Ecological Analysis of Material Selection for a Bridge

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Summary

This paper presents a relatively simple, practical method for the analysis of environmental impacts of bridge material selection. Choosing construction materials for a bridge – e.g. steel, concrete, timber, aluminium, composite – is not only an economical, functional or esthetical issue. It also affects the environment. The following discussion concerns the way to quantify environmental impacts in comparable terms – and to assess possible material choices respectively.

Keywords: Ecological analysis, material selection, bridge material, environment, pollutants, water pollution, air pollution, energy consumption, LCA.

Ecological choice

Environmental (or "ecological") consideration to the choice of construction material is an issue of growing importance in engineering. In the Netherlands, the government responds to this issue by promoting materials and technologies which reduce the environmental impact of both public and private projects. However, an assessment of this impact is complex, especially in regard to complex construction projects, like bridges. The existing methods, e.g. LCA (life-cycle analysis), require an extensive data input. These data are sometimes disputable or even not known at the early stage of projects, when the materials are usually selected.

Therefore a relatively simple ecological material analysis for a bridge is presented. The method of this analysis was originally developed to evaluate a number of material options for a footbridge in the Noordland inner harbour in the Dutch province of Zeeland. The evaluation was performed along with the costs and service life analyses. In this particular case, the analysis resulted in an advice to construct a bridge of FGRP profiles (Fig. 1).

Fig. 1: Footbridge in the Noordland inner harbour

The customer followed this advice and the bridge was put into service in 2001. It performs very well since then confirming the results of the ecological analysis. In particular, its maintenance requirements are very low, which results in insignificant pollutions to air and water. This was a precarious matter, as the bridge is exposed to direct contact with sea water.

The results of such "eco-analyses" can, however, be different for other structures or at other locations.

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Energy consumption

The performed ecological analysis referred to the entire life cycle of the bridge and was focused on the three following indicators:

- Total energy consumption
- Total loads to air
- Total loads to water

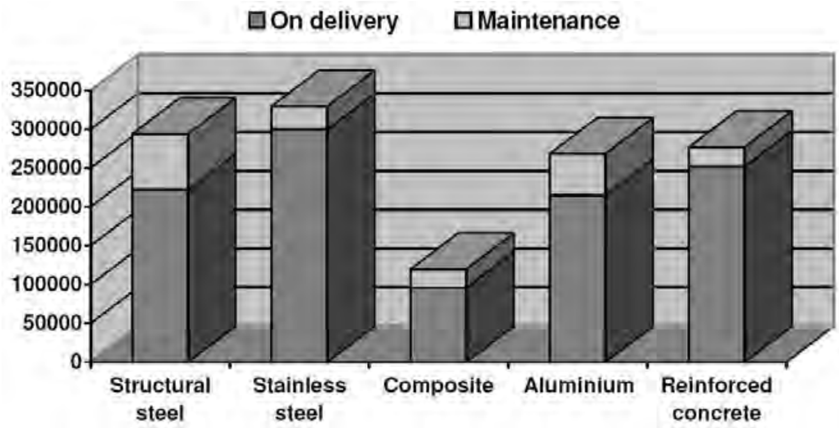
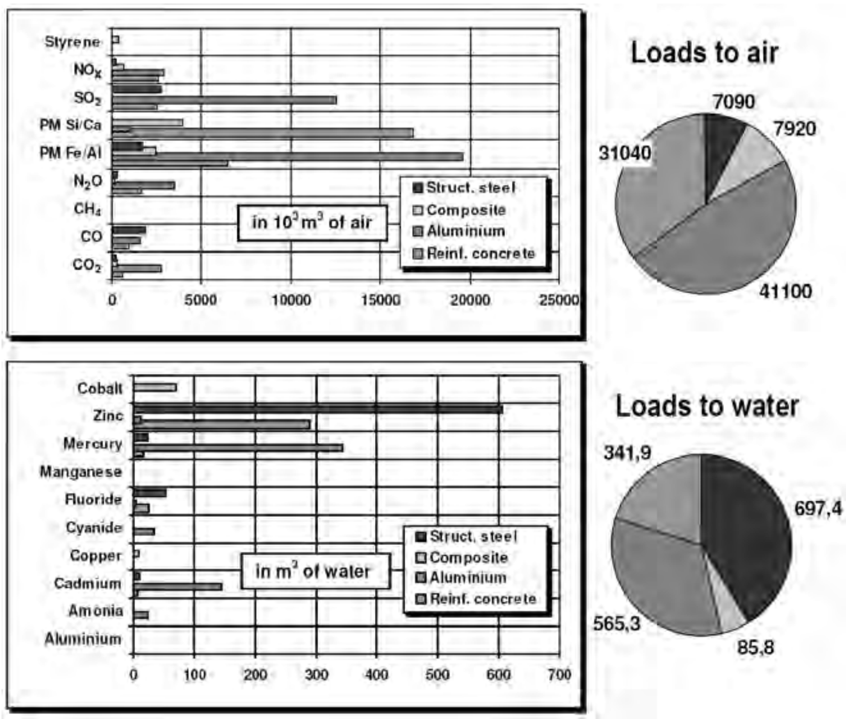


Fig. 2 shows the total energy consumption as result of five different material choices for the footbridge. Considered are energy values on delivery and due to 50 years of maintenance. One deck exchange has been foreseen due to deterioration or mechanical damage. Composite bridge proved energy-saving; stainless steel bridge dropped out of the contest.

Fig. 2: Energy consumption in MJ for five material options

Loads to air and water

In order to compare loads to air and water as result of the remaining four material options, a method was developed that enables superposing qualitatively different loads. That method is discussed in the full paper. Fig. 3 compares the resulting loads in the specified and in the total values.



These loads are expressed in volumes of, respectively air and water polluted up to the legal thresholds, i.e. pollution limits set by low. The method makes, therefore, use of the existing legislation, which makes it both:

- impartial, as there is no place for arbitrary judgments;
- reliable, as it is supported by the authority of low.

These two properties are very significant because environment is a "hot issue", vulnerable to the changing political and social trends. Moreover, the available pollution data are not quite free of arbitrariness. The full paper has more comments on this.

Fig. 3: Loads to air and water from 4 bridge material options

Conclusion

The call for sustainable environment presents a growing challenge to engineers. It is time to free our discussions about it from emotions and arbitrary judgments; and to introduce workable assessment methods for construction projects. This paper is a contribution on the way towards that goal.