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Building Circular Economy: a Case Study Designed and Built Following a BIM Based Approach for Life Cycle Assessment.

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1 Introduction

The Socrates Building is a mixed use building located in Viladecans Business Park, a new business development area dedicated to emerging company and new business models such as the industry 4.0. The building responds to the need of having a wide range of possibility of use that spans from offices and tertiary, including restoration and commercial use, to light industrial use. The building proposes an architectural and construction model for the circular economy defining as main directives: maximum spatial flexibility, comfortable and healthy occupied spaces, structural durability and material disassembling and traceability. The industrialized, dry construction system was chosen as the best option to respond effectively to life cycle strategies and to reduce the negative impact during the operating phase and deconstruction phase. Construction materials where chosen according to its level of traceability fostering the use of Cradle to Cradle materials and the commitment of the contractor to select products with material passport or Environmental Declaration of Product (EPD). The decision-making during the design process was supported with a Life Cycle Assessment (LCA) developed with a digital BIM model and implemented with environmental impact data of the BEDEC database.An important part of the project was dedicated to conceive a building with increased value during operating phase, which is usually the highest impact in the life cycle (Asdrubali, 2013); therefore spaces where designed along with energy simulations to ensure the optimum comfort in terms of lighting and thermal comfort, two aspects directly related to health and productivity at work with direct benefit on energy conservation and subsequent reduction in operating costs. Every floor plan has an open space equipped with vegetation, irrigated with recovered rainwater. The LEED v.4 certification protocol was adopted to better structure all of the aforementioned aspects related to sustainability, this decision was taken accordingly to an analysis on the office buildings market in Barcelona where the majority of buildings with ant environmental certification have higher real estate value and higher renting prices.

As a result of the implementation of energy simulation during the design process, the maximum depth of the volumes in 3rd and 4th Level is set for 10 meters, ensuring a 10-meter patio in the core, which strategically allows openings towards an interior zone with better

acoustic conditions. This choice guarantees a value of at least 2% of Daylight factor over the 75% of working areas and an efficient level of natural ventilation. The overall energy consumption of the proposal is reduced by 40% compared to the corresponding baseline model designed according to ASHRAE 90.1 2010.

Concerning the LCA, the overall results show the largest impact during the product phase and still an important impact during the use phase, the 88% of the construction materials have been identified and defined for its recyclability at the end of life, amounting for 7.800 tons. Moreover 84%, accounted for its weight has a Cradle 2 Cradle certificate. The design and construction process guaranteed a minimum waste production calculated for 25 tons of waste material, including excavation consisting of only 4kg of waste per square meter of construction. The 100% of this waste is traced in a waste management protocol and 99,3 % is revalorized.Considering the building as a system of parts and functions that spans along its life cycle, it is important to expand the concept of circular economy not only on the life cycle of construction material, but also on the operating phase and the increased value derived from spatial flexibility, health and comfort of occupants that implicates higher performance, energy and economic savings during use and maintenance.

Regarding the lifecycle analysis, the data availability is an important issue in the construction sector. In the Socrates project it was enhanced, as most of the products were Cradle to Cradle certified or had Environmental Product Declaration (EPD). However, one of the main barriers in applying the LCA methodology in the design process still was the current lack of precise and consolidated data, especially considering the environmental impact of specific construction systems in the use phase. Information about the maintenance, repair, replacement and refurbishment has to be available. In regard to the replacement, the actual durability of materials and systems

Socrates Buildings can be considered as one of the first real case studies for the integration of circular economy in the building sector. The next step required for a business model of circular economy will be to consider each component of the life cycle in terms of intrinsic economic value in the real estate market, so that buildings will increase its value beyond standard indicators and so enhancing the interest in sustainable buildings.

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