Table 1: Summary of Pretreatment Techniques for PET and HDPE

Pretreatment Type	***Method***	***Polymer***	***Process Conditions***	***Key Effects***	***Advantages***	***Limitations***
Chemical Pretreatments	*Alkaline Hydrolysis*	*PET*	*NaOH solution (1–5M), 60–90°C, 6–24 hours*	*Disrupts PET crystalline structure, making more biodegradc*	*Increases microl degradation; ecc friendly*	*Requires high temperature a long processing time*
	Deep Eutectic Solver (DES)	*PET*	*DES (Choline chloride glycerol), 50–80°C, 12– hours*	*Increases surfac wettability, improves biodegradability*	*Non-toxic, renewable, and e friendly*	*Long processing time*
	Dissolution-Precipitation	*HDPE*	*Toluene/D-limonene solvent, 1:3 solvent-to-antisolvent ratio*	*Reduces HDPE molecular weigh enhances microb attack*	*Efficient for pign removal & biodegradation*	*Solvent recovery needed*
Enzymatic Pretreatments	*Enzymatic Hydrolysi (PETase enzyme)*	*PET*	*Enzyme concentration (10 mg/mL), 30–60°C, p. 7–9*	*Breaks down PE into monomers (TPA & EG)*	*Highly selective, enables recyclin*	*Enzyme cost & low reaction rate*
Combined Pretreatments	*Chemical & UV Treatment*	*PET*	*Fenton's reagent (H_2O_2/Fe^{2+}), UV exposu (300–365 nm), 5–12 hou*	*Introduces functional group for biodegradati*	*Enhances microl attack, faster degradation*	*Energy-intensive UV treatm*
Thermal Pretreatments	*Heat Treatment & Annealing*	*PET & HD*	*100–250°C, controlled heating for 30–180 min*	*Alters crystallini to improve degradation*	*Enhances recyclability, improves materi properties*	*Requires precise temperatur control*
Thermochemical Pretreatments	*Pyrolysis & Gasification*	*PET & HD*	*400–700°C in inert/oxygen-limited conditions*	*Converts plastic into valuable chemicals*	*Produces energy reduces plastic waste*	*High energy consumption*
Solvent Optimization	*Effect of Solvent-to-Antisolvent Ratio*	*HDPE*	*Optimized 1:3 ratio, roc temperature*	*Enhances polym breakdown and pigment removal*	*Improves recyclability and biodegradability*	*Requires solvent recovery process*
Solvent Optimization	*Use of Glycerol & T Alcohols*	*HDPE*	*Glycerol-based antisolvents, 50–80°C*	*Facilitates pigm removal and microbial attack*	*Biodegradable a non-toxic*	*Long processing duration*
Characterization Techniqu	*FT-IR, TGA, DSC Analysis*	*PET & HD*	*Spectroscopic & therm analysis*	*Identifies structu and thermal changes*	*Helps monitor pretreatment efficiency*	*Requires specialized equipm*
Sustainability Aspects	***Solvent Recyclabilit***	***PET & HD***	***Recovery through distillation or filtration***	***Enables multipl cycles of solvent reuse***	***Reduces environmental impact and cost***	***Some solvents degrade over time***

Table 2: Summary of Mix Proportions for HDPE and MSF in Concrete with Corresponding Properties

Property	***Control Mix (No Fibers)***	***0.25% MSF***	***0.5% MSF***	***0.75% MSF***	***1.0% MSF***	***0.5% SF***
Workability (mm-slump)	*High*	*Medium*	*Medium*	*Low*	*Very Low*	*Medium*
MPa, or compressive strength	*24.5*	*25.8*	*26.9*	*27.8*	*27.2*	*26.4*
MPa, or splitting tensile strength	*3.8*	*4.2*	*4.5*	*4.9*	*4.7*	*4.4*
	5.2	*5.8*	*6.4*	*6.82*	*6.5*	*6.1*
MPa, or flexural strength	*Weak*	*Moderate*	*Moderate*	*Strong*	*Strong*	*Moderate*
Strength and Sustainability of Interfacial Bonds Workability of Impact Property (Slump in mm)	*Moderate*	*High*	*High*	*Very High*	*Very High*	*High*
MPa, or compressive strength	*Control Mix (No Fibers)*	*0.25% MSF*	*0.5% MSF*	*0.75% MSF*	*1.0% MSF*	*0.5% SF*
MPa, or splitting tensile strength	*High*	*Medium*	*Medium*	*Low*	*Very Low*	*Medium*
Workability (mm-slump)	*24.5*	*25.8*	*26.9*	*27.8*	*27.2*	*26.4*
MPa, or compressive strength	***3.8***	***4.2***	***4.5***	***4.9***	***4.7***	***4.4***

Table 3: Summary of Concrete Properties with Varying Mix Proportions of PET and HDPE

Property	Standard Concrete (No Plastic)	0.25% PET	0.5% PET	0.75% PET	1.0% PET	0.5% HDPE	1.0% HDPE	1.5% HDPE	2.0% HDPE	References
Slump - Workability (mm)	High	Medium	Medium	Low	Very Low	Medium	Low	Very Low	Very Low	Saikia & De Brito (2012)
MPa, or compressive strength	24.5	25.6	26.7	27.5	26.9	26.2	27	27.3	26.1	Jirawattanasomkul et al. (2021)
MPa, or tensile strength	3.8	4.1	4.4	4.8	4.6	4.3	4.7	4.9	4.5	Mohammed & Faqe Rahim (2020)
MPa, or flexural strength	5.2	5.7	6.3	6.75	6.4	6	6.6	6.9	6.3	Almeshal et al. (2020)
Bond Strength	Weak	Moderate	Moderate	Strong	Strong	Moderate	Strong	Strong	Moderate	Ferreira et al. (2012)
Durability and Sustainability	Moderate	High	High	Very High	Very High	High	Very High	Very High	High	Kou et al. (2009)

Table 4: Summary of various mix proportions of HDPE and Metakaolin with concrete

Mix Label	Cement (kg/m³)	Metakaolin (kg/m³)	Fine Aggregate (FA) (kg/m³)	HDPE Plastic (kg/m³)	Coarse Aggregate (CA)(kg/m³)	Water (ml)	Chemical Admixture (ml)
K10P5	346.5	38.5	643.15	33.85	1296	140	7.7
K10P10	346.5	38.5	609.3	67.7	1296	140	7.7
K10P15	346.5	38.5	575.45	101.55	1296	140	7.7
K10P20	346.5	38.5	541.6	135.4	1296	140	7.7
K10P25	346.5	38.5	507.75	169.25	1296	140	7.7
K10P30	346.5	38.5	473.9	203.1	1296	140	7.7
Standard Concrete (M30)	350	0	693	0	1296	157	7.7

Table 5: An overview of the mechanical and thermal characteristics and their effects on the environment

Study Title	Key Materials Used	Mechanical Properties	Thermal Properties	Environmental Impact
Experimental Study of Concrete Using Metakaolin and HDPE Plastic Waste	HDPE Plastic Waste, Metakaolin	HDPE reduces compressive strength; metakaolin enhances strength and durability	HDPE improves thermal insulation; metakaolin enhances heat resistance	Reduces plastic waste; lowers cement usage and CO2 emissions

Table 6: Comparison of Concrete Parameters in HDPE-Modified and Crumb Rubber Concrete

Parameter	Control Concrete	HDPE-Modified Concrete	Crumb Rubber Concrete	HDPE + Rubber Concrete
Compressive Strength (MPa)	High (~30-50)	Reduced (20-35)	Decreased (~15-30)	Balanced reduction (~18-32)
Tensile Strength (MPa)	Moderate (~3-5)	Slightly improved (~4-6)	Enhanced (~5-7)	Maximum improvement (~6-8)
Flexural Strength (MPa)	Standard (~4-7)	Moderate increase (~5-8)	Higher (~6-9)	Superior (~7-10)
Thermal Conductivity (W/mK)	High (~1.4-1.8)	Lower (~0.9-1.3)	Significantly lower (~0.6-1.0)	Lowest (~0.5-0.8)
Durability	Strong against wear	Increased resistance to chemicals & moisture	Enhanced freeze-thaw resistance	Superior durability in harsh conditions
Workability (Slump in mm)	Standard (~50-100)	Decreases with increased HDPE	Reduces slightly due to rubber particles	Requires plasticizers for better workability

Cost ($/m³)	*48.48*	*Higher (~55-65)*	*Moderate (~50-58)*	*Varies (~52-60)*
Energy Savings (kWh/m²)	*Standard (322.89)*	*Improved (~250-280)*	*Maximum reduction (~200-250)*	*Best efficiency (~180-220)*
Payback Period (Years)	*Not applicable*	*Longer (~5-8)*	*Shorter (~1.5-3)*	*Best (~1-2.5)*
Environmental Impact (CO_2 Reduction)	*High emissions*	*30-40% reduction*	*35-50% reduction*	*Maximum reduction (~50-60%)*

Table 7: Comparison of Concrete Parameters in Natural Aggregate Concrete and WPLA Concrete with Low and High Replacement Levels

Parameter	***Natural Aggregate Concrete***	***WPLA Concrete (Low Replacement)***	***WPLA Concrete (High Replacement)***	***References***
Density (kg/m³)	*2400*	*2000*	*1800*	*ACI Committee 213 (1994)*
Compressive Strength (MPa)	*40*	*32*	*21.8*	*Basri et al. (1999)*
Workability (mm slump)	*65*	*99*	*145*	*Choi et al. (2002)*
Workability Improvement (%)	*-*	*52%*	*123%*	*Choi et al. (2002)*
Bulk Density (kg/m³)	*1500*	*1000*	*844*	*Choi (1996)*
Water Absorption (%)	*3.2*	*Negligible*	*Negligible*	*Neville (1996)*
Structural Efficiency (%)	*100*	*89*	*79*	*Basri et al. (1999)*
Transition Zone Width	*Narrow*	*Moderate*	*Wider*	*Uchikawa (1995)*
Fire Resistance	*Standard*	*Enhanced*	*Highly Enhanced*	*Mindess et al. (2003)*

Table 8: Summary of observation/results for various parameter with various percentage of PET and various W/C ratio

Parameter	***PET (%)***	***W/C Ratio***	***Observation/Result***
Workability	*0% (NAC)*	*0.42*	*Normal workability with brick coarse aggregate.*
	20% PAC	*0.42*	*Increased workability due to smoother texture of PCA.*
	30% PAC	*0.42*	*Further improved workability; fewer voids and reduced friction.*
	40% PAC	*0.42*	*Enhanced workability, but noticeable bleeding in fresh concrete.*
	50% PAC	*0.42*	*Highest workability but excessive bleeding at higher W/C ratios.*
	50% PAC	*0.57*	*Severe bleeding observed, requiring mix adjustments.*
Density	*0% (NAC)*	*0.42*	*Standard density (baseline).*
	20% PAC	*0.42*	*4% density reduction compared to NAC.*
	30% PAC	*0.42*	*6% density reduction due to lighter PCA.*
	40% PAC	*0.42*	*8% density reduction, further lowering with higher W/C.*
	50% PAC	*0.57*	*Maximum 10% density reduction observed.*
Compressive Strength	*0% (NAC)*	*0.42*	*33.4 MPa (Reference Strength).*
	20% PAC	*0.42*	*30.3 MPa (Comparable strength to NAC).*
	30% PAC	*0.42*	*28.5 MPa (Slight reduction in strength).*
	40% PAC	*0.42*	*26.2 MPa (Further strength reduction due to weak bonding).*
	50% PAC	*0.42*	*24.1 MPa (Significant reduction, weak transition zone).*
	50% PAC	***0.57***	***Lowest compressive strength due to excessive bleeding and weak bonding.***