Influence of CO₂ Emission Pricing on the Degree of Reuse in Building Projects

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Abstract

By 2030, CO₂ emissions must be drastically decreased to meet the goals of the Paris Agreement. As a result, the modern construction sector urgently needs to transition to a circular economy. This paper investigates how pricing of CO₂ emissions at different levels impacts the viability of reuse in building projects. A recently developed design tool is used in two case studies to find appropriate reclaimed steel elements for a truss structure at Old Trafford, Manchester. Utilising optimisation algorithms, the design tool automatically proposes substitutions of elements in a designed building with reusable elements. The conducted case studies demonstrate that an increased CO₂ emission price encourages a higher utilisation of reusable elements, even considering the substantial driving distance involved in acquiring them. The results indicate that increasing the CO₂ emission price in the future will motivate the reuse of old materials in the building projects of tomorrow.

Keywords: Reuse; Digital design tool; Circular economy; CO₂ emission pricing.

1 Introduction

In the Paris Agreement, the United Nations made a commitment to limiting global warming to well below 2°C and ideally below 1.5°C by the end of this century [1]. To accomplish this goal, emissions must decrease by 45% by 2030 [2] and reach net zero before 2050 [3]. This impacts the building and construction sector, which uses about 50% of extracted resources worldwide [4]. The sector is responsible for 37% of global CO₂ emissions [5] and accounts for over 33% of the waste in the European Union [6].

The primary cause of the high CO₂ emissions in the construction sector is the linear economy, which discards resources and building materials after use [7]. Consequently, the construction industry must quickly shift towards a circular economy to reduce CO₂ emissions [8].

One method to price the CO₂ emissions in the construction sector is to use the carbon price benchmarks from The Organisation for Economic Co-operation and Development (OECD). The first benchmark defined by the OECD of EUR 30 per tonne CO₂ [9] is a historic low-end and minimum price level to start triggering meaningful efforts. The second benchmark, which is described as a low-end 2030 and a mid-range 2020 benchmark, is EUR 60 per tonne of CO₂. This price is also in line with a 2060 scenario of gradual decarbonization [10]. The third benchmark, which is set at EUR 120 per tonne of CO₂, is a central estimate of the carbon costs in 2030. To investigate how the price of CO₂ emissions affects the use of reusable building elements, this paper aims to answer the following research question:

How is the price of CO₂ emissions affecting the reuse of building elements?

First, the digital design tool used in this paper is described. Then, two case studies are defined to investigate how the price of CO₂ emissions is affecting the reuse of building elements. Lastly, the results of the case studies are presented and discussed.