Sustainable Pathways for Clay Brick: Reuse, Recycling, and Repurposing in Construction

Background

Clay brick is one of the most widely used and discarded construction materials in New York City. Brick waste is generated on a large scale from renovation and demolition projects, which is typically discarded rather than reintegrated into new construction applications. The high volume of brick debris contributes to landfill waste and increases the carbon footprint of building demolition.

NYC Uses

- Older buildings are built with solid brick walls that support the structure
- New buildings uses brick as an outer wall layer for the traditional look
- On the ground, they are used in sidewalks and courtyards set on sand or mortar for stability (NYC DOB, 2003)

NYC Specifications

- New York State Department of Environmental Conservation (NYSDEC) regulates how C&D waste is handled.
- Only clean materials can go to C&D landfills (NYSDEC, 1989)
- New York States Senate Bill S4720 requires at least 50% of debris from construction or demolition projects to be recycled or reused

Waste System

Construction and demolition waste constructers to 60% of the waste system.

Pathway #1:
1. Sorting the waste into material categories
2. Transported to recycling facilities
3. Crushed and repurposed

Pathway #2:
1. Transported to the recycling facilities
2. Permanently disposed of at a landfill

References

5 Beneficial Uses of Clay Brick

Clay Brick Powder in Geopolymer

Process:
1. Waste clay bricks crushed and ground into fine powder (WCBP)
2. Mixed with alkaline activators such as sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3)
3. Undergoes geopolymerization to form a binder for mortar or blocks
4. Cured without kiln firing, avoiding high energy use

Benefits:
- Cuts energy use and CO_2 emissions by up to 60% by avoiding kiln firing (800–1200 °C)
- Uses much less water than normal clay brick production

Limitations:
- Less heat storage capacity than fired clay
- Durability still under testing in different environments

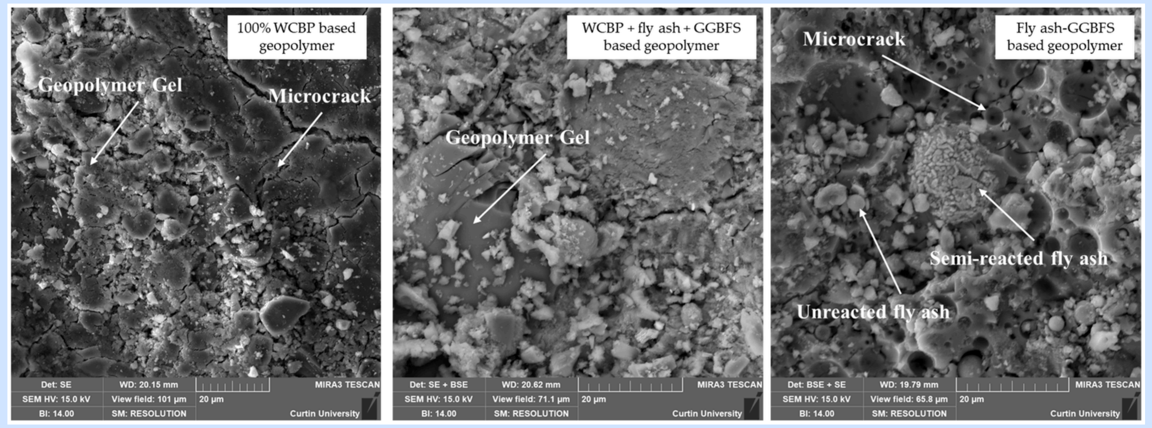


Figure 1. This demonstrates that combining waste brick powder with fly ash and slag creates a more stable, denser geopolymer, which could make it a stronger and more sustainable binder alternative

Porous Ceramic Insulation

Process:
1. Clay bricks are cleaned and ground into a fine powder
2. Mixed with foaming agents → fired at about 900 °C
3. Porous ceramics created

Benefits:
- Better insulation compared to standard clay bricks
- Better energy efficiency with reduced heating and cooling needs

Limitations:
- Higher water content increases porosity → reducing strength
- Requires precise firing control to avoid cracks or irregularities

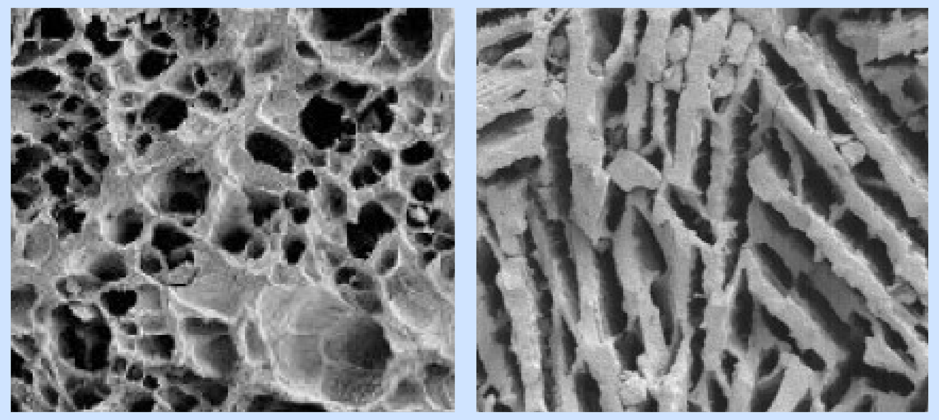


Figure 2. This demonstrates the microstructure of of the porous ceramics

Deconstruction to Repurpose Bricks

Process:
1. Bricked removed from saw-cutting or punching methods
2. Mortars residue are removed
3. Reused for new walls or facades

Benefits:
- Uses less than 1% of energy required to make new bricks
- Reduced CO_2 emission
- Promotes circular use
- 86% lower environmental impact

Limitations:
- Lower compressive strength
- Mortar residue increases porosity → weaker

Figure 3. from top to bottom: reclaimed perforated (no infill), with infill, new frogged, reclaimed frogged

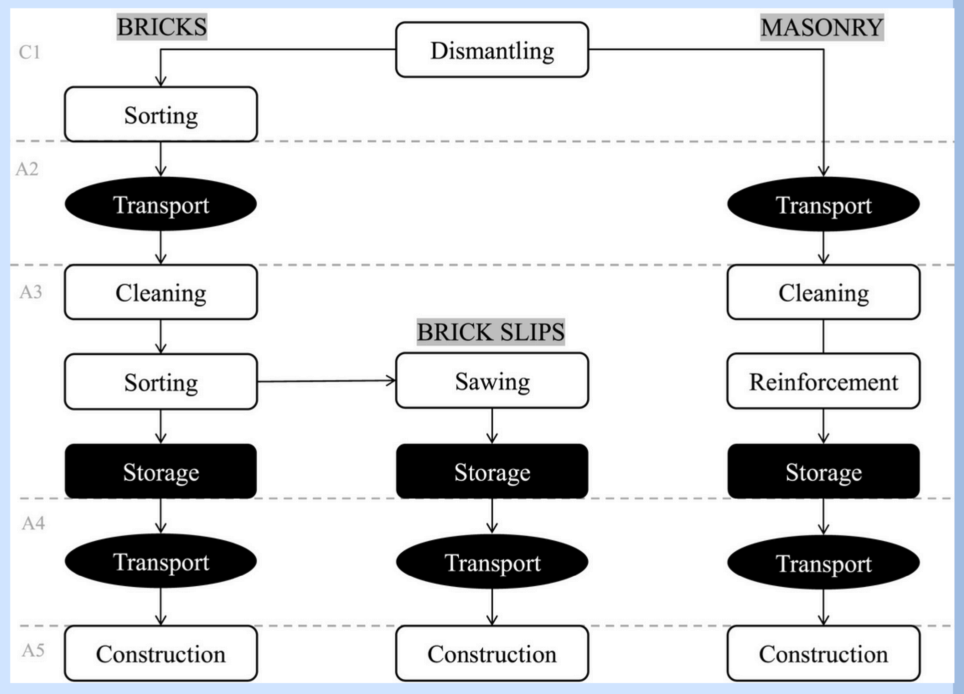


Figure 4. Process for determining which bricks can be reused, their approved applications, and their corresponding categories

Permeable Pavement Layer

Process:
1. Crushed brick → Replaces all courage aggregate
2. Open pores let rainwater pass into soil below

Benefits:
- Better water drainage & infiltration
- Dries faster → less shrinkage and flooding risk
- Support "Sponge City"

Limitations:
- Higher porosity → lower strength
- Not suitable for heavy loads/traffic areas

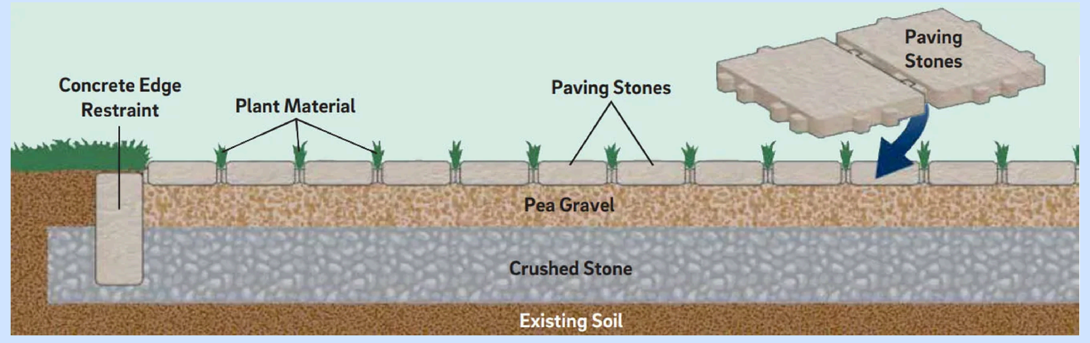
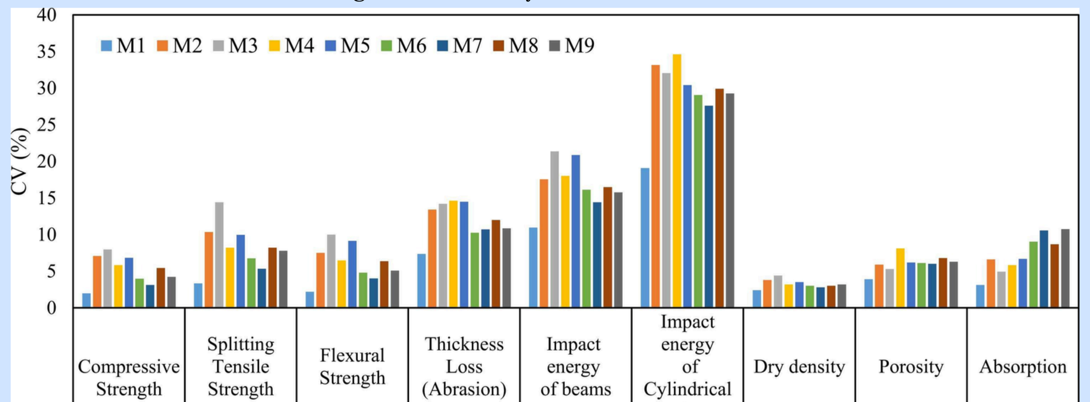


Figure 4. Basic Layers in Permeable Pavement



	Compressive Strength	Splitting Tensile Strength	Flexural Strength	Thickness Loss (Abrasion)	Impact energy of beams	Impact energy of Cylindrical specimens	Dry density	Porosity	Absorption
M1	2.0	3.4	2.2	7.3	11.0	19.1	2.4	3.9	3.1
M2	7.1	10.4	7.5	13.4	17.6	33.2	3.8	5.9	6.6
M3	8.0	14.4	10.0	14.2	21.4	32.1	4.4	5.3	4.9
M4	5.8	8.2	6.5	14.6	18.0	34.6	3.2	8.1	5.8
M5	6.8	9.9	9.1	14.5	20.9	30.4	3.5	6.2	6.7
M6	4.0	6.7	4.8	10.2	16.1	29.1	3.0	6.1	9.0
M7	3.1	5.3	4.0	10.7	14.4	27.6	2.8	6.0	10.6
M8	5.4	8.2	6.4	12.0	16.5	29.9	3.0	6.8	8.7
M9	4.2	7.8	5.1	10.8	15.8	29.3	3.2	6.3	10.7

Figure 6. M1 is the control with no crushed brick, while the remaining samples include different amounts of fine and coarse RCCB. The RCCB-containing mixes perform better than the control

Clay Brick as Aggregate in Concrete

Process:
1. Bricks are cleaned, crushed, and sieved
2. Mixes are tested for density, strength, workability, and durability.
3. Demolition bricks are cleaned, crushed, and sieved to desired sizes

Benefits:
- Lower CO_2 emissions by up to 72%
- Reduces energy use by 45%
- Denser and stronger concrete → better improved freeze-thaw resistance
- Lighter weight reduces dead loads in non-structural elements

Limitations:
- Higher waster absorption
- Higher porosity → reduced strength
- Higher water absorption than natural aggregates

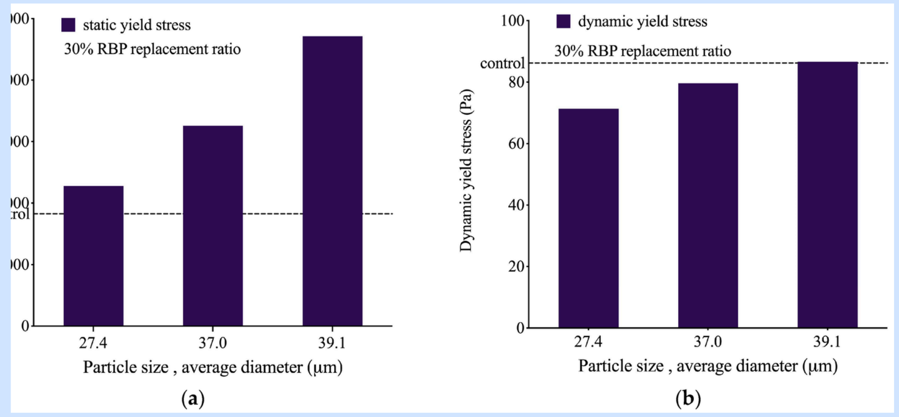


Figure 7. Suggests that using 30% RBP with a larger particle size is most effective for maximizing both static and dynamic yield stress

Figure 8. Crushed clay bricks as fine aggregate for a) concrete and b) cement mortar