Designing for sustainability and safety in urban micromobility: a novel helmet concept

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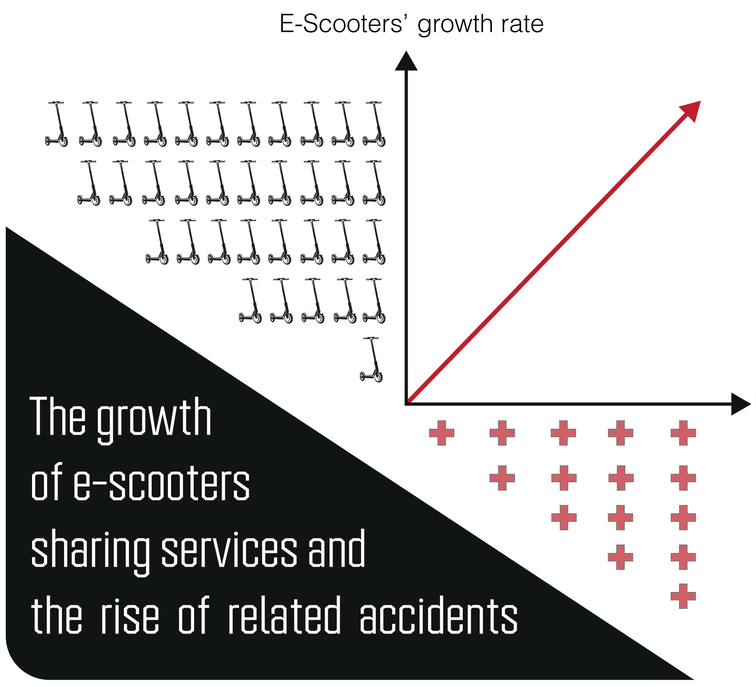
INTRODUCTION TO THE PROBLEM:

The popularity of e-scooters and e-bikes has caused a rise in severe accidents due to inadequate regulations and very low use of helmets. Traditional helmets, besides being incompatible with the spontaneity of micro-mobility, are also unsustainable due to the materials used and their manufacturing process, impairing any kind of recycling or repurposing.

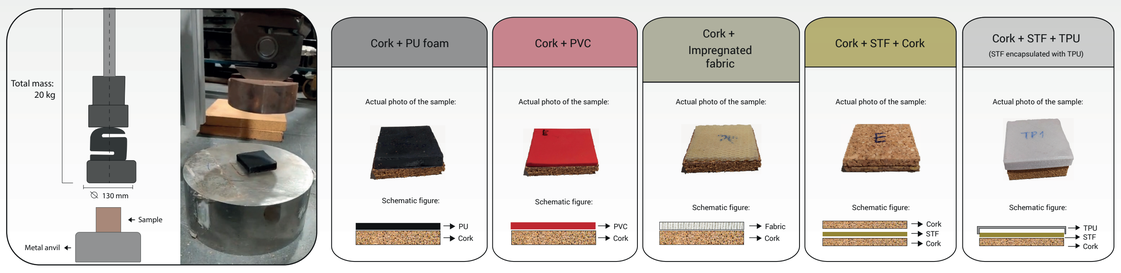


AIMS AND METHODOLOGY

Address the safety concerns and sustainability issues associated with urban micro-mobility by designing and testing a novel helmet concept using hybrid composites containing cork and other energy-absorbing materials - shear thickening fluids (STF) in bulk, polymers containing STF and fabrics impregnated with STF - , with the goal of achieving improved impact protection, reduced carbon footprint, and recyclability.

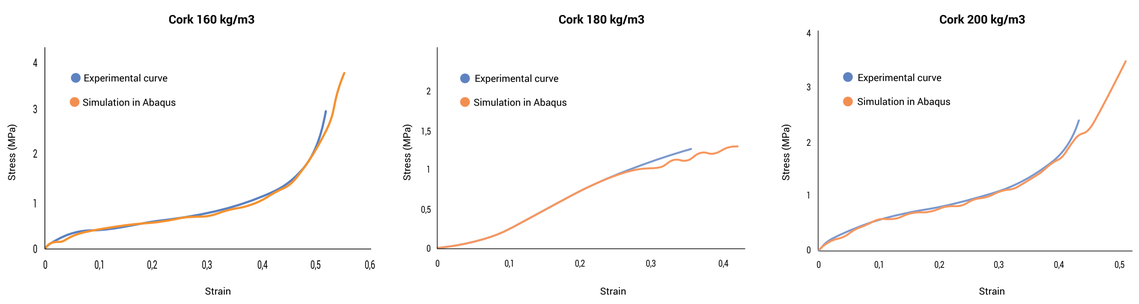
Experimental tests using a drop tower

Impact energies of 20 J and 100 J

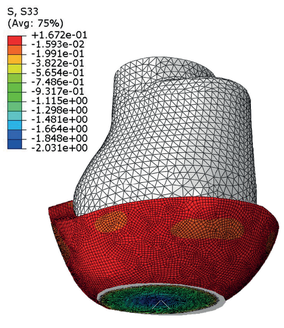


Material characterization and Finite Element Analysis (FEA) in Abaqus

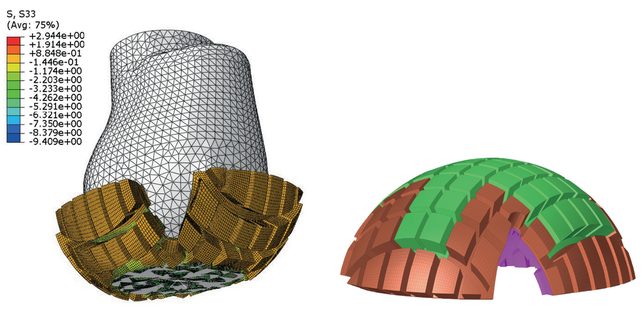
Replication of experimental tests in a virtual setup in order to validate the materials' bahaviour



Impact simulations according to the EN 1078 standard for bicycle helmets



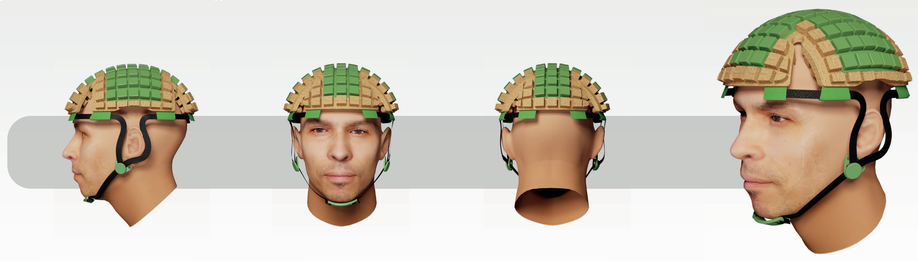
Simulation of a finite element model of a generic helmet

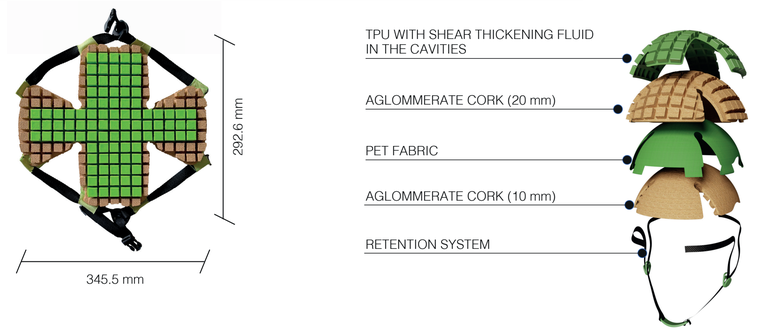


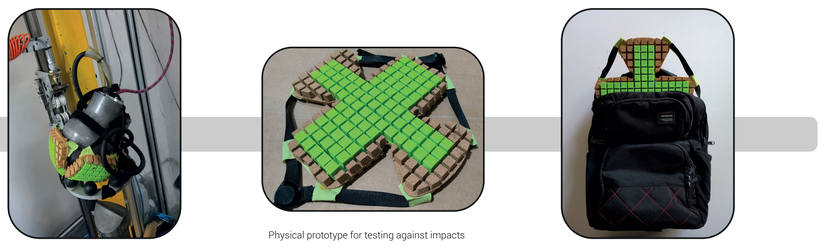
Simulation (left) and finite element model (right) of the proposed design solution

RESULTS

The results of this work include the development of an aesthetically innovative and functionally effective helmet prototype with a **42% lower carbon footprint** than standard helmets, excellent performance in multiple impact scenarios, **folds completely flat** to about the size of a 15" laptop and **has the ability to be disassembled and its parts recycled**, contributing to sustainable development goals. In terms of performance, it has an **average acceleration of 158 g** (far below from the standard's 250 g treshold) and an **average HIC of 670**, meaning it offers **less than 5% risk of a TBI**.



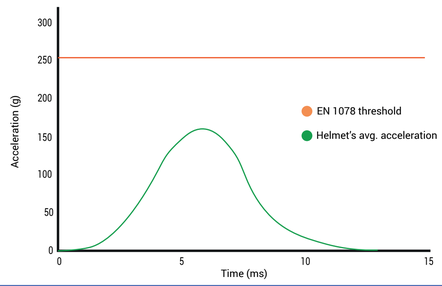




Impact tests according to the EN 1078 conducted at Abimota facilities

Physical prototype for testing against impacts

The helmet fits inside a regular backpack



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