at 2% of plastic fiber content was 14.92 % and maximum flexural strength was at 2.5% of plastic fiber content was 24.61% at 28 day more over control concrete. The increase in strength was observed with the inclusion of plastic fibers in concrete. The optimum strength was observed between 2 to 2.5% of fiber content for all types of strength thereafter reduction in strength were observed.
5) Other kinds of admixtures can be used to increase the strength of concrete at further addition of plastic pet bottles fiber.

RECOMMENDATION

The significant improvements in strengths were observed with the inclusion of plastic pet fibers in concrete. The optimum strength was observed between 2 to 2.5% of fiber content for all types of strengths, thereafter reductions in strength were observed. Hench for the optimum strength 2-2.5% of the plastic pet bottle fibers can be recommended to use in concrete production as a replacement of sand. And also from this experimental investigation, the PET bottles would appear to be low-cost materials which would help to resolve solid waste problems and preventing environmental pollution. And for the further research more percentage of the plastic pet bottle fiber can be added with the use of super plasticizers admixtures if required to meet thetarget strength of the concrete and improve the bonding of the fibers. And also the plastic pet bottle can be grinding and replacing of coarse aggregate partially can also be studied for the further application in concrete as well in future.

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