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THESSALONIKI 2021
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RECYCLING PLASTICS IN DEVELOPING COUNTRIES:
PROPERTIES OF NOVEL POLYMER-SAND COMPOSITES PRODUCED FROM WASTE PLASTICS

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Plastics in the oceans

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How did we get here?

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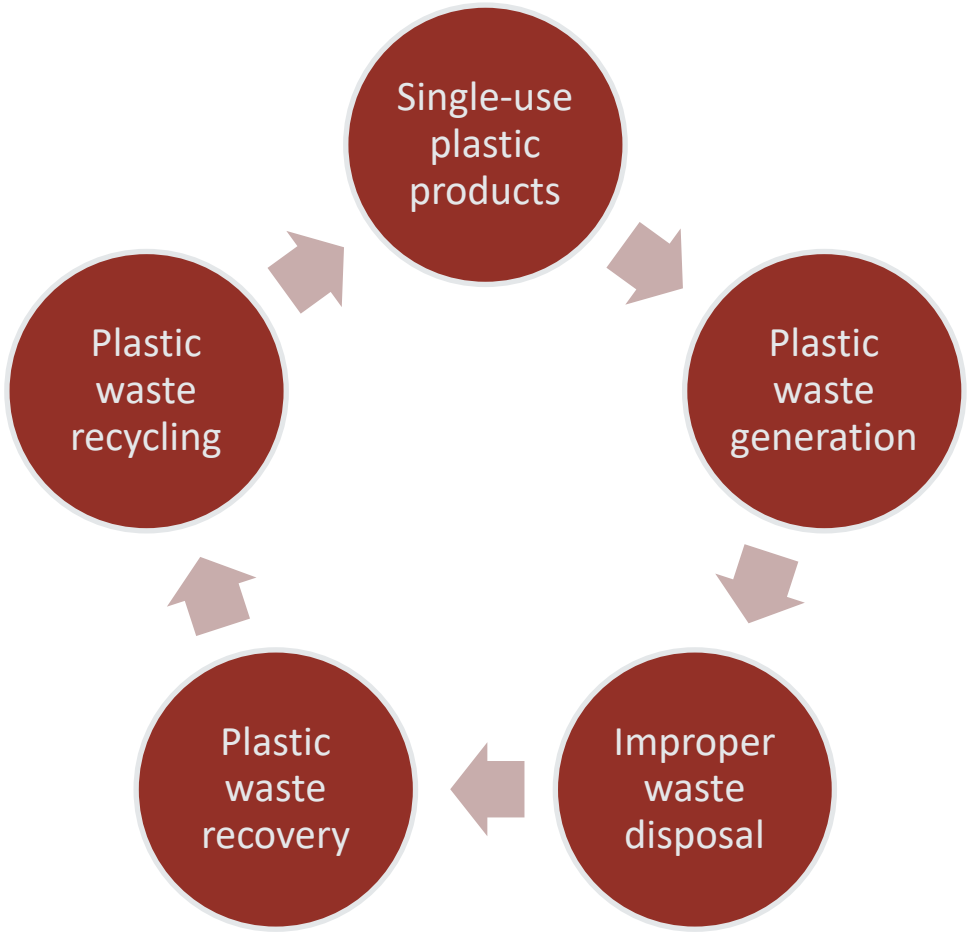
Transitioning from a linear to circular economy



Value-added products drive informal-sector plastic recovery in developing countries

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Plastic Bonded Sand Production

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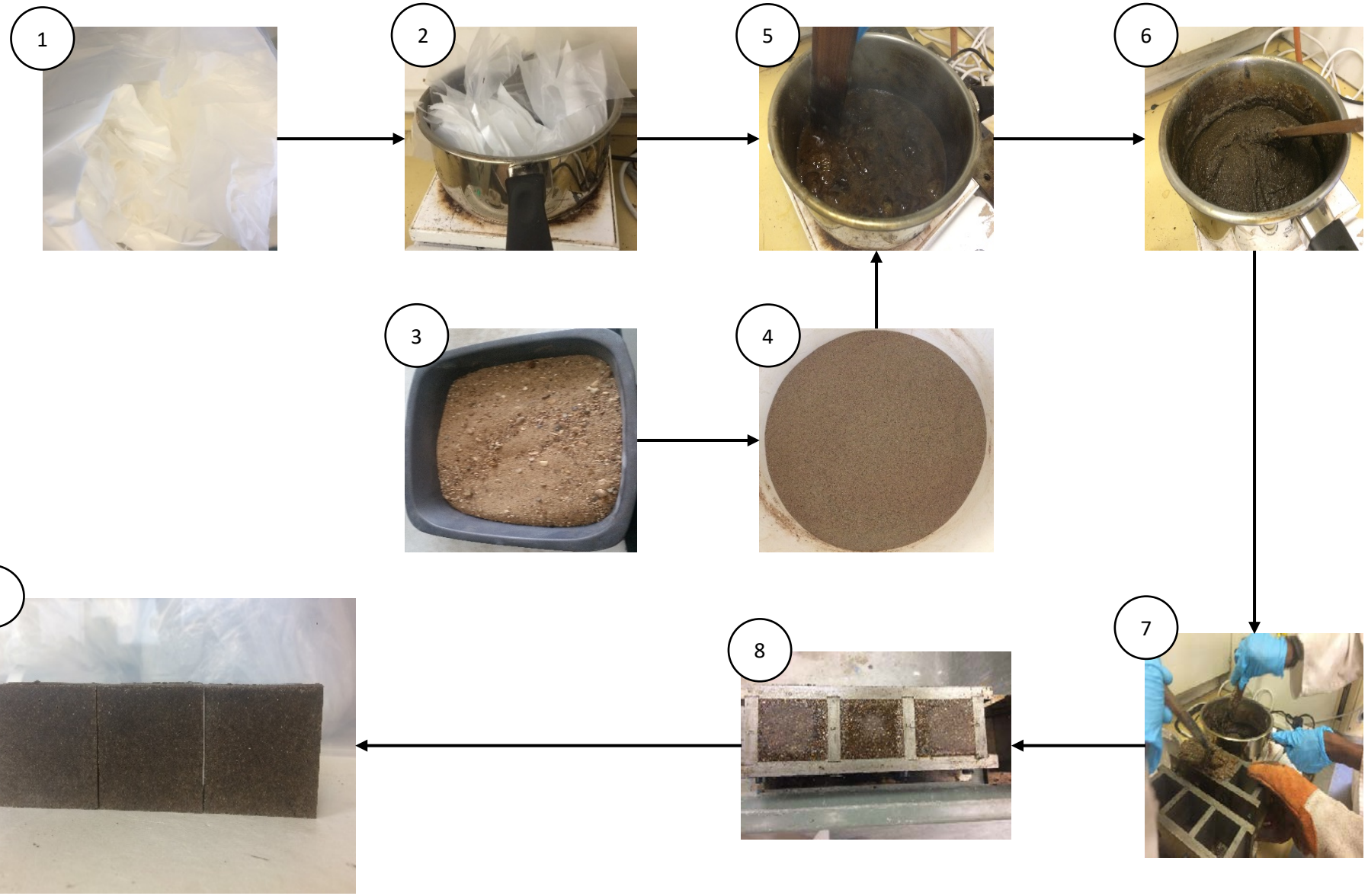
Lab-scale production process



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Experimental Design

Experiment	Plastic type	Sand to plastic proportions		Sand particle size	Processing parameters		Number of samples
		ratio	wt.%	(d in mm)	Temp. (°C)	Time (min)	
Effect of processing temperature on compressive strength	LDPE	3	75.0	d<0.30	250	32	3
		3	75.0	d<0.30	275	32	3
		3	75.0	d<0.30	300	32	3
		3	75.0	d<0.30	325	32	3
		3	75.0	d<0.30	350	32	3
		3	75.0	d<0.30	375	32	3
Effect of processing temperatures on flexural strength	LDPE	3	75.0	d<0.30	250	17 and 27	10
		3	75.0	d<0.30	275	17 and 27	10
		3	75.0	d<0.30	300	17 and 27	10
		3	75.0	d<0.30	325	17 and 27	10
		3	75.0	d<0.30	350	17 and 27	10
		3	75.0	d<0.30	375	17 and 27	10
Effect of thermoplastic binder type on compressive strength	LDPE	1	50.0	d<0.30	200-300	70	3
	LDPE	2	66.7	d<0.30	200-300	70	3
	LDPE	3	75.0	d<0.30	200-300	70	3
	LDPE	4	80.0	d<0.30	200-300	70	3
	LDPE	5	83.3	d<0.30	200-300	70	3
	HDPE	1	50.0	d<0.30	250-300	90	3
	HDPE	2	66.7	d<0.30	250-300	90	3
	HDPE	3	75.0	d<0.30	250-300	90	3
	HDPE	4	80.0	d<0.30	250-300	90	3
	HDPE	5	83.3	d<0.30	250-300	90	3
Effect of sand proportions and particle size on PBS properties	LDPE	1-5	50%-83.3%	d<0.30	200-300	70	15
	LDPE	1-5	50%-83.3%	0.30<d<0.60	200-300	70	15
	LDPE	1-5	50%-83.3%	0.60<d<1.35	200-300	70	15
	HDPE	1-5	50%-83.3%	d<0.30	250-300	90	15
	HDPE	1-5	50%-83.3%	0.30<d<0.60	250-300	90	15
	HDPE	1-5	50%-83.3%	0.60<d<1.35	250-300	90	15

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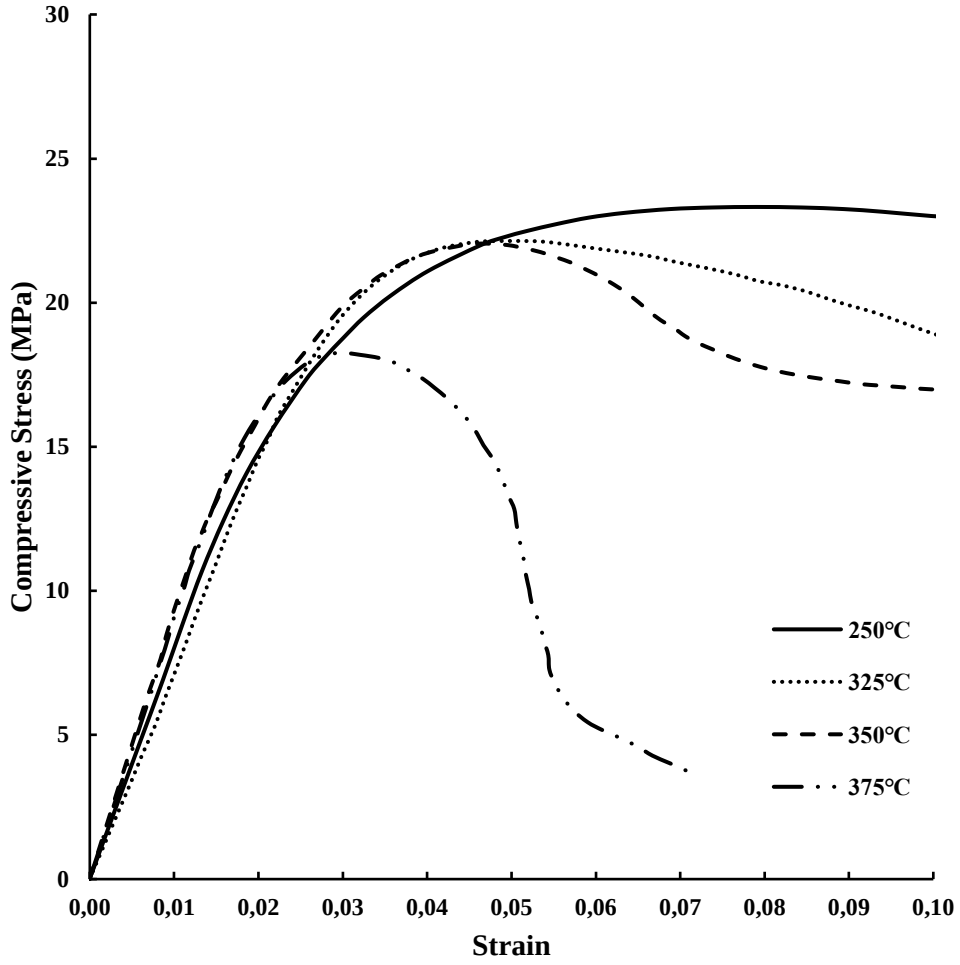
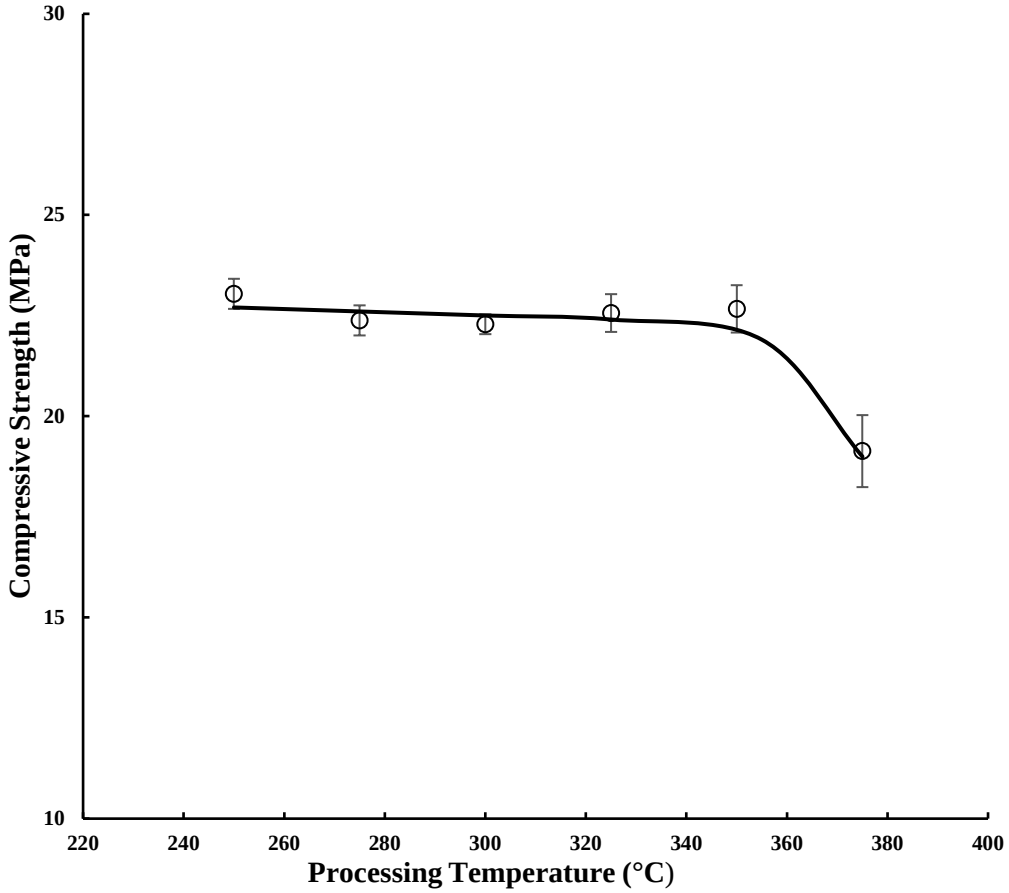
Effect of processing temperature on mechanical properties





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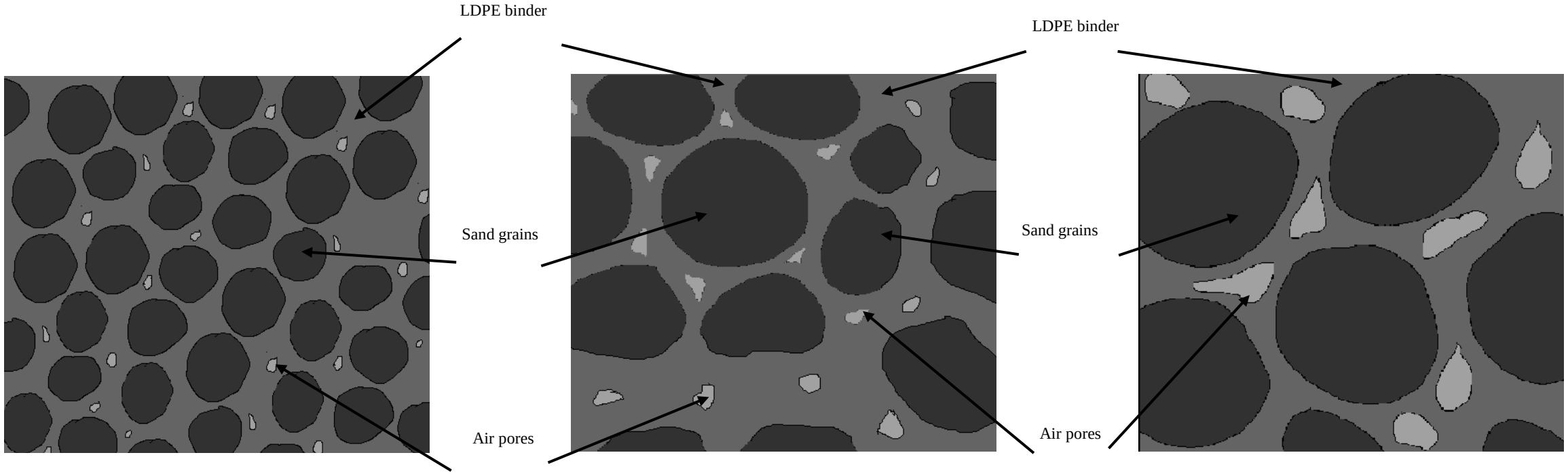
Effect of filler sizes and proportions on mechanical properties



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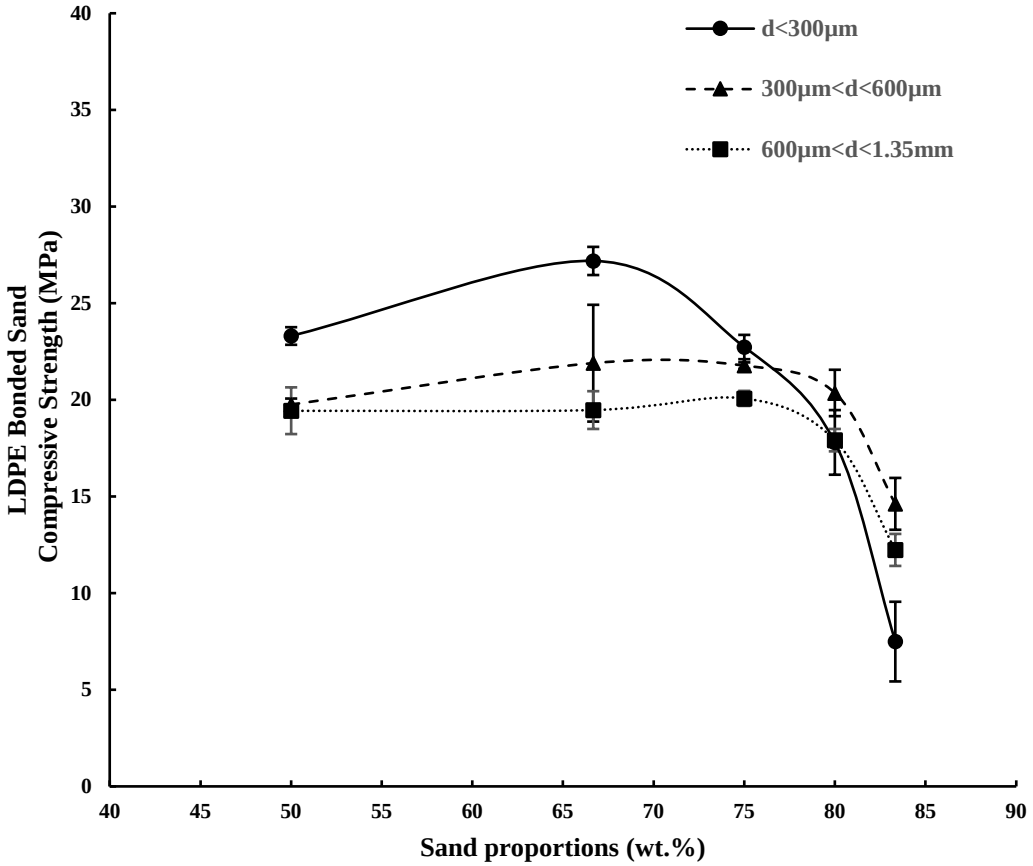
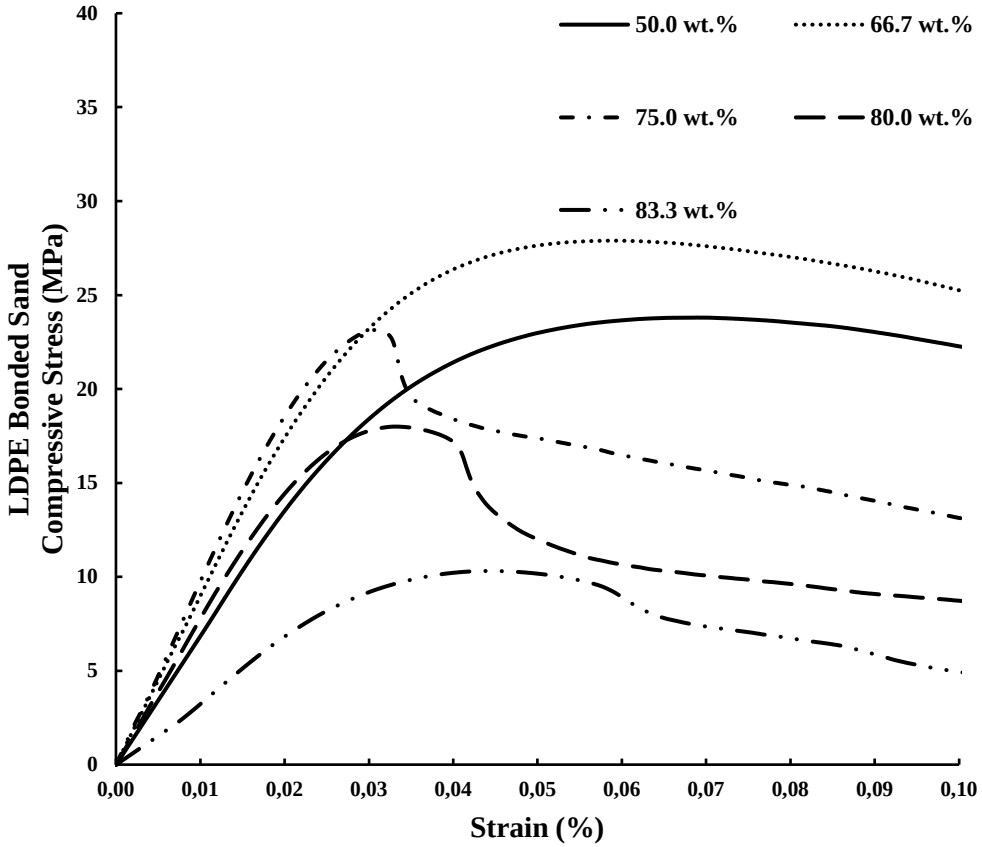
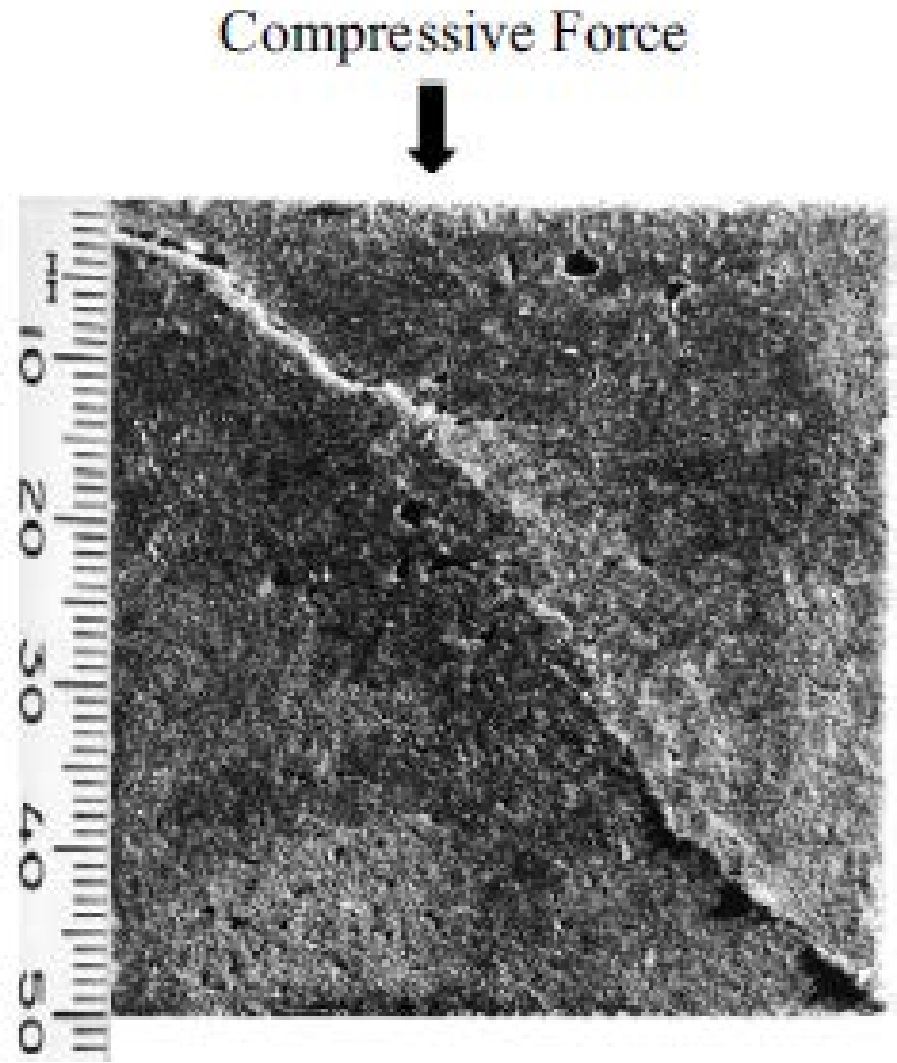
Effect of filler sizes and proportions on mechanical properties





Durability Properties



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Construction Industry Applications

Construction Industry Applications

Designation		Minimum average compressive strength (MPa)	Maximum water absorption (%)	LBS	HBS
Building	**Building brick (ASTM-C62)**				
	SW	20.7	13.26	√	√
	MW	17.2	19.36	√	√
	NW	10.3	No limit	√	√
	Facing brick (ASTM-C216)				
	SW	20.7	13.26	√	√
	MW	17.2	19.36	√	√
	Thin veneer brick (ASTM-C1088)				
	Ext.	17.2	13.26	√	√
	Int.	17.2	19.36	√	√
Pavement	**Pedestrian and light traffic paving brick (ASTM-C902)**				
	SX	27.6	8	x	√
	MX	20.7	14	√	√
	NX	20.7	No limit	√	√
	Heavy vehicular paving brick (ASTM-C1272)				
	F	69.0	6	x	x
	R	55.2	6	x	x
	Solid interlocking paving units (ASTM C936)				
		50.0	7	x	x

Key: LBS-LDPE Plastic bonded sand, HBS- HDPE Plastic bonded sand, SW-For use in severe weathering conditions, MW-For use in Medium weathering conditions, NW for use in negligible weathering conditions, Ext- Grade Exterior: for use where high resistance to cyclic freezing and thawing damage is desired, Int- Grade Interior: for use where moderate resistance to cyclic freezing and thawing damage is permissible, SX-For use where brick may be frozen with saturated water, MX- for exterior use where freezing resistance is not required, NX- For exterior use but may be accepted for interior use where freezing resistance is required. F- Brick to be set in an aggregate setting bed, R- Brick to be set in mortar or bituminous setting beds.

Technology Impacts

Supported communities in **9** countries

Developed **34** community recycling facilities

Trained **363** recycling entrepreneurs

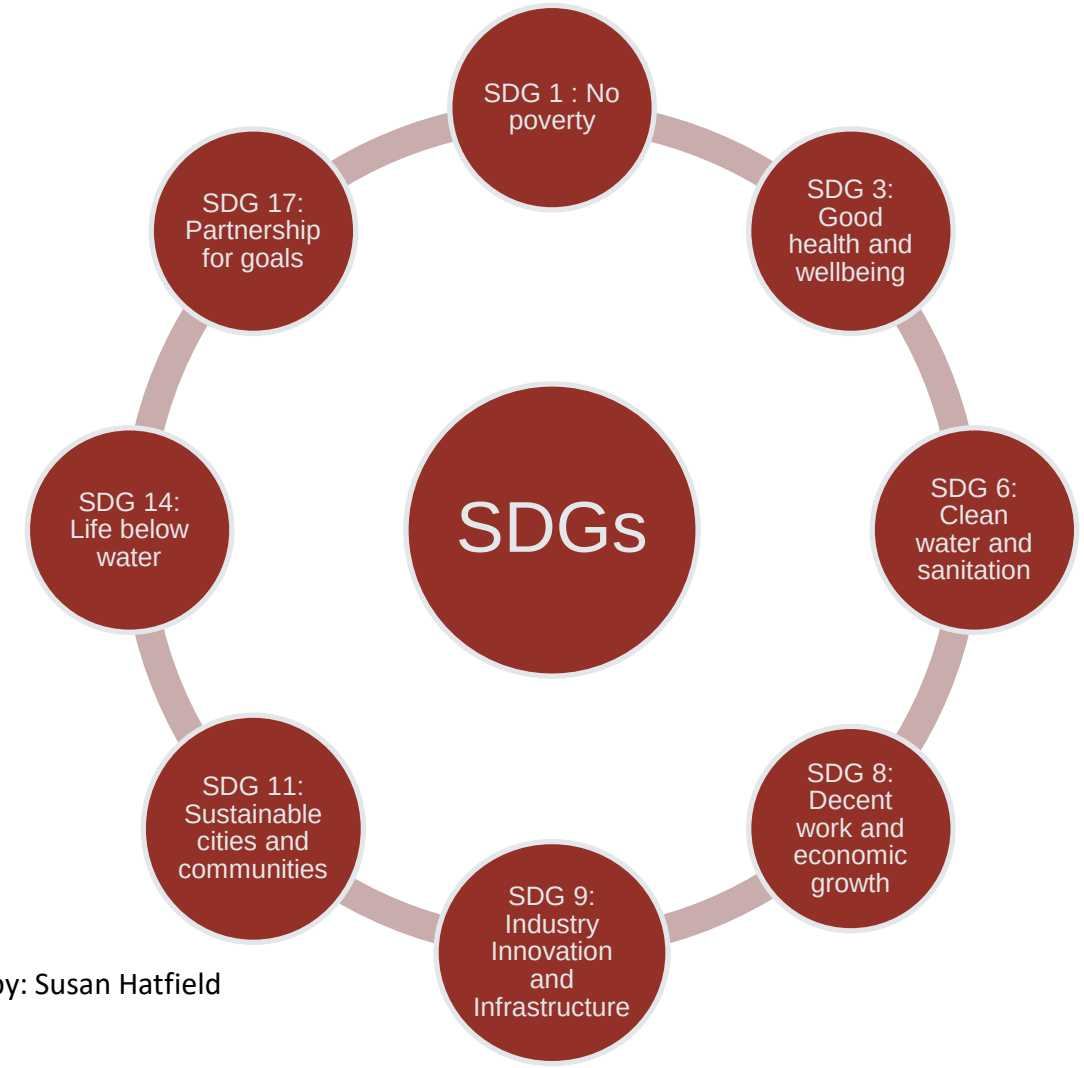
Impacted **124,000** lives

Toolkit inspiring another **25,000** people in **193** countries

MAKING WASTE WORK

By: Zoë Lenkiewicz and Mike Webster. Illustrated by: Susan Hatfield

Wasteaid.org.uk/toolkit



Kumi-Larbi Jnr, Alexander; Yunana, Danladi; Kamsouloum, Pierre; Webster, Mike; Wilson, David C.; Cheeseman, Christopher (2018) **Recycling waste plastics in developing countries: Use of low-density polyethylene water sachets to form plastic bonded sand blocks.** Waste Management. [Online] 80, 112–118. Available from: doi:10.1016/j.wasman.2018.09.003.

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One planet…..

Use of science and engineering to deliver Innovation in Waste Processing for a circular economy

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