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Abstract

Energy performance of a building is one of the main features to be assessed and optimized in sustainable building designs. While progress in reducing the operating energy is being achieved, the embodied energy remains somewhat high. The building industry is currently using around 40-50% of global raw material that is responsible for the 40-45% of the total worldwide carbon dioxide emissions.

Embodied energy and carbon calculations are rather complex since they are related to different combinations of material whether in the structure or the finishing material. Reducing the embodied energy can be done by either varying the structural design, increasing the service of the building, or using recycled material. Conventionally, these calculations are not strictly part of the designer's work during the conceptual design phase; hence, if done, they are calculated

during the design evaluation phase when the design decisions have been already set, and change in design decisions is not easy. Under most circumstances, the environmental impact assessment of designs was performed by sustainability consultants who may not be present in many projects. It is better to bring the embodied energy calculations to the conceptual design phase so both the architect and the structural engineer can make informed design decisions for a more sustainable building. Many organizations are using in-house tools to make these calculations, but the tools used are not flexible enough to be adopted by a wide variety of users. A better way is to use the functionality of Building Information Modelling (BIM) software by developing plug-in tools that are simple to use in early stages of conceptual design.

This paper explores two existing plug-ins that function with Rhinoceros (Rhino) and Grasshopper (GH) software, where they define a set of parameters to evaluate the embodied energy in the structure of the building. The aim of this paper is to develop a tool that can be used more easily and that adds to the existing parameters to give a more accurate estimation of the building's embodied energy during the conceptual design stage. For this purpose, a comparative analysis will be performed of both plug-ins to determine their best features and to add the missing components concerning the embodied energy of finishing material. The proposed tool will be developed using visual basic scripting language to be used with Rhino and GH. Finally, the prototype will be open sourced for testing and verification while conclusions concerning the limitations and future development opportunities will be discussed.

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Index Terms

Computer Science Artificial Intelligence

Keywords

Embodied energy, embodied carbon, conceptual stage simulation, computational tool, design optimization