

# MOTHERWELL COMMUNITY AND ENVIRO HUB PROJECT

## *A GUIDE TO MAKING BUILDING BLOCKS WITH WASTE*

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# How to make a building block using waste

## Equipment

- 1 x polystyrene shredder
- 1 x glass bottle cutter
- 1 x glass crusher and sieve
- 1 x drill and mixer attachment
- 1 x generator (if no electricity for drill)
- 1 x mixing trowel
- 1 x dowel stick for compacting
- 1 x gloves
- 1 x mask
- 1 x safety googles/glasses
- 1 x measuring vessel (~ 1 or 2 l volume)
- 1 x 25 l (minimum size) bucket for soap mixing
- 1 x 25 l (minimum size) bucket for mixing materials
- 1 x block mould

## Materials

- Cement
- Building sand (can consider using crushed glass powder as alternative)
- Liquid soap
- Shredded polystyrene (using meat trays, take-away containers etc.)
- Eco-Bricks
- Cut glass bottles
- Duct tape
- Wiping cloth
- Gloves
- Oil to line mould
- Water for mixing

## Method

### ***How to shred polystyrene trays/containers:***

- Make sure trays/containers are clean
- Separate into similar sizes
- Take a bundle and push down in the middle of the shredder
- Turn the handle, and push down on the base of the shredder with your foot to keep it steady
- You should feel the polystyrene tray 'grip' and start shredding from the tray closest to you. The back tray will start to buckle after a few turns.
- If shredding stops, separate out 'flat' pieces (these are generally shiny and are unlikely to shred further). Discard of these. Turn the handle back and forwards, rock it from side to side; and dislodge any pieces blocking the shredder.
- Turn the trays on their sides, and shred some more
- Continue until ~3 cm left (to protect your fingers from getting caught in the screws)
- Once the bag under the shredder is half full, pour contents into your storage container

### ***How to cut glass bottles:***

- Make sure bottles are clean
- Position glass bottle in the cutter, and insert a suitable size cork to keep it in position.
- For the standard block size, use the 'notch' set for a bottle cut length of 9.5 cm
- Position the glass cutter in the notch, with teeth facing upwards.
- Push down on the cutter (angled at ~60 degrees), and turn the bottle towards you
- You should hear a grating sound as you turn the bottle and make a score line
- Avoid making multiple score lines (i.e. try get one clear cut line). This prevents shattering later
- Heat water, and gentle pour over the score line. Use a fine trickle, and try keep the water to the line only.
- Alternative with cold water
- The bottle should crack along the score line. Be careful of sharp edges at this stage.
- Once cut, keep the unusable part of the bottle in a separate box/container for crushing
- NOTE: always wear safety gear when working with glass

### ***How to crush glass:***

- Place the glass crusher on a level surface, and straddle over a wooden block to absorb 'shocks' when crushing
- Put glass offcuts into the top of the crusher
- Put top on
- Use the dropper to crush the glass by continuous up and down movements. You will need to feel the glass under the metal dropper to be sure it is being crushed (i.e. it may slip out of position)
- Keep dropping the metal rod until the glass is crushed
- Empty the crushed glass through a mesh into a container to collect the desired size of 'glass aggregate'
- Separate out the bigger pieces into a different container for further crushing
- Further sieve 'glass aggregate' through a mesh of a fine size to separate glass 'sand' from aggregate
- NOTE: always wear safety gear when working with glass

### ***How to make a 'Building Block'***

- Building blocks can be any size that suits your purpose. For convenience and ease of building, a standard block size of 190 x 190 x 390 (mm) will be used for majority of the 'infill panels' at the Enviro-Education facility in Motherwell.
- For all blocks, the standard 'matrix' is a combination of:
  - 0.5 parts building sand or crushed glass sand
  - 1 part cement
  - 5 parts crushed polystyrene
  - 5 parts 'foam'
- Blocks can be made from a variety of 'void filling' materials between the 'matrix' – e.g. glass bottles, Eco-Bricks. Blocks can also just be made with the matrix (i.e. not bottles or Eco-Bricks)
- How to make the 'matrix'
  - Step 1: using a standard size measuring vessel, put 1 part cement into a bucket. Add water (slowly) and mix using a trowel. The final mixture must be a slurry. Do not add too much water. Make sure that all cement powder is thoroughly mixed in.
  - Step 2: in a separate bucket, add a small volume of water, and squirt in liquid soap (not too much). Use the drill and mixer attachment to make a foam. The foam must be the consistency of a shaving cream. Avoid making it to 'aerated'.
  - Scoop 5 parts of foam into the cement slurry to make 'Foamcrete'. Be careful not to pour any excess water in the soap bucket into the mixture. Mix using a trowel and the cement mixer – the consistency must be 'foamy', but not too aerated.
  - Add 1 part sand, and mix in.

- Add 5 parts shredded polystyrene to the cement/foam/sand mix. Stir in using a trowel, making sure that all the polystyrene bits are well covered and 'blended' in the mix.
- The glass bottle block:
  - Preparing glass bottles:
    - Select 2 halves that have a good 'fit' with one another. Secure together with duct tape.
    - Arrange in 2 bundles of 4 each.
    - Secure the bundle with duct tape. Avoid overlapping the tape binding.
  - Position in the block mould
  - Scoop in matrix mixture around the bottles. Try keep bottles steady in position throughout the process. Make sure that all 'gaps' between the bottles are filled from the bottom up (i.e. do not leave gaps).
  - It is crucial to compact the matrix material as you go along to ensure 'solid' block consistency all the way through. A dowel stick or similar can be used for compacting.
  - Once all matrix material has been added, do another round of compaction and add more material to fill gaps if needed. Note that if your original matrix mix is good, it should compact relatively easily.
  - Put the 'lid' in position, and tighten the wing nuts.
  - After ~12 to 24 hours, clean excess cement off of exposed bottle surfaces.
  - If the block feels hard enough at this stage, you can remove the mould casing.
- For the Eco-Brick option:
  - One Eco-Brick fits into the standard block size. No preparation is required.
  - Place a layer of matrix material in the mould.
  - At desired height, place Eco-Brick in the mould on its side.
  - Compact as you go along, to prevent gaps in the block
  - Add matrix material around the bottle, to the top.
  - Do another round of compaction, and add more matrix material if required.
  - Put the 'lid' in position, and tighten the wing nuts.
  - If the block feels hard enough after ~12 to 24 hours, you can remove the mould casing.
- Note: make sure to wear safety gear at all times.

**Estimated volume of non-waste materials needed for a standard block, and the cost:**

- ~4 to 5 kg of cement (R10)
- ~2 kg of sand (R2)

**Notes on different types of blocks tested:**

Different configurations and sizes of blocks were tested to see which will work best as infill panels at the Enviro-Edu Centre at Motherwell. Factors considered are:

- Cost, amount of waste used, time taken to make one block, weight of block, structural integrity, thermodynamic properties, fire resistance, ease of construction (in terms of skills required), aesthetics, and 'show-casing' of waste material used.

These are listed below for 4 block types tested. **Of these, Block Type 1 and 3 will be used in construction phase.**

	Size	Cost	Time to make block	Weight of block	Structural integrity	Thermodynamic properties	Fire resistance	Ease of construction	Aesthetics	Show-casing of waste
<b>Block 1</b>	190 x 190 x 390 mm	Cement + sand (less than Block 2 and 4)	Time consuming	Not restrictive to building	Acceptable	Acceptable	Good	Standard, no special skills needed. Bottle arrangement good for corners	Good – glass and light	Good – bottles visible
<b>Block 2</b>	440 x 280 x 300 mm	Cement + sand (more than Block 1)	Time consuming (but less than Block 1)	Not restrictive to building	Acceptable	Acceptable	Acceptable	Standard, no special skills needed. Bottle arrangement limiting for corners.	Good – decorative exposure of bottle tops and backs	Good: bottle tops and backs visible Risk: material degradation with light, and rats
<b>Block 3</b>	190 x 190 x 390 mm	Cement + sand (less than Block 2 and 4)	Quick	Not restrictive to building	Acceptable	Acceptable	Acceptable (better than Block 2 and 4)	Standard, no special skills needed. No exposed bottles	Fair, can improve with decorative aspects on surface	Poor. But no risk of degradation of materials by light or rats.
<b>Block 4</b>	310 x 310 x 600 mm	Cement + sand (more than all other blocks)	Time consuming (but less than Block 1)	Heavy, restrictive for building	Acceptable	Acceptable	Acceptable	Standard, no special skills needed. Bottle arrangement good for corners	Good – decorative exposure of bottle tops and backs	Good: bottle tops and backs visible Risk: material degradation with light, and rats

### **Block Type 1: Standard Block size, with glass bottles arranged in 2 groups of 4**

- Size: 190 x 190 x 390 mm
- Cost: cement and sand
- Time to make a block: time consuming – cutting and preparing bottles, filling gaps with matrix between bottles
- Weight of block: not restrictive to building
- Structural integrity: acceptable
- Thermodynamic properties: acceptable
- Fire resistance: good
- Ease of construction: standard, no special skills needed. Arrangement of bottles makes it easier to change angles (i.e. at corners)
- Aesthetics: good – light filtering through glass bottles. Limited by rigid alignment of bottles. Consider placing randomly in block.
- Show-casing: good, bottle backs visible



### ***Plate 1: Block Types 1***

### **Block Type 2: Block size '2', with 6 Eco-Bricks, backs and tops exposed**

- Size: 440 x 280 x 300 mm
- Cost: cement and sand (will require more than Block Type 1 and 3, because block width needs to accommodate a 2 l plastic bottle)
- Time to make a block: time consuming –filling gaps with matrix between bottles (but less than Block type 1)
- Weight of block: not restrictive to building
- Structural integrity: acceptable
- Thermodynamic properties: acceptable
- Fire resistance: acceptable
- Ease of construction: standard, no special skills needed. Arrangement of bottles limits changing angles (e.g. at corners)
- Aesthetics: good – can use exposed bottle tops and backs in decorative manner
- Show-casing: good, bottle tops and backs visible.
- Risk of exposed bottle tops/backs degrading with light exposure, rats.



***Plate 2: Block Type 2.***

**Block Type 3: Standard Block size, with 1 hidden Eco-Brick**

- Size: 190 x 190 x 390
- Cost: cement and sand (as per Block Type 1)
- Time to make a block: quick.
- Weight of block: not restrictive to building
- Structural integrity: acceptable
- Thermodynamic properties: acceptable
- Fire resistance: acceptable (better than other Eco-Brick bottles, since bottle is entirely encased in matrix)
- Ease of construction: standard, no special skills needed.
- Aesthetics: fair, but can be improved with decorative aspects on the outer surface (e.g. bottle tops or metal caps or crushed glass on surface layer)
- Show-casing: poor. As alternative, waste used can be show-cased by means of informative posters and photos.
- No risk of waste exposure to rats or the elements, and degradation of block.



***Plate 3: Block Type 3.***

**Block Type 4: Block size '3', with 8 Eco-Bricks, backs and tops exposed**

- Size: 310 x 310 x 600



- Cost: cement and sand (more than all other blocks, because block width needs to accommodate 8 x 2 l plastic bottles)
- Time to make a block: time consuming –filling gaps with matrix between bottles (but less than Block type 1)
- Weight of block: heavy, will create a problem when lifting blocks above a certain height.
- Structural integrity: acceptable
- Thermodynamic properties: acceptable
- Fire resistance: acceptable
- Ease of construction: standard, no special skills needed. Weight of block is restrictive above a certain height.
- Aesthetics: good – can use exposed bottle tops and backs in decorative manner
- Show-casing: good, bottle tops and backs visible.
- Risk of exposed bottle tops/backs degrading with light exposure, rats



***Plate 4: Block Type 4.***