Introducing the Athena Impact Estimator for Highways

An LCA-based software package that measures the environmental impact of Canadian regional roadway designs.

The Athena team, with support from Environment Canada, the Cement Association of Canada and Morrison Hershfield Transportation engineers, has developed a user-friendly LCA tool for transportation engineers and roadway designers, which is now available for “free” on our website. This tool will meet a new and growing demand for infrastructure sustainability.

The Athena Impact Estimator for Highways provides life cycle assessment (LCA) results for the materials manufacturing, roadway construction, use and rehabilitation life cycle stages. It allows custom roadway design, or users can draw from a library of 50 existing designs. With a large materials database and the flexibility to specify unique pavements, the software allows for quick and easy comparison of multiple alternative design options.

The Impact Estimator for Highways software supports nine regional locations from Vancouver to Nova Scotia and can model a host of road types from arterial streets to multi-lane highways.

Moreover, it is the first commercial software capable of modeling pavement vehicle interactions (PVI), so designers can optionally consider roadway roughness and deflection on predicted traffic fuel consumption.

How it works

The Athena Impact Estimator for Highways is an LCA-based software package that makes life cycle assessment data easily accessible to roadway decision-makers. Built using the same methodology as the well-established Impact Estimator for Buildings, it provides a life cycle inventory profile for a given three-dimensional roadway design. The inventory results comprise the flows from and to nature: energy and raw material flows, plus emissions to air, water and land. The software reports life cycle impact assessment results by activity stage and enables easy comparison of different design options. The purpose of the software is to enable decision-makers to bring environmental effects to bear.

Inputs. Users quickly describe roadway construction and rehabilitation parameters through a few easy input screens (base, sub-base and surface pavement), and can then view results a variety of ways. In the background lie several large databases on materials, energy, equipment and transportation, sourced from the Athena Institute, the US LCI Database, and others. Material data represent national or industry averages for the extraction, processing and manufacturing of each material. Regional energy grids and transportation distances are applied to the average data to arrive at regional data profiles. Roadway lifespan is variable and dictates rehabilitation events such as scheduled resurfacing. Results are reported on a gross roadway surface area basis.

Results. The Impact Estimator for Highways reports footprint data for the following environmental impact measures consistent with the US EPA TRACI methodology: global warming potential, acidification potential, human health respiratory effects potential, ozone depletion potential, smog potential, and eutrophication potential.

The software also reports fossil fuel consumption and presents a Bill of Materials report that sums up the totals of each material in the user’s roadway design. Operating energy can be included in the LCA if the user inputs an estimate for annual operating energy consumption by fuel type. Similarly, PVI effects can be estimated by entering roadway roughness and deflection modulus values between major roadway rehabilitations. The software will calculate total energy, including pre-combustion energy (the energy used to extract, refine and deliver energy) and the related emissions to air, water and land over the life cycle of the roadway, and can subsequently compare the life cycle operating and embodied energy and other environmental effects of various design options, allowing the user to better understand trade-offs. The software takes into account the environmental impacts of the following life cycle stages, including related transportation: material manufacturing, including resource extraction and recycled content; on-site construction; use phase (with or without PVI effects) and maintenance and replacement effects. Demolition and disposal are excluded, as highways typically have very long service lives.