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Sustainability assessment of road marking systems

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Abstract

Environmental issues are becoming increasingly important in the domestic, business and public sectors. Due to population growth and growing number of megacities, Green Public Procurements concepts is also becoming an increasing trend in the road infrastructure sector.

This study assessed the environmental impacts of road markings considering the whole life cycle from manufacturing to disposal. For the correctness of the study, an external expert panel reviewed the assessment. By using the LCA-Methodology based on DIN ISO 14040 and 14044, an objective comparison of the following line markings was performed: Solvent-borne paint; Water--based paint; Thermoplastic and Thermo Spray Plastic; Cold Plastic and Cold Spray Plastic. Typical material formulations in characteristic application scenarios have been modelled using the data of corresponding official approval test certificates held by a major local manufacturer of all evaluated technologies. Empirical data was used to determine a typical service life of the various road marking systems at a typical average daily traffic of 10,000–15,000 vehicles per day.

The life cycle assessment results, i.e. considering the whole life cycle from manufacturing to disposal, showed that a global warming potential reduction of more than 50% can be achieved by a more durable road marking system.

The study concluded that in order to access the actual environmental impact of road markings, a lifetime evaluation including, for instance, production, application, transport, service life, and disposal must be taken into consideration.

Peer-review under responsibility of Road and Bridge Research Institute (IBDiM)

Keywords: Life Cycle Costs; road marking; cradle to grave; cold plastics; durability

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1. Introduction

Environmental issues are becoming increasingly important in the domestic, business and public sectors. Politicians worldwide are therefore, developing Greenhouse gas emissions reduction targets (EU Action 2015). GPP guidelines implemented by the European Union, for example, are calling for the consideration of environmental aspects based on solid scientific evidence when deciding various product alternatives.

Green Public Procurement (GPP) guidelines recommend that public purchasers consider environmental aspects based on solid scientific evidence when deciding on various product alternatives (GPP 2015). Due to population growth and growing number of megacities, GPP concepts are also becoming an increasing trend in the road infrastructure sector.

For instance, horizontal road markings are widely accepted as the only road safety device in the road infrastructure sector that accompanies drivers throughout their entire journey. Every day millions of road users worldwide benefit from the efficient and indispensable ability of road markings to provide them with guidance and protection.

The selection of materials for road markings is traditionally based on technical requirements, climatic and topographic conditions, traffic density and cost considerations. Environmental aspects might not be considered properly because of the lack of comprehensive environmental impact data for all major road marking systems.

According to ISO 14040, the Life-cycle assessment (LCA), also known as ecological balance, is a scientific tool used to assess the environmental impacts of a product throughout its entire life cycle, from cradle to grave. It aids in process improvement, and supports policies in creating a sound basis for well-founded decisions that involve environmental considerations.

However, lowering environmental impacts ultimately depends on efforts and decisive actions of governments, industries and consumers. The aim of this study is to assess the environmental impacts of the major binder-based road marking systems on the market, in typical formulations and characteristic application scenarios over the entire life cycle. Main focus of the study will be a comparison of spray road marking, and agglomerate road markings application scenarios, attention paid to refreshment of expired road markings.

This assessment takes into consideration all contributions from raw materials, production, application, usage, and disposal or recycling, to all necessary transport, auxiliary and packaging materials.

2. Methodology and scope

The study was conducted in accordance with DIN ISO 14040 and 14044 and reviewed by a panel of external experts. It was geared toward marking practices in Germany as one of the largest national markings market in Europe, where all materials technologies are used in significant amounts. The pavement surface of a typical German federal road bears a moderate average daily traffic of about 10,000–15,000 vehicles and requires renewal approximately every 10 years. Consequently, in this study, the lifecycle of the marking was evaluated for a period of 10 years.

The four major binder-based marking systems assessed were Solvent-borne (SB) paint; Water-based (WB) paint; Thermoplastic (TP) and Thermo Spray Plastic (TSP); MMA (Methyl Methacrylate) Cold Plastic (CP) and MMA (Methyl Methacrylate) Cold Spray Plastic (CSP) also referred to as MMA (Methyl Methacrylate). The road marking systems consisted of marking material and drop-on material. The following environmental impact categories were analyzed considering a one-kilometer marked road, using the CML method [CML 2001] of the Institute of Environmental Sciences (CML) of Leiden University with the updated characterization factors from November 2009:

- Global warming potential (GWP100) [kg CO_2-equiv.]
- Acidification potential (AP) [kg SO_2-equiv.]
- Eutrophication potential (EP) [kg phosphate-equiv.]
- Photochemical ozone creation potential (POCP) [kg ethene-equiv.]
- Human toxicity potential (HTP) [kg DCB-equiv.]
- Terrestric ecotoxicity potential (TETP) [kg DCB-equiv.]