

# Valorization of Waste Glass in Low Carbon Construction Products

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## Background

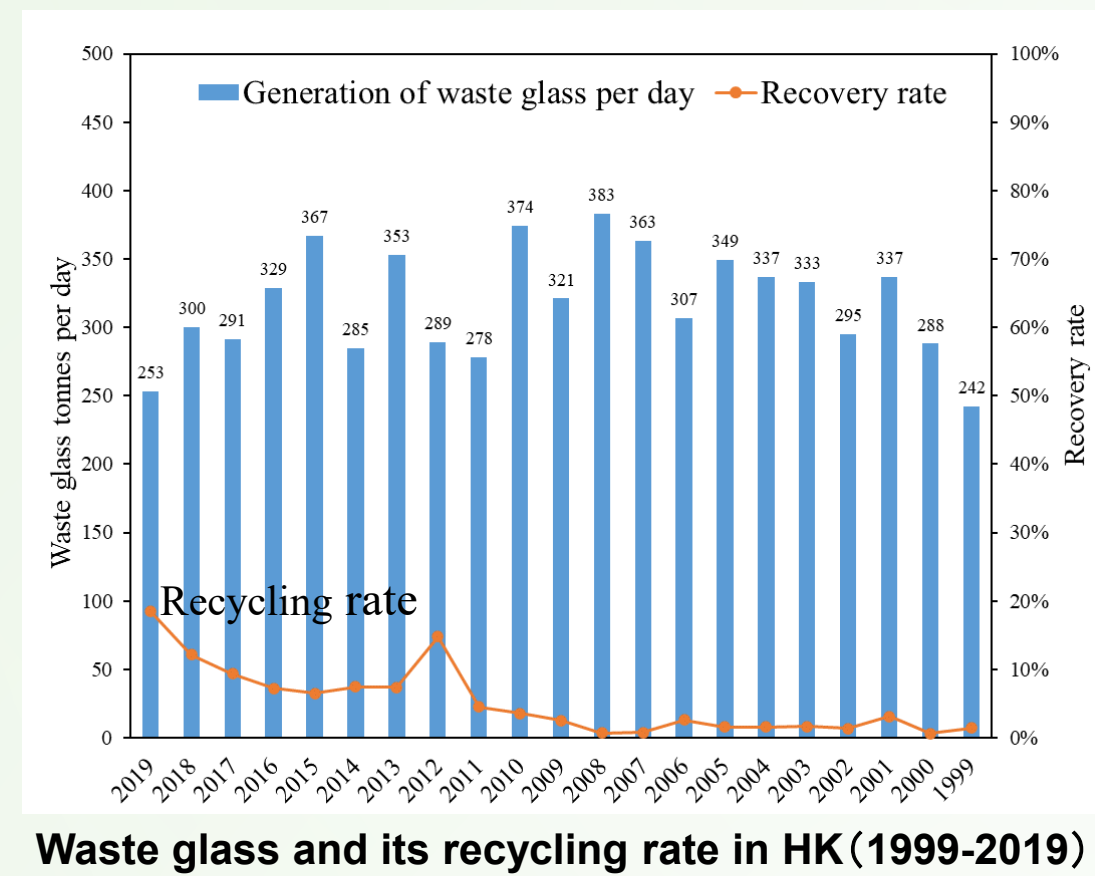
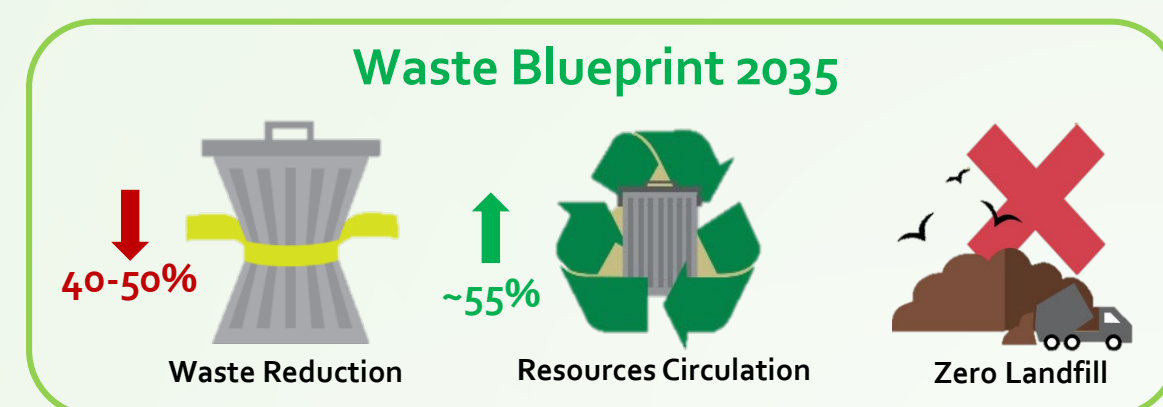
- The 2020 Policy Address announced that Hong Kong would strive to achieve carbon neutrality before 2050. HK is moving towards the 2030 target of reducing carbon intensity by 65% to 70% compared to 2005 based on Hong Kong's Climate Action Plan 2030+.
- In HK, nearly 7% CO<sub>2</sub> emission comes from wastes. It is essential to develop value-added construction materials by recycling wastes.



- Waste glass has become an important part of the municipal solid waste stream. Due to its low commercial values and the lack of a glass manufacturing industry in HK, the recovery rate of waste glass is less than 20%. For this reason, it is very important to develop viable recycling technologies to recycle more waste glass.



- Reduce the per capita MSW disposal rate by 40-45%;
- Raise the recovery rate to about 55%;
- Zero reliance on landfills for direct waste disposal.



## Objective and Scope

**Objective:** to explore the feasibility of using waste glass as total/partial replacements of aggregates and cement in producing different types of low carbon construction materials.

**Scope:**

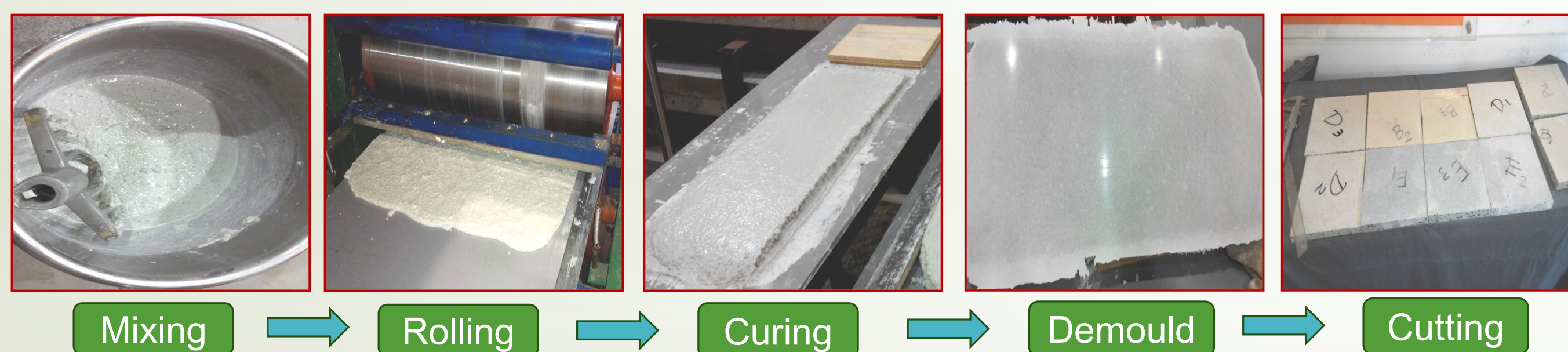
- Laboratory:** Physicochemical mechanism and engineering performance
- Field:** Large-scale production and trial applications

## Waste Glass-based Architectural Tile

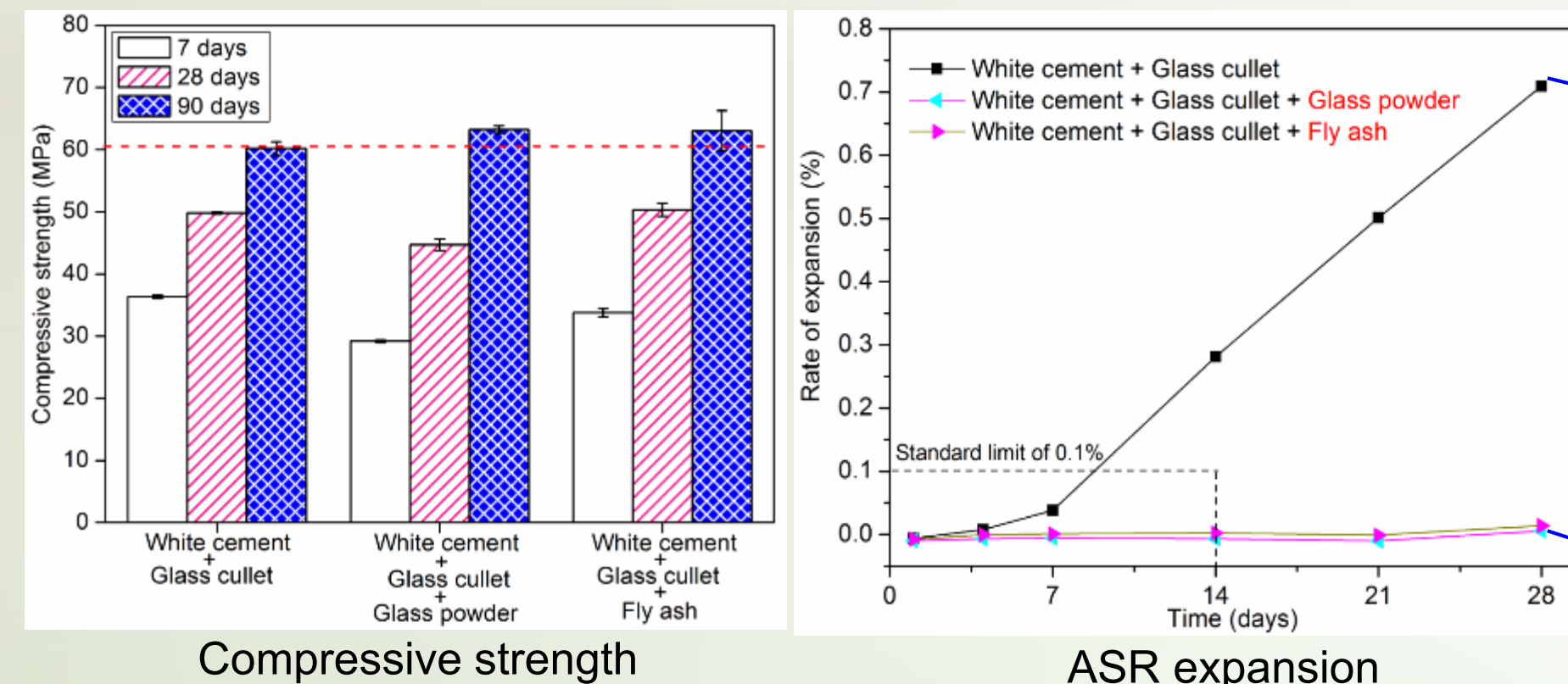
**Good Aesthetic Property of Glass** → Maximize the use of the waste glass in architectural mortar



**Innovative Production Method** → Calender Extrusion Method can effectively improve the productivity



## Glass-based Architectural Tile



- Low carbon glass cement has similar strength to pure cement and fly ash cement.
- Low carbon glass architectural mortar has resistance to ASR and better durability properties.

## Glass-based High Strength Permeable Concrete

- A high performance permeable concrete is prepared with large volume percentage of waste glass.

### Sustainable Permeable Concrete for Urban Drainage

Permeable concrete with two layers

- This product consists of an **aesthetic-functional** permeable surface, a high-performance permeable substrate and an ultra-high performance cement (UHPC)-based **super inorganic glue**. The concrete has **high strength** and **good water permeability**, and also provides multiple environmental benefits as a paving material.

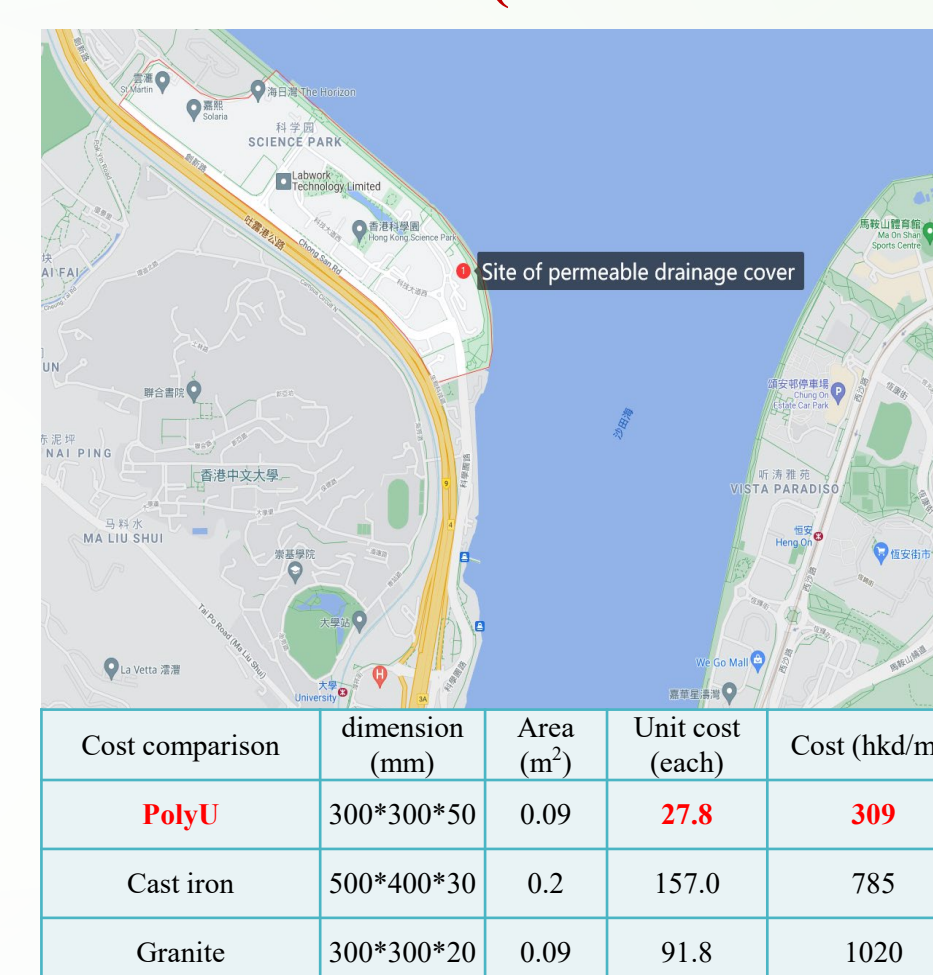
## Pilot-scale Production, Application and Award

**Local plant** **Mixing** **Compaction** **Demoulding**

**High strength**

Permeable concrete blocks

### Trial in real site (aesthetic and cost-effective)



### Photocatalytic effect of permeable concrete

Photocatalyst enter the pores

Porous surface of permeable concrete

Photocatalytic reaction: Turn harmful into harmless

NO<sub>x</sub> + H<sub>2</sub>O + hν → NO<sub>2</sub> + OH

NO<sub>2</sub> + OH → HNO<sub>3</sub>

H<sub>2</sub>O + hν → H<sub>2</sub> + OH

NO<sub>x</sub> + OH → HNO<sub>2</sub>

HNO<sub>2</sub> + OH → HNO<sub>3</sub>

Method	HKS/m <sup>2</sup>	HKS/per block
Spraying	1.2	0.024
Intermixing	38.8	0.776

## Green Innovations Award: Merit Award (2016) & Silver Award (2020)



## Summary and Findings

- It is feasible to maximize using of waste glass as aggregates and binder to produce architectural mortars without compromising the mechanical properties and durability.
- The low carbon glass-based architectural mortar produced by Calender Extrusion Method exhibits good aesthetic appearance.
- High strength permeable concrete could be produced with high volume of waste glass.
- The high performance eco-permeable concrete not only has aesthetically pleasing surface, but also has environmental functions, such as air purification (removal of NO<sub>x</sub>).
- Site trials indicate that the glass-based permeable concrete is a promising solution to partially address the flooding problems in Hong Kong.

## Acknowledgement

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