

# Effect of differently shaped recycled PET plastic on the early-age properties of cement mortar

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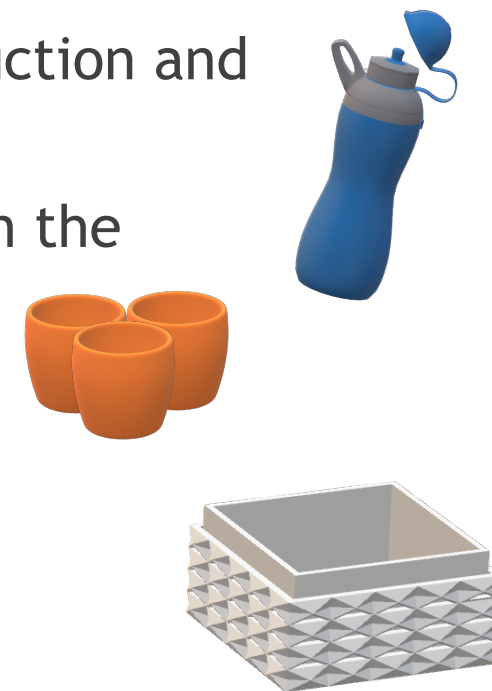
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# Introduction

- Production of plastics has been steadily increasing in the last 50 years,
- Plastic demand mostly comes from the packaging industry, construction and building, and the automotive industry,
- Polyethylene terephthalate (PET) - most commonly used plastics in the packaging industry (bottles, smaller containers),
- PET plastic products:

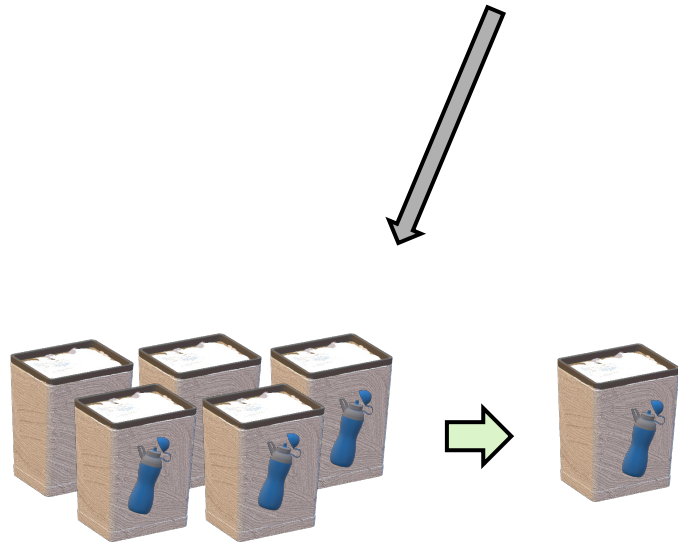
- 
- easily available
  - affordable

- 
- mostly made for single use only
  - large amount of PET plastic waste
- 

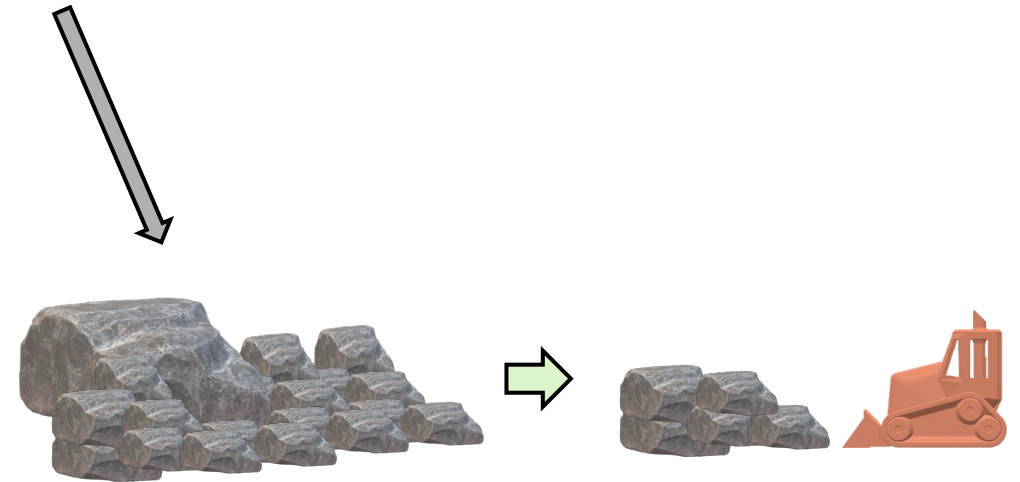


# Introduction

Recycled PET plastic use in building materials (cement mortar)



PET plastic waste reduction



Reduction of natural aggregate consumption



# Materials and Methods

- 3 differently shaped recycled PET plastics 0/4 mm,



Figure 1. Different shapes of recycled PET plastic.

- Ordinary Portland cement CEM I 42.5 N,
- Natural aggregate (sand) 0/4 mm,
- Water to cement ratio (w/c) of 0.45,
- Cement content in mortar: 450 kg m<sup>-3</sup>.



# Materials and Methods

- Recycled PET plastic as a partial natural aggregate replacement → 5% of the volume of natural aggregate in mortar,
- Compressive and flexural strength tests (SIST EN 1015-11:2020),
- Fresh density (SIST EN 1015-6:1998),
- Flowability of fresh mortar (SIST EN 1015-3:2001),
- X-ray diffraction (XRD) analysis → phase composition.



# Results

Compared to plain mortar:

- Increase in flow diameter,
- Slight decrease in fresh density.

	Mortar mix			
	Plain mortar	PETG	PETS	PETF
Flow diameter (mm)	127±2.5	127±0.7	171.3±5.3	168.3±2.4
Fresh density (kg m <sup>-3</sup> )	2342.10±0.30	2285.15±0.95	2336.20±1.40	2308.80±1.00

PETG - mortar with PET granules  
PETS - mortar with PET particles ground like sand  
PETF - mortar with PET flakes

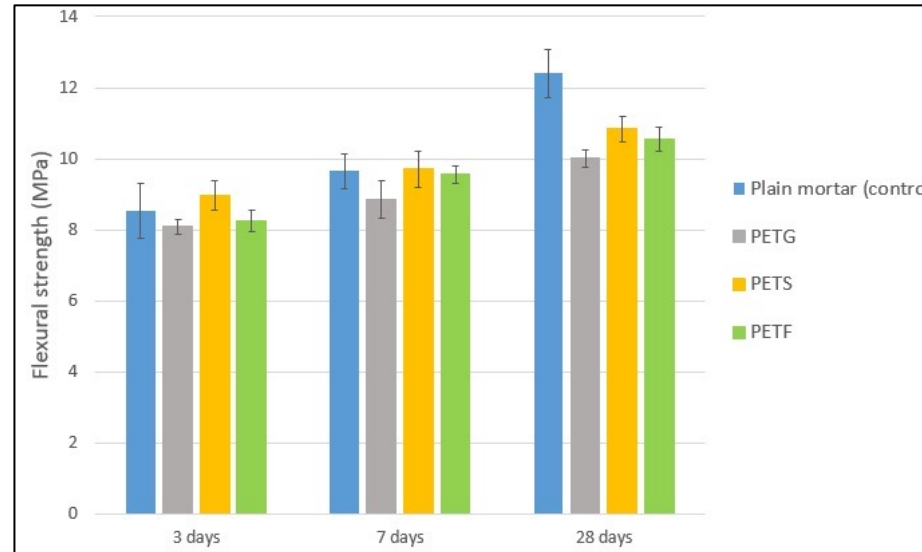
**Figure 2.** Flowability and fresh density of fresh mortar mixtures.



# Results

## Flexural strength test:

- PET granules and flakes in mortar decreased flexural strength compared to plain mortar,
- PET particles (ground like sand) increased 3-day and 7-day flexural strengths.



PETG - mortar with PET granules  
PETS - mortar with PET particles ground like sand  
PETF - mortar with PET flakes

Figure 3. Flexural strength of mortars.



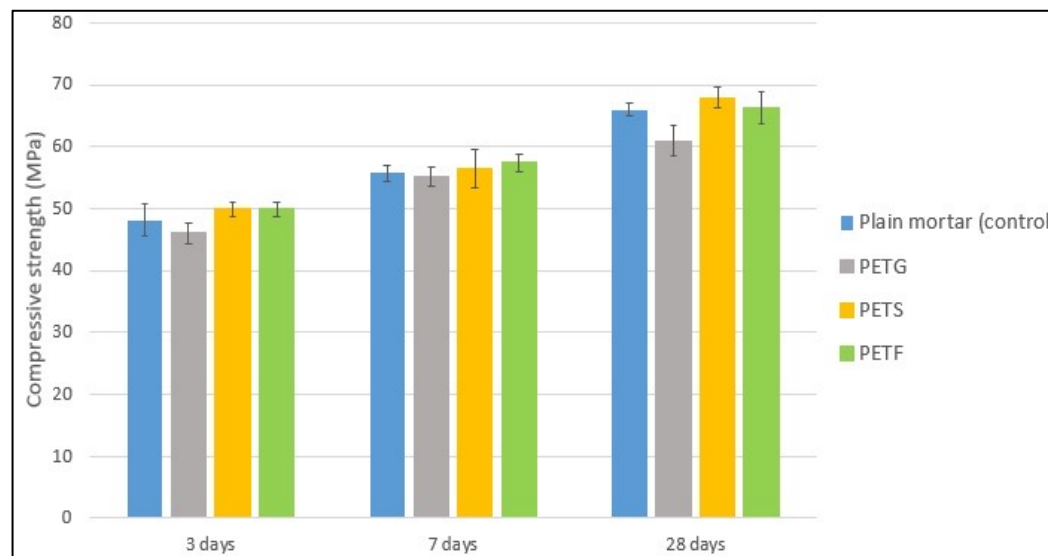
# Results

## Compressive strength test:

- PET granules decreased compressive strength compared to plain mortar,
- PET particles (ground like sand) and flakes increased compressive strengths.



up to 5% higher than control



PETG - mortar with PET granules  
PETS - mortar with PET particles ground like sand  
PETF - mortar with PET flakes

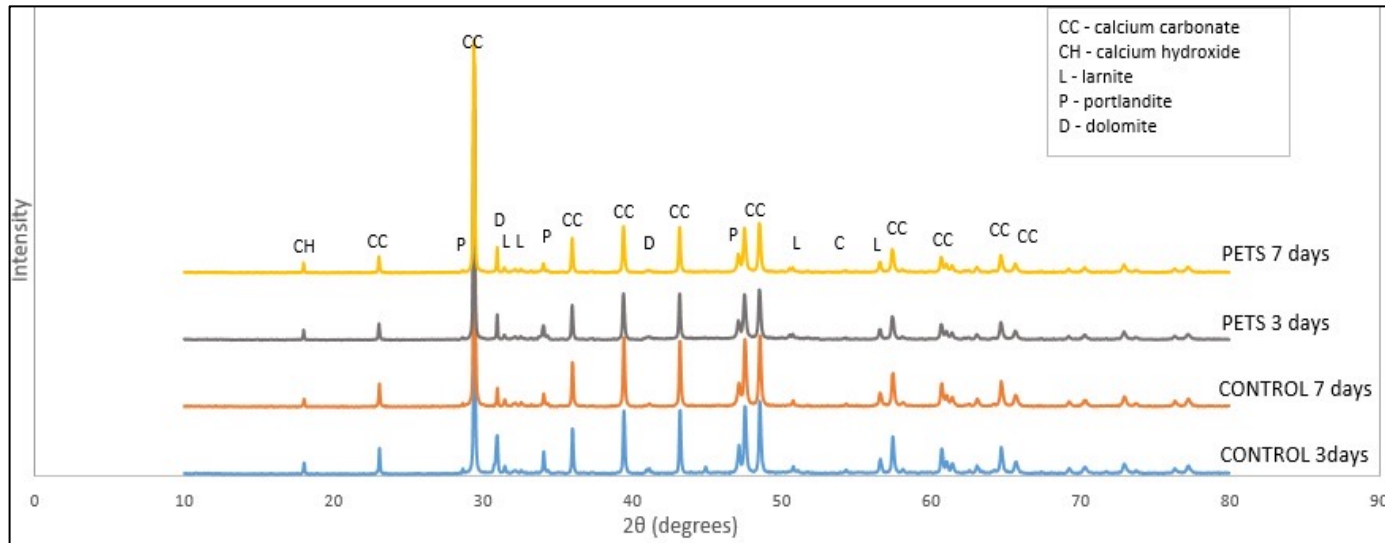
Figure 4. Compressive strength of mortars.





# Results

- Lower intensity of peaks in PET-containing mortars than in the plain mortar,
- Fewer hydration products.



PETS - mortar with PET particles  
ground like sand

Figure 5. XRD patterns of mortar mixtures.



# Conslusions

- Different shapes of PET plastic differently affect fresh and early-age properties of mortar.
- Importance of the similarity of PET particles to natural aggregate (shape and roughness).
- Great potential of recycled PET flakes and PET particles (ground like sand) as partial replacement of natural aggregate in mortar

