Application of Lifecycle Assessment and Finite Element Analysis in the Design of Raised Access Floor Products

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ABSTRACT

In this research, two key methods, Lifecycle Assessment (LCA) and Finite Element Analysis (FEA), are applied in sustainable product design. Reliable assessment of environmental performances is crucial to achieve sustainable product design, and the LCA applied in this research ensures the product's sustainable features. To meet a required strength is fundamental for a successful product design, and the FEA conducted in this research confirms that the product meets the requirement.

In the research, a flooring product, raised access floor panel, is used as a vehicle to illustrate how the LCA and FEA are applied in sustainable product design. The product design specifications for the sustainable features are derived from the standards of environmental management system, and EU regulations and directives of sustainability. The materials used to develop the floor panel is Sheet Moulding Compound (SMC) with 30% glass fibres. The product is modelled in SolidWorks software package. Based on the CAD model of the product, the LCA and FEA are then conducted.

Solidworks FEA module is used to conduct the FEA of the product, which includes floor material selection, identification of workloads and constrains, mesh, and strength calculation. According to the British Standard BSEN 12825:2001, the flooring product is required to apply 3000N workloads in the middle of the floor panel, to analyse and evaluate the stress and deformation. Figure 1 presents the FEA result via loading 3000N at a 25mm square area in the centre of the floor panel. The result shows that the maximum yielding stress is 172.90 MPa, which appears on the position near the corner of metal stringer. According to the "Maximum Von Mises stress criterion", the maximum yielding stress must be less than the stringer's allowable stress 202 MPa. Therefore, the analytic result meets the requirement of strength of flooring product. Under this strength, the safety factor is 2.67 and the maximum deformation of flooring product is 2.5 mm, which reach the Class A standard of deformation of flooring product.

Solidworks sustainability module is used to conduct LCA for the designed prototype. Within the LCA, CML methodology is adopted to evaluate its performance in the perspective of materials, manufacturing, transportation and end of life. The evaluation results show the materials contribute significant negative impacts in the four environmental impact categories: 84% in Carbon Footprint, 91% in Total Energy Consumed, 73% in Air Acidification, and 66% in Water Eutrophication (see Figure 2). The evaluation results not only clarify the optimized design targets, but also are able to use as benchmarking values for design iterations.

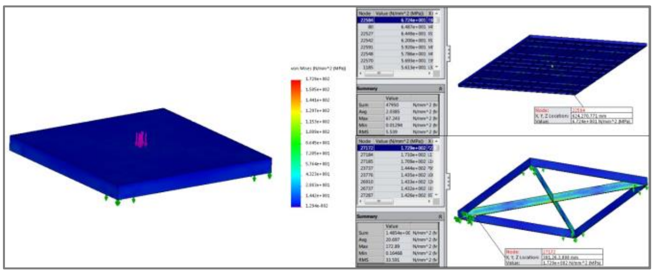

Figure 1. Max yielding stress for the floor panel and stringer with loading 3000N forces at the central panel

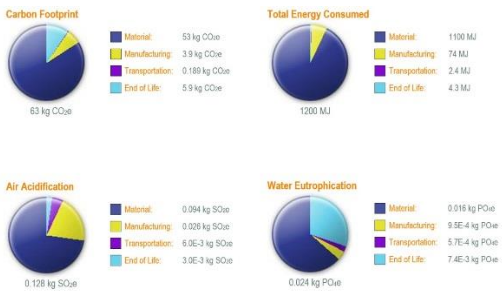

Figure 2. LCA results adopting CML methodology in SolidWorks 2015