World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:18, No:03, 2024

Building Carbon Footprint Comparison between Building Permit, as Built, as Built with Circular Material Usage

Authors : Kadri-Ann Kertsmik, Martin Talvik, Kimmo Lylykangas, Simo Ilomets, Targo Kalamees

Abstract : This study compares the building carbon footprint (CF) values for a case study of a private house located in a cold climate, using the Level(s) methodology. It provides a framework for measuring the environmental performance of buildings throughout their life cycle, taking into account various factors. The study presents the results of the three scenarios, comparing their carbon emissions and highlighting the benefits of circular material usage. The construction process was thoroughly documented, and all materials and components (including minuscule mechanical fasteners, each meter of cable, a kilogram of mortar, and the component of HVAC systems, among other things) delivered to the construction site were noted. Transportation distances of each delivery, the fuel consumption of construction machines, and electricity consumption for temporary heating and electrical tools were also monitored. Using the detailed data on material and energy resources, the CF was calculated for two scenarios: one where circular material usage was applied and another where virgin materials were used instead of reused ones. The results were compared with the CF calculated based on the building permit design model using the Level(s) methodology. To study the range of possible results in the early stage of CF assessment, the same building permit design was given to several experts. Results showed that embodied carbon values for a built scenario were significantly lower than the values predicted by the building permit stage as a result of more precise material quantities, as the calculation methodology is designed to overestimate the CF. Moreover, designers made an effort to reduce the building's CF by reusing certain materials such as ceramic tiles, lightweight concrete blocks, and timber during the construction process. However, in a cold climate context where operational energy (B6) continues to dominate, the total building CF value changes between the three scenarios were less significant. The calculation for the building permit project was performed by several experts, and CF results were in the same range. It alludes that, for the first estimation of preliminary building CF, using average values proves to be an appropriate method for the Estonian national carbon footprint estimation phase during building permit application. The study also identified several opportunities for reducing the carbon footprint of the building, such as reusing materials from other construction sites, preferring local material producers, and reducing wastage on site. The findings suggest that using circular materials can significantly reduce the carbon footprint of buildings. Overall, the study highlights the importance of using a comprehensive approach to measure the environmental performance of buildings, taking into account both the project and the actually built house. It also emphasises the need for ongoing monitoring for designing the building and construction site waste. The study also gives some examples of how to enable future circularity of building components and materials, e.g., building in layers, using wood as untreated, etc.

Keywords : carbon footprint, circular economy, sustainable construction, level(s) methodology
Conference Title : ICBSE 2024 : International Conference on Building Science and Engineering
Conference Location : Sydney, Australia
Conference Dates : March 25-26, 2024