# Impact of Use Phase in Pavement Life Cycle Assessment: A Case Study of Alternative Designs in Different Contexts

## PROBLEM

Life cycle assessment (LCA) has been introduced to the pavement industry for the past decade, but it has not been widely used. One of the important challenges has been quantifying the impacts of various components in the use phase such as pavement-vehicle interaction (PVI), albedo, etc., and how these components affect the overall results. Understanding the role of use phase and its components under different contexts is crucial to the interpretation of LCA results.

## APPROACH

A comparative LCA has been conducted using functionally equivalent pavement designs across a wide range of contexts (i.e., locations and traffic levels). Two examples from this study are presented here that include alternative designs made from asphalt concrete (AC) and portland cement concrete (PCC) for two different contexts: an Arizona state highway and an Arizona interstate highway. The life cycle model includes construction (both the impact of raw material production and pavement construction), use (excess fuel consumption from PVI, carbonation, lighting, but not albedo), maintenance and rehabilitation (M&R – both materials and construction effects), and end-of-life (demolishing pavements in preparation for complete reconstruction).

## FINDINGS

Fig. 1 presents the results of the analysis in terms of global warming potential (GWP) as the life cycle impact on the environment by different phases. In the case of the Arizona state highway, initial construction for the PCC pavement is the biggest contributor to the total impact while M&R is only a minor contributor. For the AC pavement, initial construction, use, and M&R each contribute about one-third to the total life cycle impact. In the interstate highway case, as traffic level increases, use phase impact for both asphalt and concrete pavement increases greatly, and its contribution to the overall performance becomes as important as initial construction impact. These results suggest that traffic volume is the key driver for use phase impact for the interstate highway. This is due to the fact that excess fuel consumption from PVI is directly proportional to traffic levels. It is also evident that apart from the differences in initial construction and M&R between the two alternatives, the difference in use phase could potentially drive the difference between the total life cycle impacts of the asphalt and concrete designs, depending on the context.

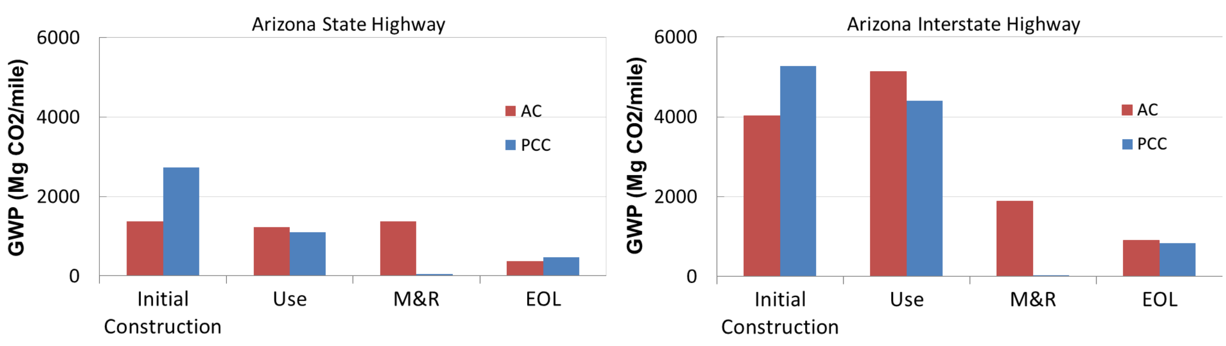


Fig. 1: Life cycle impact by different phases in terms of global warming potential (GWP) under two contexts: Arizona state highway (left) and interstate highway (right).

## IMPACT

The use phase plays a significant role in a pavement's life cycle environmental impact. For both cases shown here it accounts for over 25% of the total GWP. However, its contribution depends upon the specific context: for lower traffic volume applications it has lower impacts, and for higher volumes it has higher impact.

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