

Recycled Plastic Brick 2.0

By: Geert Talsma

Plastic pollution is a massive problem and one of the most pressing environmental issues (Parker, 2019). Plastic waste is everywhere, especially in low-income countries where the waste management is poor. This needs a solution. Introducing the Recycled Plastic Brick (RPB). A building material that can be made from plastic waste in small scale recycling workshops around the world. The first version has been made by Precious Plastic and Recycle Rebuild in 2020. However, this brick was still too expensive for it to be a viable alternative building material. The aim of this assignment is to redesign the production and design of the RPB in order for the brick to be a viable alternative building material (in developing countries).

In the first phase, the design and production method of the brick have been analysed. The original RPB is 300mmx100mmx165mm (LxWxH). The brick is produced by extruding 1,7kg of plastic into a mould. This takes 4min, very long for moulding plastic. To finish a complete brick, it takes around 8 min (Recycle Rebuild, 2020). The extruder also imposes some limitations, it runs at a pressure of 8 bar and has an extrusion rate of 7,9cm³/sec. These limitations have resulted in the decision to change the manufacturing method. The brick can withstand a force of 271kN (Seeger, 2021), however, to build a simple house a strength of 15kN (safety factor of 1,8) is enough. The original RPB costs £18,385-£35,547 per square meter. An alternative building material, concrete hollow blocks would cost around £7,83 per square meter. The new design aims to cost similarly or less than the concrete alternative. To lower the costs, the amount of plastic and the production time should be reduced, the durability of mould should be increased.

The new manufacturing method will be compression moulding. This method has the most opportunities to improve the design of the brick. This method can, relative to the extruder, produce more pressure and has a faster filling time of the mould, resulting in higher quality bricks. The required compression force should be lower than 10tons, to keep the compression moulding machine affordable.

For the design of the brick, different design considerations have been made. The brick can be two or three times as long as it is wide. The 2x1 brick is more versatile with building one, two or three layered walls or with ribs inside the walls. The interlocking teeth have to be square with some plastic in-between due to compression moulding limitations. Lastly, a draft angle of three degrees should be applied to the teeth and inside of the brick. The exterior will not have a draft angle to keep the walls straight.

From the analyses and considerations, a requirement specification has been made with which three different concepts have been made. A 2x1 brick, a 3x1 brick and a 3x1 saw-able brick. This last one could be sawn in thirds, so no additional moulds were required to make additional smaller sized bricks. Due to plastic sawdust creating microplastics this concept was dropped. Compared to the 3x1 concept, the 2x1 brick concept requires one less mould to create the additional sizes which reduces the costs and the 2x1 brick is more flexible in its use. Therefore, the 2x1 brick will be developed further.

The production time of the RPB is linked to the amount of plastic required, which is largely determined by the size of the brick. The first two determine for a large part the cost of the brick and thus, the dimensions. The optimal dimensions for the brick, optimum between the size and number of bricks per m², are 400x200x125mm (LxWxH). The cost is one of the lowest and the dimensions

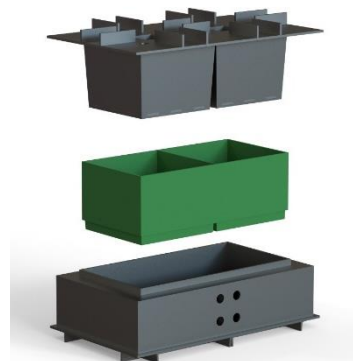
connect well to standards in lumber and existing masonry. The final RPB costs lie in the range of £10,45-£19,07 per square meter.

To reach the final design, Moldex3D compression moulding has been used to simulate the moulding process. Changes have been made to optimize the design for manufacturing and simpler mould construction. Final parameters for the compression moulding process: compression speed, 10mm/sec; compression force, 10tons and plastic temperature, 210°C. With some cooling a moulding time of under 4 min should be easily reachable. The final design uses 1,3kg of plastic and can be produced every 4,01min.

With a smallest wall thickness of 4mm, the maximum von Mises stresses in the brick are 19,46MPa (yield strength of 24MPa) and the maximum deformation is 0,81mm with a force of 15kN.

The final design of the RPB and the mould can be seen in the images below. The mould will be created with laser-cut steel plates, welded together, this is a relatively affordable option. The mould is designed to be simple to assemble and to weld. A simple cooling system has been integrated into the structure of the mould.

So, is the Recycled Plastic Brick 2.0 a viable alternative building material? It has a good chance in areas where building materials are relatively expensive. For example, a workshop, that collects local plastic waste on an island and recycles it into RPBs has a good chance to compete with imported building materials.



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