UNIVERSITETET I AGDER

Emnekode : BYG 404
Kandidatnr. : 312
Dato : 12/12-17
Ark nr. : 6 av 6

6. Interpretation and SimaPro

a) EPD: EPDs are typically made by producers of the product that the EPD is about. As they want their own product to seem as good as possible they tend to assume best case senarios. Thereby concluding with ~~smaller~~ less emissions than what might be realistic.

(4)

b) Under "Documentation" info about the product, assumptions that has been made description of product, who has made it and so on is written.

(3)

c) Marked is used when considering the economic marked for product, while transformation is ~~used internally or for comp companies~~ not considering the ~~fer~~ market for given product.

0 x

(7)

Bitumen: $36 \cdot 22{,}91 \cdot 10^3 = 824760$ MJ

Welding: 2000 kWh $\cdot 3{,}6 = 7200$ MJ

~~Total: 824760 + 7200 + 4379957,6 = 5211917,6 MJ~~

Earthwork: $2000\,m^3 \cdot 0{,}2 = 400\,l \rightarrow 400 \cdot 44 = 17600$ MJ

TOTAL: 7987517,6 MJ

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5 Life cycle impact assessment:

a) Characterization: This means calculating the impact of emissions in the environmental impact categories. It is used to show how the emissions effect different parts of the environment and enabeling us to compare them to one another.

More explanation needed

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b) Endpoint indicators for human health determined (climate change impacts):

Endpoint indicator for human health is determined by looking at "DALY" (disability adjustment in life years).

DALY = YLL + YLD, YLL = Years lost life
YLD = Years lived disabled

YLD = w · D, w = weighting between healthy (0) and dead (1)
D = duration of disability

Climate change looks at global warming due to greenhouse gasses (CO_2-eq) which will in a broader perspective affect humans in different parts of the world. Extreme weather, shortage of food and land may follow from this and will affect human health ~~How much it will affect is uncertain, but using a longer time perspective will~~

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→ not exactly, too vague

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b) Material requirements:

Steel Arch: Steel arch: (140m · 0,9m · 1,05m) · 2 = 264,6 m³ 3
Beams: 32(20m · 0,35 · 0,2m) = 44,8 m³ 3

Steel hangers: Hangers: 42(5m · 0,07 m³/m) · 2 = 14,7 m³ · 2 = 29,4 m³ 3
Bolts: 24 · 42 · 0,4kg = 134,4 kg 2

Concrete deck: Recycled steel: 0,12 · (0,65m · 120m · 18m) = 168,48 m³ 3
Concrete: 0,65m · 120m · 18m − 168,48m³ = 1235,52 m³ 3

Bridge foundation: Recycled steel: 0,12 · 1200m³ = 144 m³ 3
Concrete: 1200m³ − 144m³ = 1056 m³ 3

Asphalt/ pedestrian lane: Asphalt Bitumen: 0,07(0,15 · 120 · 18) = 22,68 m³ 3
Gravel: 0,93(0,15 · 120 · 18) = 301,32 m³ 3
Rail: Recycled steel: (18 kg/m · 120m) · 2 = 4344 0kg 1

Reinforcement steel: (264,6 + 44,8) · 8050 = 2490,67 ton
Prestressed steel: 29,4 · 8050 + 134,4 = 236,8 ton
Recycled steel: (168,48 + 144) · 8050 + 43440 = 2558,9 ton
Concrete: (1235,52 + 1056) · 2350 = 5385,07 ton
Bitumen: 22,68 · 1010 = 22,91 ton
Gravel: 301,32 · 2200 = 662,9 ton

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c) Total transport (tkm) required:
Reinforcement steel: 2490,67 · (65 + 4500) = 11397298 tkm
Prestressed steel: 236,8(65 + 4800) = 1152032 tkm
Recycled steel: 2558,9 (450) = 1151505 tkm
Concrete: 5385,07 · 110km = 592357,7 tkm
Bitumen: 22,91 · 200 = 4582 tkm
Gravel: 662,9 · 20 = 13258 tkm

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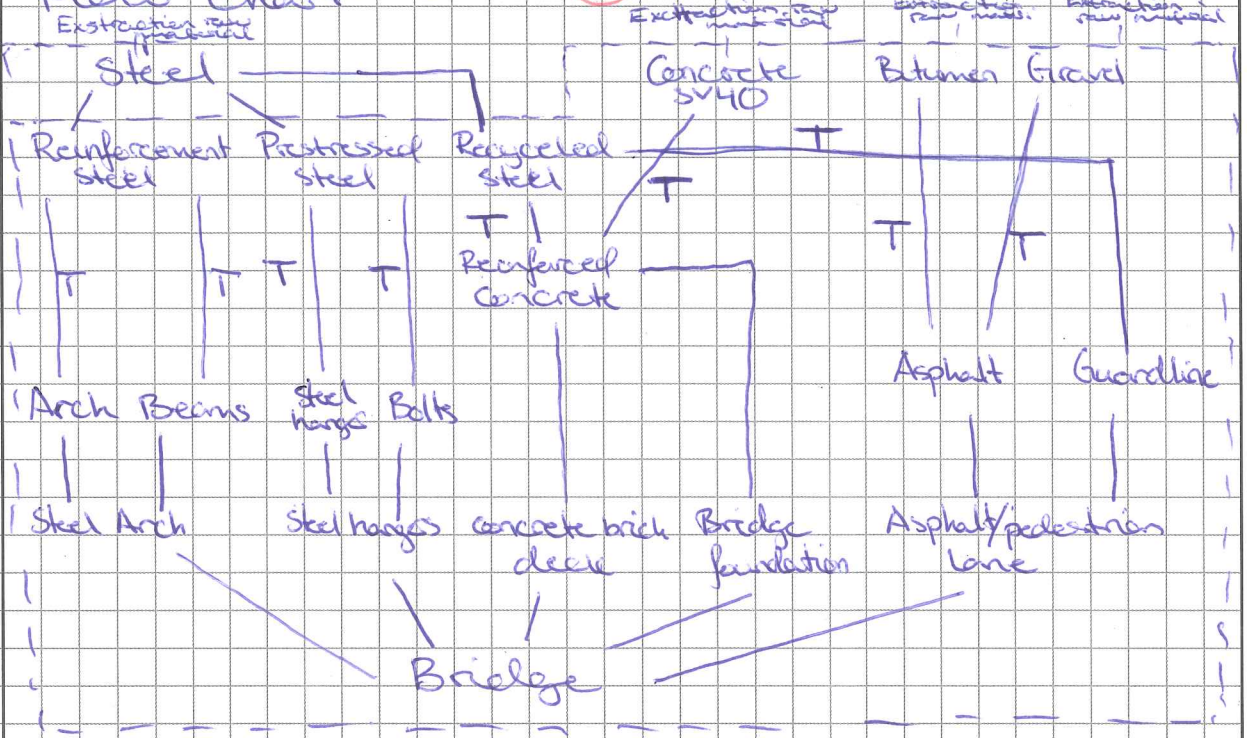
d) How much direct energy is required? (MJ)
Transport: 2490,67 · 65 · 0,02 + 2490,67 · 4500 · 0,01 +
236,8 · 65 · 0,02 + 236,8 · 4800 · 0,01 + 1151505 · 0,02
+ 592357,7 · 0,02 + 4582 · 0,02 + 13258 · 0,02
= 162226,31 Liters

44 · 162226,31 = 7137957,6 MJ

44

4. Inventory analysis (10/10)

a) Flow Chart



Assumptions:

- All steel and concrete are delivered at sight and will be put together there
- Transport of Asphalt from mixing to sight is not considered
- Extraction of raw materials is not considered
- Production of steel is considered to be part of the underlaying groups; Reinforced steel, Prestressed steel and recycled steel.
- Considers only until bridge is constructed Not including life time, or end of life

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3. Allocation and system expansion

a) Economic allocation: kg CO_2 emissions pr unit output

Output	Units	Profit per unit	Total
Fly ash	85 tons	1200 kr/ton	102000 kr
Electricity	35 GJ	200 kr/GJ	7000 kr
Heat	75 GJ	111 kr/GJ	8325 kr
Total			117325 kr

Fly ash = $\frac{102000}{117325} \cdot 15 = 13,04\ CO_2$ ($= \frac{13,04}{85}\ CO_2/ton$)

Electricity $\frac{7000 \cdot 15}{117325} = 0,8946\ CO_2$ ($= \frac{0,8946\ CO_2}{35}/GJ$)

Heat = $\frac{8325 \cdot 15}{117325} = 1,064\ CO_2$ ($= \frac{1,064}{75}\ CO_2/GJ$)

~~Fly ash CO_2 per ton = 0,15 ton~~

Ton CO_2 pr ton fly ash = 0,15

Ton CO_2 pr GJ electricity = 0,03

Ton CO_2 pr GJ heat = 0,014

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b) ~~Your reasoning behind mass allocation~~

You can't use any other type of allocation if you are to include all three outputs, given that two of them are measured by energy and one is measured by mass.

3

c) Total CO_2 emissions for 1 ton of cement today vs using fly ash.

Today: $\frac{80 \text{ tons} + 700 \text{ tons} + 70 \text{ tons}}{1000} = 0,85 \text{ tons } CO_2$

With fly ash: $\frac{80 \cdot 0,085 \cdot 80}{1000} + \frac{700 \cdot 0,085 \cdot 700}{1000} + \frac{70 \cdot 0,085 \cdot 70}{1000}$

$= \frac{73,2}{1000} + \frac{640,5}{1000} + \frac{64,05}{1000} = 0,78 \text{ tons } CO_2$

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Total emissions today is 0,85 tons CO_2 per ton Portland Cement produced, while GreenCement with fly ash will have 0,78 tons CO_2 per ton Cement.

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1. Functional units:
   a) Production of aluminium: kg per day
   b) An apartment building: m^2
   c) An organic waste management system: ton per year
   d) Airplane vs train: person-km
   e) Hydro power prod vs nuclear power prod: kwh per year

3 3 1,5 2 3

13,5/15

2. Goal and scope
   a) The distance and type of transport will have a huge impact on the environmental impact. These will differ depending on which country you buy timber from. Different countries will also vary in what type of energy they use to cut down and prepare the timber (f.ex. Norway is considered to have very clean energy as most of it comes from renewable energy sources). Lastly, rules, regulations and common practice will also vary between countries and can effect the environmental impact of the product.

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   b) A t-shirt used in Norway vs one used in f.ex. China will differ in lifetime environmental impact. This is due to shipping from production site being different, different types of energy being used when washing the t-shirt (Norway is considered to have "cleaner" energy than China). In addition to this the lifetime might also differ depending on how long it is normal to keep a t-shirt in each of the countries. Lastly, what is done with the t-shirt once it is a waste product may also differ between the two countries.

6/10

29,5