Prevention of Construction and Demolition waste in a BIM environment

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Introduction

The construction sector is responsible for about 60% of the lithosphere mining, of which about 40% refers only to buildings, that means 24% of the world's mining (Zabalza Bribián et al., 2009).
Moreover, Figure 1 shows how much the material production contributes to **GHG emissions**: the construction sector is responsible for 5 $GtCO_2$-eq.
Construction and demolition waste (CDW) is one of the heaviest and most voluminous waste streams generated in the EU. It accounts for approximately **25% - 30% of all waste generated in the EU** and consists of numerous materials, including concrete, bricks, gypsum, wood, glass, metals, plastic, solvents, asbestos and excavated soil (European Commission, 2019). In a circular economy approach, a better and more efficient use of resources should be promoted and, correspondingly, the reduction of CDW.

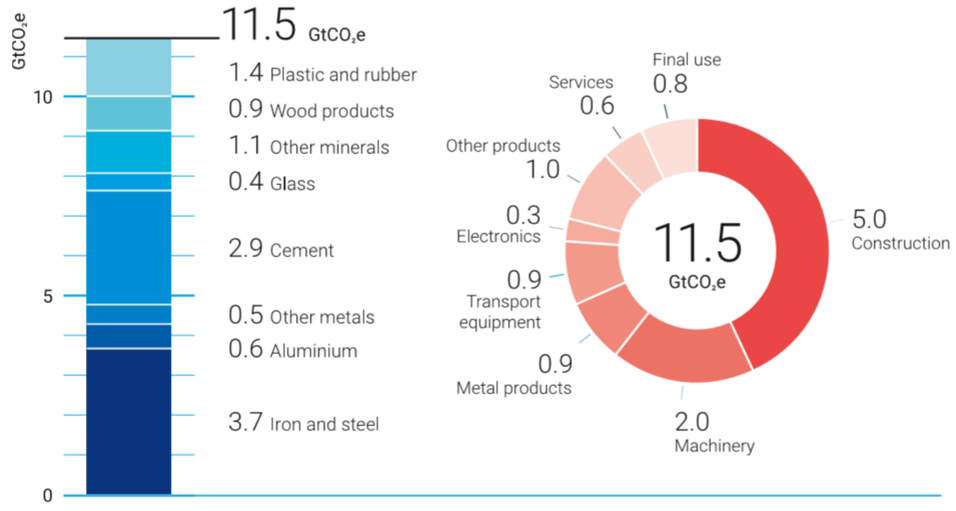

FIGURE 1- GHG emissions in GtCO2e associated with materials production by material (left) and by the first use of materials in subsequent production processes or final consumption (right). Source: United Nations Environment Programme, 2019

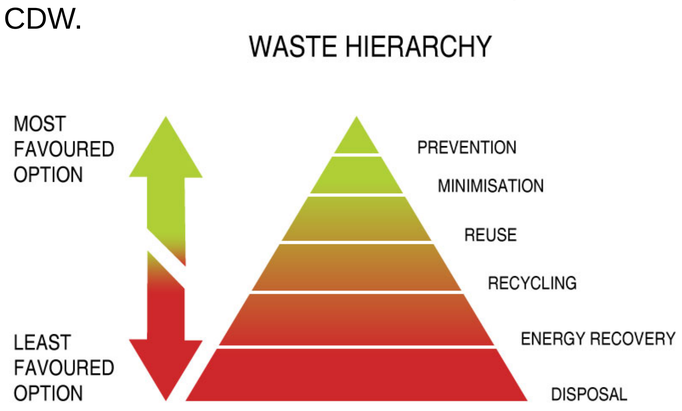

FIGURE 2- Waste hierarchy, Directive 2008/98/EC on waste, Article 4

As **waste hierarchy** highlights (Figure 2), waste prevention is the most favorable waste management option, above reuse, recycling and recovery (Directive 2008/98/EC, Article 4).
The commitment of European institutions on this topic is increasing. For example, Directive 851/2018 states that "*by 31 December 2024, the Commission shall consider the setting of preparing for re-use and recycling targets for construction and demolition waste*" (art. 1).

Proposed method

A smart and efficient sorting and recycling can offer an important alternative to traditional waste management becoming a mandatory choice for environmental, economic and social sustainability.
The aim of this research is to study and promote strategies for the prevention of CDW at local/regional scale, considering the whole life cycle of a building (design, construction, management, maintenance, dismissing), in a circular economy perspective and fulfilling a natural resources optimization.

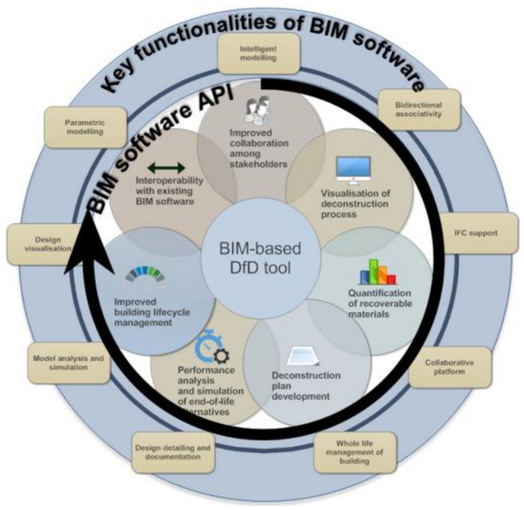

FIGURE 3- Example of a possible interaction between BIM and D-f-D. (Akinade et al., 2018)

It is pivotal to manage qualitative and quantitative data since the design stage in order to know what will happen at the end of life of building. For this reason, a digital model has been carried out in **Building Information Modelling (BIM)** that will consider several criteria related to **Design for Deconstruction** (D-f-D) and **Design for Adaptability** (D-f-A) as depicted in Figure 3.

Among the benefits that BIM technology can deliver to the construction sector is the ability for multidisciplinary collaboration between architect, engineer and construction teams. As the design process is crucial for the reduction of CDW later on, BIM software offers possibilities to optimise this stage and to deliver up to 15% less CDW (European Commission, 2019)

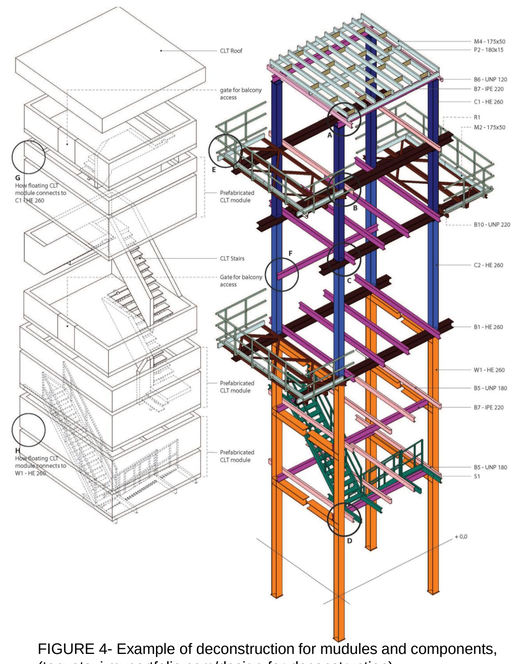

FIGURE 4- Example of deconstruction for mudules and components, (tanyatsui.myportfolio.com/design-for-deconstruction)

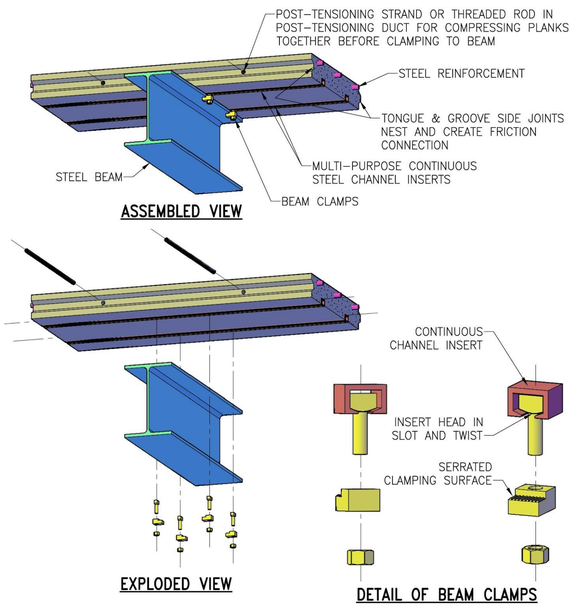

FIGURE 5- Deconstructable and Reusable Composite Slab (Simpson Gumpertz & Heger Inc.)

D-f-D and D-f-A intend to design buildings by means of prefabrication, preassembly, modular constructions and by standardizing and simplifying connection details, systems, but at the same time also ensuring high levels of efficiency for buildings and high levels of safety for workers and users (Figure 4 and 5). This model could manage the waste flows properties (type of waste, criteria of adaptability, criteria of decommissioning and deconstruction, recycling) with all instructions already loaded since the project phase, and all information available by means of shared platform in a common data environment, with databases referring to different buildings.

Future implementation

BIM could support the CDW management in many ways, such as minimizing CDW through design validation, providing material information regarding waste, and quantifying the generation of waste before construction or demolition. Further research is needed to understand its potential impact. This might be a useful tool both for local planning and for management of urban built environment, boosting a digital market for secondary raw materials in the construction sector, in a circular economy perspective. On this line, recently in Italy it has been launched new web application that aims to promote, the market of recycled aggregates from CDW involving a sector with a potential basin of 55 million tons of waste, throughout the Country. It is called "**Market inerti**" and represents a huge database which, through of a web portal, available as a contact between supply and demand.

FIGURE 6- Web implementation of Market inerti.

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