Smart Transportation Alliance

ENVIRONMENTAL IMPACT OF VEHICLE RESTRAINT SYSTEMS

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1. Introduction

Climate change is nowadays considered as the most devastating environmental threat of our time. Several scientific studies are clearly identified in human activities the main cause of the global warming, through lifestyles, consumption and choices that pollute and exploit resources in an unsustainable manner.

The increased awareness on climate change and the urgent need of reducing greenhouse gases emissions have pushed worldwide Institutions to take severe counter-measures. The Kyoto protocol in 1997 (ratification in 2005) and the Paris agreement signed in 2016 represent the two most important examples of Nations pledge to reduce emissions.

Market is becoming more and more affected by these arrangements: demands for sustainable and eco-friendly products are growing (ex. Green Public Procurement).

Standardization committees have worked in drafting international standards for the assessment of the sustainable use of resources and of the impact of products on the environment. Environmental Product Declarations (EPD®) are the certified sustainable ID-cards of products.

Due to the consumption of large amounts of energy and the production of high levels of CO2 – equivalent emissions, transportation and construction sectors have not been spared by this *sustainability wave*. As a result, it is fundamental to consider environmental impacts when designing new solutions for road infrastructures and for construction of new road networks.

2. What's an EPD®

An EPD® is an independently verified and registered document that communicates transparent information about the life-cycle environmental impact of products. It discloses the full story of a product's environmental impacts including energy use, efficiency, emissions and waste, from raw material procurement, to production, to shipping, to consumption, to disposal at end of life and to recycle/reuse.

EPD®s are a voluntary and transparent declaration of life-cycle environmental impact. They do not act as product ratings: having an EPD® for a product does not imply that the declared product is environmentally superior to alternatives.

EPD® validity is 5 years.

2.1. Regulatory framework

An EPD® is created and verified in accordance with the international standard ISO 14025 "Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures", where it is referred as *type III environmental declaration*.

In Europe, the European Committee for Standardization (CEN TC 350) has published the EN 15804 "Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products", providing core product category rules (PCR) for Type III environmental declarations for any construction product and construction service.

Since 2013, due to the ratification of the European Construction Products Regulation (CPR), construction products will be required to sustainably use natural resources (CPR, (55)). Therefore, EPD® could serve in the future as a basis to measure environmental performances in line with CPR requirements (CPR, (56)).

The use of EPD®s will be spread-out by the promotion of the Green Public Procurement (GPP), "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (COM (2008) 400).

2.2. EPD® process

The process to create an EPD® consists of 5 steps:

i. *Identification or Development of Product Category Rules (PCR) or procedures that govern development of an EPD*: Since an EPD® is based on PCR, first of all the operator shall check if any PCR documents already exist. In case no docs are available, new PCR shall be drafted and approved according to the standard procedure.

ii. *Life-cycle assessment (LCA) performing*: LCA shall be performed according to the relevant standards and the calculation rules in the PCR, considering the whole cradle-to-grave chain.

iii. *EPD® creation*: All the required information is gathered in a unique pdf document.

iv. *Third party verification*: to ensure the reliability of the EPD®, the document is verified by an accredited certification body or recognised institute.

v. *EPD® registration and publication*: once verified in step iv. EPD®s are registered and published online in the EPD database.

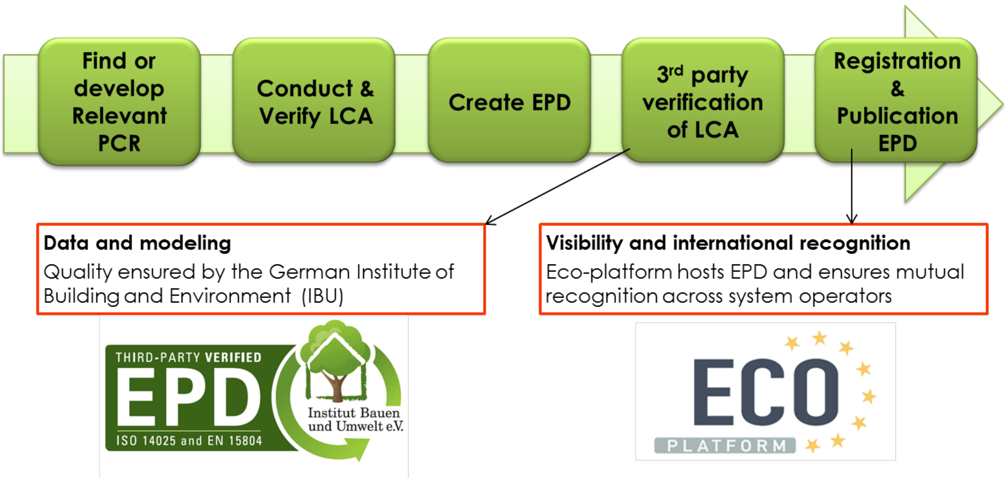


Figure 1: EPD® process

2.3. EPD® at a glance

According to the EN 15804, the life-cycle stages of a product can be subdivided into several modules, each of them defines a specific phase (Figure 2):

- *Module A*:
  - Product stage (ex. raw material extraction and processing, transport to manufacturer, manufacturing).
  - Construction process stage (ex. transport to the building site, installation into the building)
- *Module B*:
  - Use stage (ex. use or application of the installed product, maintenance, repair, replacement, refurbishment, operational energy use, operational water use).
- *Module C*:
  - End-of-life stage (ex. de-construction, demolition, transport to waste processing, waste processing for reuse, recovery and recycling, disposal).
- *Module D*:
  - Benefit and loads beyond the system boundary (reuse, recovery and/or recycling potentials).

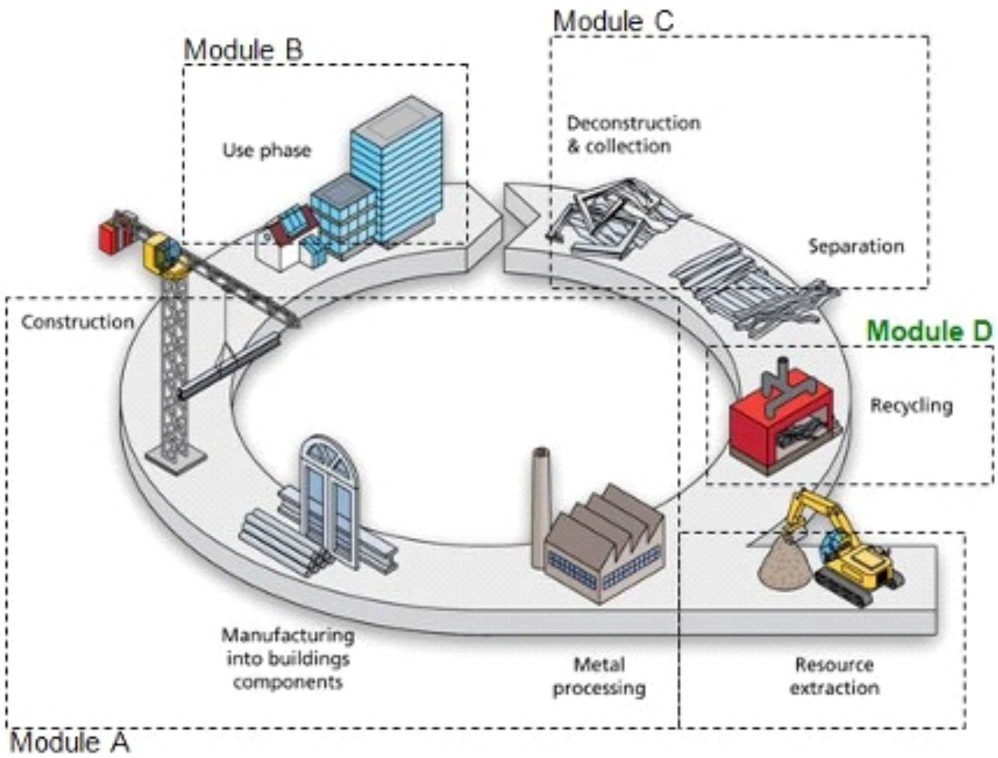


Figure 2: System boundaries

All value reported in the EPD® (Figure 3) are normalized with respect to a functional unit that defines the way in which the identified functions or performance characteristics of the product are quantified. This normalization makes EPD®s available for integration in a complete assessment of construction works, either building or infrastructure.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 running metre of steel road restraint system

Parameter	Unit	A1-A3	C3	D
Global warming potential	[kg CO_2-Eq.]	7.91E+1	6.17E-2	-5.22E+1
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	2.99E-10	2.31E-12	-2.38E-10
Acidification potential of land and water	[kg SO_2-Eq.]	1.42E-1	1.96E-4	-2.00E-1
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	1.49E-2	2.17E-5	-1.57E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	2.58E-2	1.36E-5	-2.88E-2
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	4.10E-4	2.29E-8	4.68E-6
Abiotic depletion potential for fossil resources	[MJ]	6.53E+2	6.85E-1	-4.91E+2

RESULTS OF THE LCA - RESOURCE USE: 1 running metre of steel road restraint system

Parameter	Unit	A1-A3	C3	D
Renewable primary energy as energy carrier	[MJ]	3.82E+1	3.22E-1	2.96E+1
Renewable primary energy resources as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary energy resources	[MJ]	3.82E+1	3.22E-1	2.96E+1
Non-renewable primary energy as energy carrier	[MJ]	6.79E+2	1.04E+0	-4.70E+2
Non-renewable primary energy as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary energy resources	[MJ]	6.79E+2	1.04E+0	-4.70E+2
Use of secondary material	[kg]	7.45E-1	0.00E+0	0.00E+0
Use of renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of non-renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of net fresh water	[m³]	2.86E-1	4.60E-4	-3.01E-2

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 running metre of steel road restraint system

Parameter	Unit	A1-A3	C3	D
Hazardous waste disposed	[kg]	3.71E-6	5.60E-9	-3.53E-7
Non-hazardous waste disposed	[kg]	7.05E-1	3.17E-1	-7.26E-1
Radioactive waste disposed	[kg]	1.06E-2	1.42E-4	8.11E-3
Components for re-use	[kg]	0.00E+0	0.00E+0	0.00E+0
Materials for recycling	[kg]	0.00E+0	3.13E+1	0.00E+0
Materials for energy recovery	[kg]	0.00E+0	0.00E+0	0.00E+0
Exported electrical energy	[MJ]	0.00E+0	0.00E+0	0.00E+0
Exported thermal energy	[MJ]	0.00E+0	0.00E+0	0.00E+0

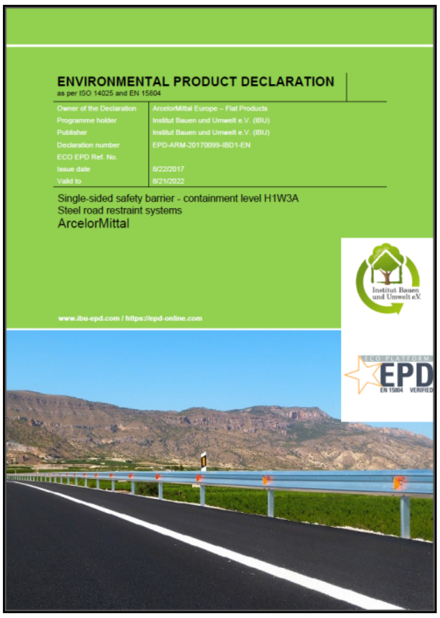
Figure 3: LCA results overview

3. EPD® for vehicle restraint systems

First exchanges on sustainability impact have been started within the CEN Technical Committee TC226 dealing with “Road Equipment”.

Even if for the time being, the Basic requirements of works (BRW) 7 “Sustainable use of natural resources” of the CPR, Annex I, has not yet been implemented by Mandates addressed to CEN, vehicle restraint systems (VRS) manufacturers have started to *think green*. Production processes have been modified and upgraded in order to match better sustainable performance, reducing energy consumption and waste.

Some EPD® for steel construction products has been recently published (Figure 4). The LCA has been evaluated based on modules A, C and D.



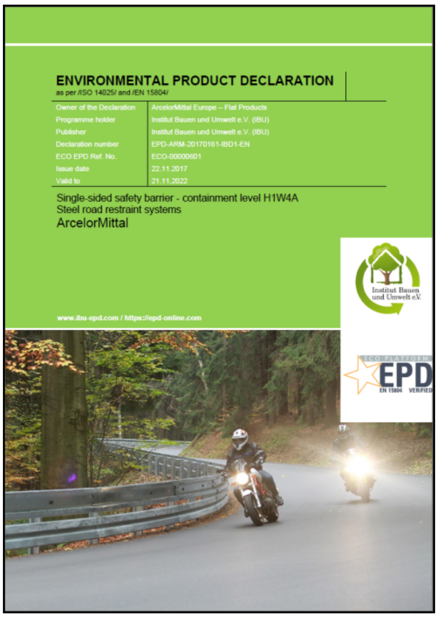


Figure 4: Published EPD®s for VRS

3.1. EPD®s comparison

Environmental reports can be used by operators from public and private sectors to compare construction solutions in the same category and to help selecting the best eco-design solution.

This is possible under certain conditions: functional units and related performances should be equivalent.

To better understand how the comparison can be done, the EPD®s of the following products have been analysed:

- *Road barrier A*:
  - Type of barrier: side barrier
    - Containment Level: H1
    - Working width: W3
    - Impact severity level: A.
  - Steel grade: High Strength Steel
  - Coating: 100% Continuously hot-dip ZM coating (EN10346)

- *Road barrier B*:
  - Type of barrier: side barrier
    - Containment Level: H1
    - Working width: W5
    - Impact severity level: A

- Steel grade: Commodity Steel
- Coating: 11% Continuously hot-dip Z600 coating (EN10346)
  89% Batch-galva (EN1461)

For both products, the LCA values reported in the respective EPD®s refer to the same functional unit of 1 running metre (rm) of safety barrier including foundation.

The same End of Life (EoL) scenario of 99% Recycle/Reuse has also been considered as hypothesis.

The results of the comparison between Road barrier A and Road barrier B are reported in Table 1.

	Weight [kg/m]	GWP* [kg CO2-eq./m]		
		A1-3	D	A1-3+D
Road barrier A	**20.3**	50.7	-33.6	**17.1**
Road barrier B	**24.4**	58.4	-24.4	**34.0**
*Preliminary results				

Table 1: EPD®s comparison results

Innovative steel products as high strength steel grades and ZM coatings represent a strong improvement toward sustainability, contributing to:

- 17% Weight reduction
- 50% GHG reduction

The introduction of High Added Values steel products has led to a new level of innovation in road safety.

Thanks to their better and more controlled mechanical properties, the new grades are replacing commodity grades, enabling manufacturers to design road safety systems, lighter, more performing and more cost-competitive.

Moreover, the durability of road solutions is enhanced by using a new generation of metallic coating based on zinc-aluminium-magnesium alloys. Due to this chemical composition, these new ZM coatings are more environmentally responsible. It has been proved that they ensure the preservation of natural resources as they use significantly less zinc than pure zinc coatings

4. Recycling potential

Recycling stage represents a fundamental parameter for the evaluation of the environmental performance of a product since it can make a considerable contribution to reducing the total environmental impact.

The recycling potential depends on the type of material considered: sometimes the difference between two different materials can be very evident.

Figure 5 shows the comparison of End of Life, includes Reuse - Recovery - Recycling potential, of steel solution vs concrete solution:

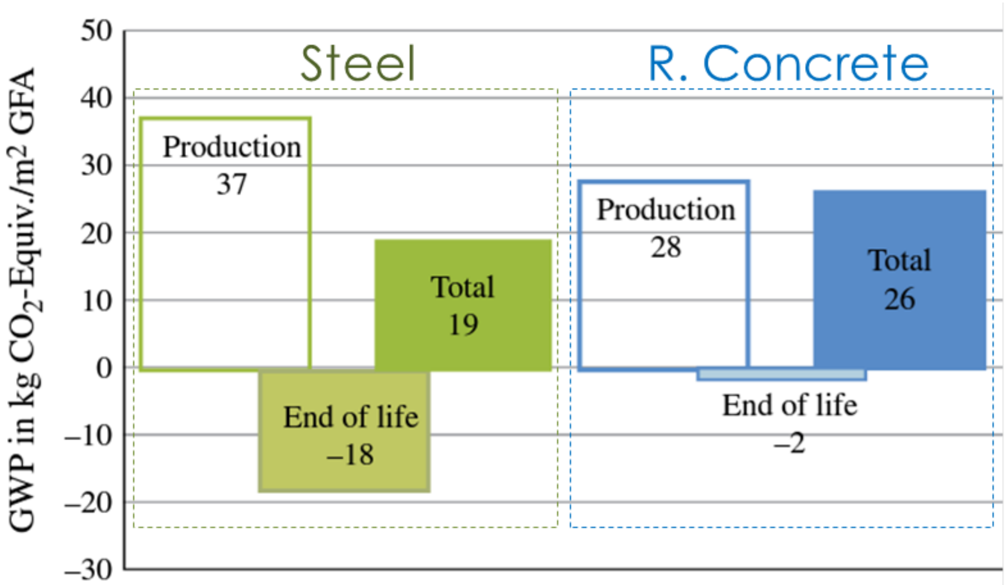


Figure 5: Recycling potential of steel vs concrete

Using steel the Global warming potential is reduced of about 89%.

The main reason of this big gap lies in the capacity of steel of being permanently 100% recyclable: recycled steel products have the same performance than the original ones. In the case of concrete, instead, there is the so called downcycling: concrete is reused as a lower-value product, eg. aggregate or filling material.

5. Conclusions

- EPD®s will enable:
  - Manufacturers to assess the environmental impact of their products;
  - Operators from private and public sectors to compare different solutions for road equipment works from a sustainability perspective.
- Published EPD®s demonstrate that high strength steels and new coatings decrease the use of natural resources and are 99% recyclable (and effectively recycled) at the end-of-life.
- EPD®s are a strong asset in considering benefits of recycling at the end-life as part of the products environmental performance.
- Safety improvements & Sustainability approach are rocking road infrastructure engineering enabling further innovations.

6. Bibliography

- http://unfccc.int/2860.php
- http://unfccc.int/kyoto_protocol/items/2830.php
- http://unfccc.int/paris_agreement/items/9485.php
- https://ec.europa.eu/growth/sectors/construction/product-regulation_en
- http://www.greenbooklive.com/search/scheme.jsp?id=262
- https://www.cen.eu/Pages/default.aspx
- https://www.iso.org/standard/38131.html
- https://www.astm.org/CERTIFICATION/filtrexx40.cgi?-P+PROG+7+cert_detail.frm
- http://ec.europa.eu/environment/gpp/what_en.htm
- http://ec.europa.eu/environment/gpp/pdf/report_gpp_roads.pdf
- To find ArcelorMittal’s EPDs about safety barriers & other construction products: http://constructalia.arcelormittal.com/en/tools/epd