Carbon Emissions, Lifespan and Circularity Interaction Strategies

Dr David Collings

ARCADIS, Guildford, UK

Contact: david.collings@arcadis.com

Abstract

Capital and whole life carbon emissions; circularity, waste and reuse; useful lifespan; net zero and other sustainability issues are often assessed independently. However, there is a significant interaction between these sustainability issues. In this paper the interactions are highlighted and good and poor strategies to combining them are outlined. Examples from published sources are used to illustrate the interactions and strategies. The paper is based on recent research by the author and others in industry and academia. The carbon-circularity- life interaction is primarily focused on bridges and transportation infrastructure. The paper highlights the key differences between infrastructure and building structures, on which much of the current circularity, waste and reuse considerations are aimed.

Keywords: Carbon emissions; circularity; life span.

1 Introduction

Capital and whole life carbon emissions; circularity, waste, reuse; useful lifespan; net zero and other sustainability issues are often assessed independently. However, there is a significant interaction between these sustainability issues. In this paper the interactions are highlighted and good and poor strategies to combining them are outlined.

1.1 Definitions

The term carbon is used in this paper as a shorthand for the carbon dioxide equivalent of all greenhouse gases (the global warming potential) measured in tonnes (tCO2e). The term capital carbon [1,2] is the combined carbon emissions at product and construction stage associated with the creation of the asset, it accords with life cycle stage A using EN 15978 [3]. Operational Carbon is the emissions associated with the operation and maintenance of the asset (EN 15978 stage B) Whole life carbon combines both capital and operational carbon together with any end-of-life carbon (EN 15978 stages C, D). Circularity is where, assets and materials are kept in circulation through repair, maintenance, reuse, refurbishment and recycling for as long as possible.

2 Carbon Footprint

To limit carbon emissions and then reduce them we need to understand where and how much we use now.

2.1 Capital Carbon

Estimates of the carbon footprints of infrastructure [1] bridges [2,4,5] and buildings [6] are well documented. In Figure 1 below, the total capital carbon of transport infrastructure is plotted versus the total asset length (data plotted on log-log axis to allow the full range of the data to be viewed). The trend shows an increased carbon with asset

https://doi.org/10.2749/manchester.2024.0133
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