ECOCELL, building material in large constructions

Context and objectives

The continuous growth of the population and the increase of migrations imply the need to find intelligent and environmentally sustainable solutions for the construction of new homes. Moreover, the classical concrete construction techniques use too many resources and take a lot of time to be built. Innovations are thus required in the sector to adapt to the current demographic dynamics.

ECOCELL Technology AG, a Swiss company founded in 2012, has developed a concept of honeycomb cardboard structure, coated with mineral cement. This structure, when sandwiched between two wood panels, forms lightweight and robust walls. The prefabricated elements can then be transported on-site where a small team of builders can assemble a house in just a few days.

These building elements are thought to become an alternative solution to worldwide spread concrete constructions. This technology allows fast and easy construction while guaranteeing insulation and structural properties.

The scope of this study is to identify where improvements can be made in the composition of the ECOCELL building element. The choice of the base materials and their relative impact is analysed through a life cycle assessment. Investigation on alternatives raw material for the cardboard fabrication is also performed.

Finally, we have considered some future perspectives and implementation options of this technology into the global context of moving and increasing populations.

Method

Life Cycle Assessment (LCA): SimaPro software
Database: ECOMERT, Ecoinvent 3 - allocation, default - unit
Methods: IMPACT 2000+, IPCC 2013 GWP 100a
Norm: ISO 14040-40 and UCD Handbook

Scenarios

In order to assess which material has the biggest impact, five different scenarios were set for performing the life cycle assessments. It was not possible to reproduce the true ECOCELL composition so a standard scenario was defined. Then only one material at a time was changed to measure each individual environmental impact. The real composition of the ECOCELL element is not of primary importance due to the flexibility of the concept and the objectives of the study.

Dimension of the standard element are 200x200x115mm that give a volume of 0.0027m³ for the wood, 0,00036m³ for the cardboard and 0,00002m³ for the cement. For the core structure, we hypothesised that 90% of the volume is air and the remaining half is made by 2/3 of cardboard and 1/3 of cement.

Alternative materials

ECOCELL building blocks are very flexible in the type of material used. While the honeycomb structure of the core and its mineral coating remains, the external panels and the cardboard can be composed of different type of materials.

This flexibility of ECOCELL allows to use local resources such as sugar cane, hemp or jute as raw material for the cardboard production. The use of local wood and other resources would reduce the ecological impact as well as decrease the price while developing the local economy.

Results

After assembling the ECOCELL elements in SimaPro according to the different scenarios, we calculated and compared their environmental impacts. The graph on the left resumes the results obtained with the first method (IMPACT 2000+) and groups the impacts under different endpoints. The right table summarises the calculated amount of CO₂ equivalent under the IPCC 2013 GWP 100a method.

Implementations and perspectives

Refugee camp

By its design, ECOCELL building elements provide an easy way to build many hard wall houses in a short time. These houses could replace the tents camp normally built and provide long-term and acceptable conditions of living for the refugees. An advantage of ECOCELL constructions is their high customizability: they adapt well to many cultural and social type of families. Moreover, the diversity of material that can be used for the creation of ECOCELL elements enable to build it nearly everywhere.

Vision Hill

The Vision Hill neighborhood is a futuristic project conceived by Erich Chien. It aims to create a society where working and living are close together in the same environment. ECOCELL building materials fit into this vision as the first building blocks. Its lightweight allows to build houses on the surface of the hill without an heavy structure before supporting it. All these factors, associated with the attached energy efficiency and ecological philosophy, correspond to the emergence of such a futuristic project.

Conclusion

Building with ECOCELL compared to traditional methods is more environmental friendly mainly because of the less quantity of concrete used. In order to further improve this technology, attention should be put in the choice of the wood since it is the major contributor to pollution in ECOCELL building elements. In fact, the types of wood and fibers used to fabricate the plate and the cardboards are not of crucial importance, strength and resistance of the panels are given by the cement mix patented by ECOCELL AG. In this way local and cheap resources can be favored. ECOCELL is then an interesting solution to be applied worldwide, especially in developing countries or in a context of refugee crisis where numerous habitations must be constructed in a short time.