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DIGITALIZATION OF EPDs FOR ASPHALT – EXPERIENCE FROM SWEDEN AND INPUT FROM NORWAY

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Abstract

There is a major socioeconomic challenge in converting current construction processes into more climate-neutral and cost-effective processes based on an entire life-cycle perspective so that the high-level European climate policy goals can be achieved. Different actors, clients, contractors, asphalt manufacturers need a clear guidance to be able to make smarter choices during procurement, technical design, optimization of pavement production processes etc., in order to meet increasing demands for measurement, reporting and reduction of carbon emissions from asphalt pavements. An industry-joint project has been conducted with the aim of reaching consensus among Swedish asphalt manufacturers, clients, entrepreneurs and raw material manufacturers about how an Environmental Product Declaration (EPD) should be used as a certificate of environmental performance for asphalt pavements in Sweden. Since the development of an EPD is costly and resource-intensive requiring expert knowledge, the experience from Norwegian asphalt industry in the creation of a digital solution for the development of EPDs for asphalt pavements has been evaluated. The project has found out that Swedish asphalt manufacturers show a great interest in use of EPDs, but that Swedish clients in the construction industry do not have a uniform requirement for calculation, reporting, optimization and follow-up of the climate impact. This complicates the transition to a more climate-neutral process for Swedish asphalt manufacture. In Norway, the asphalt industry has established a practice for technical design and procurements towards using EPDs as certificate for the environmental impact of asphalt pavements.

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1. Introduction

1.1 Background

In the European Union, including Sweden, there is a tendency for standards and regulations to be created with the aim of reducing the climate impact of products. The effect of these standards in actually reducing the climate impact of road pavements is unknown and it is not verifiable and confirmed with laboratory or field tests. Existing standards for developing an EPD leave some freedom and the comparison between different EPDs, as well as between different asphalt manufacturers, becomes unreliable if different actors use different conditions for the calculations required. The need for correctly made comparisons is increasing, especially in connection with new types of climate-neutral fuels, machines and materials, so that sub-optimizations and oblique competition do not arise at various stages in the construction process: in early planning, procurement, detail planning, production, operation, maintenance and recycling.

In the Nordic market and during recent years, the number of environmental product declarations (EPDs) for building materials has increased. EPD International, originating in Sweden, is a global EPD operator for EPDs and is operated by EPD International [1]. In the EPD International database, there are today 525 EPDs for building materials, building products or components and 11 EPDs for buildings and engineering works. Norway has its own EPD operator, EPD Norway, which has currently published 437 EPDs for construction products [2]. An asphalt manufacturer is free to choose program operator for the publication of an EPD, and at present there are EPDs from Swedish suppliers published by both EPD International and EPD Norway, and also by the German counterpart, IBU EPD [3].

There are different purposes of EPDs in the industry. The branch associations can develop a generic or industry-average EPD for a particular product type. This type of EPD is most common on the Nordic market. Product specific EPDs are often produced by material manufacturers. The asphalt industry is driven to develop climate- and energy efficient manufacturing processes and products. Internally, a product specific EPD can be used either to optimize and follow-up the environmental impact of the manufacturing processes or as a basis for investment decisions in more modern equipment. The development of a product specific EPD is a comprehensive, time-consuming and costly task where external expertise is needed.

The product specific EPDs are currently limited to the assessment of environmental impact only for the production phase of asphalt pavements. There is a risk of sub-optimization and unfair competition if comparison is made without regard to the whole life cycle perspective when choosing the best environmentally adapted alternative for an asphalt pavement. The use of EPDs in order to obtain quantitative information on the environmental impact of the use phase, the repair and maintenance work and the final demolition phase are not yet a practice when comparing alternative pavements within a given procurement requirement or design process. Evaluation of the environmental impact from those phases within an EPD requires creation of product specific life cycle scenarios. These scenarios should reflect the actual technical performance of the pavement according to the national technical design standards verified by laboratory tests and observations. The lack of these data prevents a wider use of EPDs as a certificate of environmental performance in infrastructure projects in Sweden.

In Norway, the asphalt producers have agreed on main life cycle scenarios for frequently used pavements and this has opened new business opportunities for using EPDs in public and private procurement and the optimization of the Norwegian asphalt production process. In Norway, the asphalt industry has developed a web-based digital tool for creating EPDs for asphalt, an EPD-generator [4]. The Norwegian EPD-generator is owned by Norwegian Contractors Association (EBA) and can be used by asphalt manufacturers who are members of this organization [5]. This tool lowers the cost of developing product specific EPDs.

In Sweden, the Excel based LCA tool (EKA) [6], is used, which has a clear focus on Life Cycle Assessment (LCA) for the construction of asphalt roads. EKA stands for Energy and Carbon Dioxide in Asphalt Production. The tool makes LCA calculations possible for the entire chain in asphalt manufacture - from input of material to the finished asphalt road. At present, EKA is used by all asphalt manufacturers in Sweden in order to be able to choose the most climate-optimized asphalt for a specific infrastructure project.

1.2 Objective and scope

The project objective is to achieve a common definition of how the Swedish asphalt industry shall measure and report the climate and environmental impact of asphalt pavements with EPDs.

The scope of the project is to map actions needed for this to happen and whether there are several different options for digitalizing an industry-wide method of making EPDs for asphalt pavements in Sweden.

1.3 Methods of this study

Workshop about the EPDs was initially organized with representatives from the Swedish and Norwegian asphalt industries, to discuss the current situation and future vision of EPDs for asphalt pavements in Sweden and Scandinavia, and to define a comprehensive status of the industry's needs, challenges and opportunities with EPDs.

In addition to the workshop, knowledge has been acquired from a literature survey and interviews. Several Norwegian and Swedish organizations participated in interviews that took place within the project: the Swedish Transport Administration, Nordic Construction Company (NCC), EPD Norway, EPD International, LCA.no and EBA. The interviews were conducted in a semi-structured way with prepared questions designed to promote discussion and new follow-up questions.

The adaptation of the EPD standard regarding calculation rules for assessment of the environmental impact of asphalt pavements was charted in Sweden and Norway. A comprehensive analysis of technical performance dimensioning standards and procurement models with EPDs was conducted in both Sweden and Norway. Two LCA tools for calculation of the environmental impact of asphalt pavements, currently used in the procurements, were analysed.

2. Methodology

The development of an EPD is based on a set of standards and regulations, from basic standards on environmental management systems, ISO 14001 [7] and the standard series for life cycle analysis ISO 14040 [8] and ISO 14044 [9], to more specific EPD standards ISO 14025 [10], EN 15804 [11] and product specific calculation rules (PCR) [12,13,14,15]. Figure 1 summarizes relevant standards for the development of an EPD.

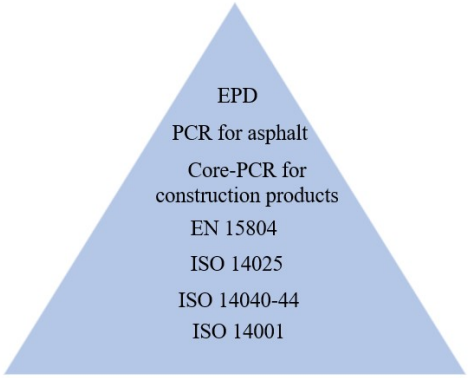

Figure 1: Standards for the evaluation and communication of environmental impact for building products.

To be able to develop an EPD for a product, a PCR is required, where the definition of an LCA, for this product group is summarized. The LCA gives measurement values that, numerically, describe the total environmental impact during a product's life cycle.

The Framework Standard, EN 15804, lays the foundation for all PCRs and EPDs for building products and sets principles regarding system boundaries, reported environmental impact categories etc. Thus, EPDs for building materials can serve as components of an EPD for an entire building or engineering work, such as a road or a bridge. According to EN 15804, there is a minimum requirement for an EPD to include the environmental impact from raw material extraction to the factory gate ("cradle-to-gate"), which in the Standard is referred to as module A1-A3, see Figure 2.

A PCR is produced by an expert group and must be approved by an EPD operator, such as EPD Norway [2] or EPD International [1]. In addition, the General Program Instructions (GPI) of the EPD must be followed when an EPD is being developed. ISO 14025 regulates the program operator, i.e. the organization that ensures the verification and publication of EPDs in accordance with the PCR, that apply to the product in question.

In addition to the requirements of the EPD operators, industry-wide requirements, e.g. from clients, manufacturers, contractors in the form of industry-wide scenarios for the use phase, the demolition and recycling can be put into a PCR. However, this requires industry-wide consensus on the scenarios.

Within the EPD system there are different types of PCRs. There are general, core PCRs, e.g. PCRs for all construction products [12, 13]. There are product specific PCRs, for example for asphalt [14, 15]. Both EPD Norway and EPD International have their own core PCRs for construction products and PCRs for asphalt. The asphalt PCR from Swedish based EPD International [15] aims to be used by companies throughout Europe. This PCR for asphalt is an independent

PCR according to EN 15804. The asphalt PCR from EPD Norway [14] is adapted to industry-wide scenarios for handling asphalt pavements in Norway. This is a sub-PCR underlying the core PCR for construction products [13] and EN 15804.

Work has started in the standardization committee, working group CEN / TC 227 / WG6, on the development of a harmonized PCR for asphalt. This PCR will apply to all EPD operators in Europe. The aim is to create a guide to facilitate a common approach within Europe on how to develop an EPD for asphalt [16].

3. Results

3.1 Analysing methods and tools in Sweden and Norway

The Swedish Transport Administration's EKA tool [6] and the Norwegian EPD-generator [4] have been evaluated to determine whether they can be used to make digital EPDs for asphalt in Sweden. The project has evaluated two existing PCRs for developing EPDs for asphalt, PCR from EPD Norway [14] and PCR from EPD International [15].

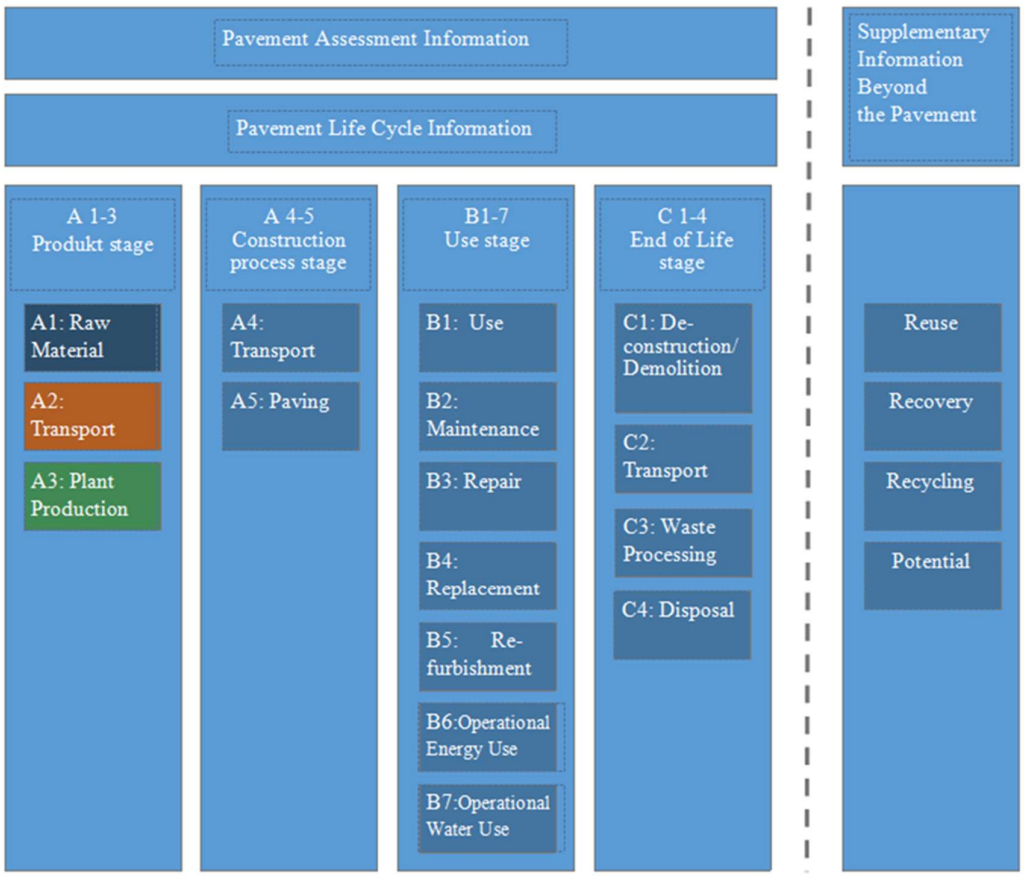

Figure 2: The environmental impact of asphalt is divided into several life cycle stages or modules according to EN 15804.

3.1.1 Comparison of PCRs

Calculation principles for the compulsory modules A1-A3 are identical in these two PCR documents. In the Norwegian PCR, there are specific scenarios for other modules based on Norwegian technical design standards [17] and procurement procedures, and those are not necessarily applicable in other countries. The Norwegian PCR has been developed through industry-wide consensus on how environmental impact should be calculated, reported and used in comparisons. The various calculation scenarios for modules B and C have been developed based on the life expectancy of the most common Norwegian asphalt pavements. A broad industry-wide effort to develop the Norwegian PCR has created clear practical guidelines that enable asphalt manufacturers to reduce the climate impact.

The PCR from EPD International has an international character and is not adapted to specific national conditions. This PCR does not take into account Swedish national design standards for asphalt pavements [18]. There is a greater degree

of freedom in the EPD International PCR when applied to the development of a product specific EPD for a certain country.

Neither EPD International or EPD Norway's PCR take into account modules B5-B7, as they are not considered to be relevant for asphalt pavements. The EPDs developed based on these separate PCRs are comparable only for modules A1-A3, which is the production phase of an asphalt. It is expected that the standard being developed by CEN / TC 227 / WG6 will create further comparability for all life cycle stages of asphalt pavements. Before that, clear conditions must be developed that create comparability for EPDs with the system boundaries in addition to modules A1-A3. A more detailed comparison of these two PCRs is given in the project report [19].

3.1.2 Comparison of LCA tools

The Swedish Transport Administration is developing and managing a tool for calculating emissions of CO_2-eq and energy use from various processes in asphalt production, the EKA tool [20]. The EKA tool enables LCA calculations of the entire chain in asphalt manufacture - from input of material to the finished road. A calculation model has been developed for estimating carbon dioxide emissions and energy consumption from components, machines, manufacturing processes and the asphalt paving. Calculation results in EKA provide a good overview of factors that affect energy consumption and emissions of CO_2-eq and thus make it possible to identify improvement areas. Unit for comparison is CO_2-eq and kWh per tonne or per m^2 of asphalt pavement.

The current version of EKA cannot be verified as an EPD tool for asphalt, as it does not meet the requirements of EN 15804 or any of the analysed PCRs. Calculation in the EPD format requires that all modules and the environmental impact categories, such as acidification, eutrophication, etc. are calculated in accordance with EN 15804. Also, documentation and quality of the emission factors used and the LCA method used do not meet the verification requirements.

A Norwegian digital EPD-generator has been developed to support the development of EPDs regardless of whether or not individual asphalt manufacturers have access to EPD expertise in Norway [5]. The tool allows development of EPDs both per asphalt plant and per asphalt pavement. This is done by selecting different functional units, in accordance with the asphalt PCR from EPD Norway. The Norwegian EPD-generator is a web-based solution where different actors, with different roles, are responsible for different work tasks when developing an EPD.

In Norway, three industry-wide EPDs for the most common asphalt pavements have been developed based on the National Road Administration's technical regulations on permitted asphalt pavements [17]. This tool makes it possible to develop EPDs for the different asphalt pavements most common in Norway, but only for module A1-A3 (the production of an asphalt mixture). These declarations are "cradle-to-gate" EPDs and are used as a kind of parent EPD in the preparation of company- or product specific EPDs. Asphalt manufacturers can create more specific and project unique EPDs, but only with the parent EPDs as a basis. If a deviation far too large occurs in a new EPD, it must be approved by EPD Norway [21]. EPDs which are developed in the Norwegian EPD-generator according to the Norwegian PCR can be double-registered within EPD International for an additional one-time fee. The same applies to the EPDs produced according to the PCRs of EPD International.

3.2 Potential for the development of a digital EPD tool in Sweden

Based on the analysis of published sources and interviews with company LCA.no, which develops the Norwegian EPD-generator, it should be fairly easy to adapt the LCA model in their tool to Swedish conditions [22]. EBA has paid for the development of the EPD-generator for Norwegian conditions, and the cost of adapting the generator to Swedish conditions should be moderate. All large and small Nordic asphalt manufacturers, i.e. those who manufacture asphalt in both Sweden and Norway, can use the Norwegian EPD-generator if they are members of EBA.

The EPD-generator is currently only adapted to EPD Norway's PCR, but it is desirable to publish Swedish EPDs within EPD International and this means that a major customization job must be done, and that the EPD-generator must be verified by the Swedish EPD operator. EPD Norway and EPD International have a mutual recognition agreement, which should mean that the adaptation becomes a less demanding job. Pre-verification of the Norwegian EPD-generator by EPD International means that calculations in the tool must be harmonized with EPD International´s PCR for asphalt. In an interview with EPD International, they stated that they do not foresee major problems in verifying calculations for module A1-A3 in the current version of the Norwegian EPD-generator, since the calculation rules in both PCRs are the same for this part of the life cycle [23]. EPD International pointed out that the introduction of common European requirements for the remainder of the life cycle will be ensured by the forthcoming standard from CEN / TC 227 / WG6.

In Sweden, there is a well-established process for the performance design of asphalt pavements, which should be integrated with the climate optimization work. The EKA tool is already being used as an industry-wide tool for calculating the climate impact of asphalt. The project has identified that the existing information in EKA about Swedish asphalt types is a main building block of a future digital EPD tool for asphalt. However, some of the desired functionality of EKA may already exist in the Norwegian EPD-generator or it may be developed. The Norwegian

asphalt EPD-generator is designed to include all the modules and the environmental impact categories defined by EN 15804. In an interview with LCA.no, they state that if the Swedish industry wants more modules, e.g. scenarios for the use phase (B module), data for this can also be developed. If a Swedish asphalt manufacturer already has produced EPDs with specific datasets, it is possible to add them to the EPD-generator.

3.3 Harmonised terminology

EPD standards are in place but are not fully used by Swedish clients. The significance of the current procurement requirement for "an EPD according to EN 15804" can be very broad. In the examples of project requirements that this study has evaluated [24, 25, 26, 27], the system boundaries of EPDs for asphalt are not clearly formulated. The project has identified a need to create a common terminology for working with EPDs in the Swedish asphalt industry, in the Swedish Transport Administration's procurement requirements and in the EKA tool.

The EPD system is designed for estimating the environmental impact of a product. The system is not yet adapted to be used at a road project level. The environmental impact of an asphalt product can be securely calculated and verified by using product specific data on raw materials amount, energy use and emissions by an asphalt manufacturer. The project has proposed that comparisons of different environmental performance with EPDs should initially be limited to the same asphalt mix type from different manufacturers for the production phase (module A1-A3) of asphalt in Sweden.

The use of EPDs for comparing environmental performance between alternative asphalt pavements requires more detailed knowledge of service life scenarios, maintenance etc. The potential environmental impact of the entire life cycle of a road project is not verifiable now. The project has proposed to require an EPD, depending on whether it is an “EPD for asphalt”, an “EPD for a road project” or an “EPD for a road project with additions”, see Table 1. It is important that clients specify their requirements regarding the modules A4-D. If modules A4-D should be included in an EPD, the industry needs a clear guideline for generic scenarios for an “EPD for a road project” (A4-A5), “EPD for a road project with additions, type I” (A4-B7) and “EPD for a road project with addition, type II” (A4-C4).

It is expected that the standard being developed by CEN / TC 227 / WG6 will define these generic scenarios for modules A4-D as a common ground for further comparability for all life cycle stages of asphalt pavements. Before that, scenarios for A4-D can be defined by the client for each large road project based on the project's conditions. This will create a reference for comparison of alternative solutions for a road project.

Table 1: Designations of different EPDs based on the life cycle stages included.

<table>
<tr><th>A1</th><th>A2</th><th>A3</th><th>A4</th><th>A5</th><th>B1-B7</th><th>C1-C4</th><th>D</th></tr>
<tr><td colspan="3">EPD for asphalt</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">EPD for a road project</td><td></td><td></td><td></td></tr>
<tr><td colspan="6">EPD for a road project with additions, type I. This type of EPD should be limited to the large infrastructure projects with the purpose of comparing alternative road structures with regard to the environmental impact of future maintenance and repair.</td><td></td><td></td></tr>
<tr><td colspan="7">EPD for a road project with addition, type II. This type of EPD should be limited to the large infrastructure projects with the purpose of comparing alternative road structures with regard to the environmental impact of the entire life cycle.</td><td></td></tr>
<tr><td colspan="7"></td><td>Reuse, recovery, recycling potential.</td></tr>
</table>

4. Conclusions

The study has shown that Swedish clients in the construction industry currently have no uniform requirements regarding calculation, reporting, optimization and follow-up of the actual environmental impact of asphalt pavements. This makes the transition to a more climate-neutral process in Swedish asphalt manufacturing more difficult. In Norway, the established practice for technical and functional sizing has been linked to customer requirements and the industry joint PCR and the EPD-generator for asphalt. The main conclusion is that the environmental assessment with EPDs should be integrated with the Swedish national asphalt pavement design standards and the national client’s procurement requirements.

Common Swedish public customers such as the Swedish Transport Administration [27], the Stockholm County Council [28, 29] and Swedish municipalities [24, 25, 26] have already created advanced procurement requirements and follow-up systems regarding the climate impact of asphalt pavements. There is still a great potential to adapt the PCR and the EPDs more clearly with these customer requirements in Sweden. The project has shown that the Swedish asphalt industry is mature in working with EPDs following the module A1-A3, namely the part of the life-cycle that

manufacturers can influence and verify. Applying an EPD to make comparison of different road project alternatives, it is crucial to develop the industry joint scenarios for A4-D.

The project's result is intended to contribute to an increased knowledge of the EPD system in general, but the focus is on EPDs for asphalt in Sweden. The results can be used by the asphalt industry as a description of the current situation for work on digitalization of EPDs for asphalt pavements. The project has mapped actions needed and whether there can be several different options for digitalizing an industry-wide method of making EPDs for asphalt pavements in Sweden. The report should be seen as a first cornerstone for future work, as the developed description of the current situation should be supplemented and adapted based on future international standards, new experiences of EPD use in the building and engineering work projects, and future legislation in the European Union and in Sweden.

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