PIARC International Seminar | Global approaches on Sustainable Pavements
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Reducing the life cycle carbon footprint of pavements

Oliver Ripke

Objectives

The presentation summarizes the work of PIARC TC 4.2 “Road Pavements” Working Group 3 in the previous four-year-cycle 2012 to 2015 !

Which were the objectives?

- Review field feedback on recent **innovations** (products, equipment) which contribute to reduce the **carbon footprint** in pavements.

- Critical review of the **assessment of reductions** in carbon footprint as compared to standard methods of construction including the use of reused, recycled and recovered materials.

Methodology

4 stages

- **Questionnaire** (case studies) + **literature survey** as information source

  ✓ partially dependent on questionnaire responses

  Sustainability
  > indicators describing sustainability
  > environmental indicators
  > carbon footprint is important & measures GWP

- Selection of carbon footprint (**CF**) assessment **tools** critically reviewed
- Review of **innovations**
- Assessment of **innovations**

Review of some CF tools (1)

- sound understanding of the calculation behind & **hypotheses**
- establish **strengths & weaknesses** of the tools
- challenge is to use the **right tool** in the right situation
- broad **variety** is available
  - ✓ SEVE ; ECORCE ; HACCT ; AsPECT ; CHANGER ; DUBOCALC ; GHGC; PALATE ; CEREAL ; EKA ; TAGG Carbon Gauge Calculator tool
  - ✓ Variation in covered life cycle **stages** (e.g. production, or complete life cycle), user friendliness & **flexibility**, **focus** (e.g. design- or construction process-oriented), single or multiple **output**

Review of some CF tools (2)

Life-cycle stages covered by the different tools

	Production stage			Construction stage		Use stage		End-of-life				beyond system boundaries
asPECT	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D
CHANGER	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D
DUBOCALC	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D
ECORCE	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D
GHGC	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D
HACCT	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D
PALATE	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D
SEVE	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D
EKA	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D
CGCT	A1	A2	A3	A4	A5	B1	B2-4	C1	C2	C3	C4	D

Key; dark blue = covered in detail, light blue = covered more superficially, white = not covered

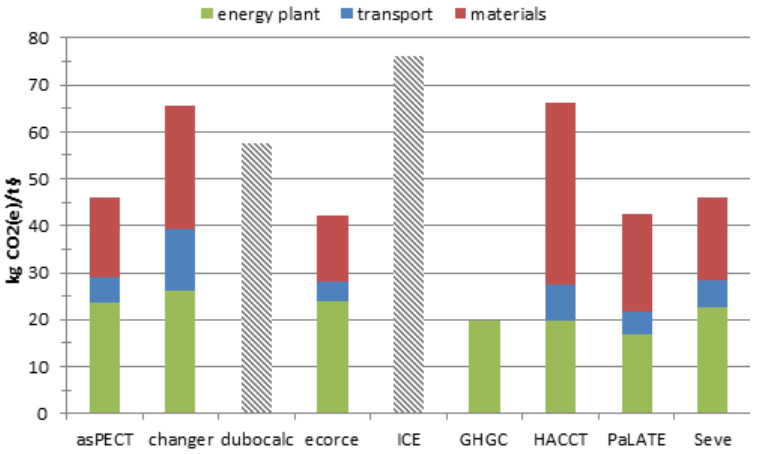
Review of some CF tools (3)

Output covered by the different tools evaluated

	GWP	GWP	Energy	Water use	Acidification	Eutrophication	Smog	Human toxicity	Ecotoxicity	Ozone depletion	Depletion of abiotic resources	
	CO_2	CO_2e										
asPECT		X										
CHANGER		X										
DUBOCALC	X				X	X	X	X	X	X	X	
ECORCE		X	X	X	X	X	X	X	X			
GHGC		X										
HACCT	X											
PaLATE		X	X									
SEVE		X	X									
EKA		X	X									
CGCT		X										

Review of some CF tools (4)

- differences in **source data**, **assumptions** and leading to variations in output



- Most tools cover the **production & construction** stage, but can have different focus (e.g. mixture composition, others on the construction phase)
- None of the tools incorporates the '**in-use**' phase (traffic)

Questionnaire & responses (1)

- 23 countries answered to questionnaire
- Among them, 13 countries have a national action plan for green public procurement
- 5 countries consider carbon footprint on pavement construction and maintenance, 5 other countries plan to do it

Questionnaire & responses (2)

- 7 countries have models available to assess carbon footprint and take it into account in public procurement for roads pavement
- Most of their models are «cradle to site», not «cradle to grave»
  They almost never assess «in use» phase
- 17 countries implement technical innovations which reduce carbon footprint of pavement

Review of innovations on design

Long-Life Asphalt, Concrete pavements:

carbon footprint reduction is expected thanks to longer service life

beware of higher construction carbon footprint

Two-Lift Concrete:

more durable material on the thinner surface layer

less transport, then lower carbon footprint

Review of innovations on construction: simple and efficient ideas

Covering aggregate stockpiles to prevent water ingress:

very simple way to earn energy to dry and heat aggregates

Insulation of bitumen pipes and tanks:

reduces heat loss in plants then reduces carbon footprint

Review of innovations on construction: less energy often means less CO2 emission

Warm Mix, Cold Mix Asphalt:

additives improve workability but beware of carbon footprint of additives

Low emission cement:

high carbon footprint to get clinker; fly ashes, blast furnace slag can reduce carbon footprint

Review of innovations: recycling

Use of Reclaimed Asphalt Pavement: avoids carbon footprint with the production of virgin material; beware of transport

Cold In-Place recycling, Hot In-Place recycling: earns transport

Use of rubber from scrap tyres: reduction carbon foot print to be demonstrated

Review of innovations: in use

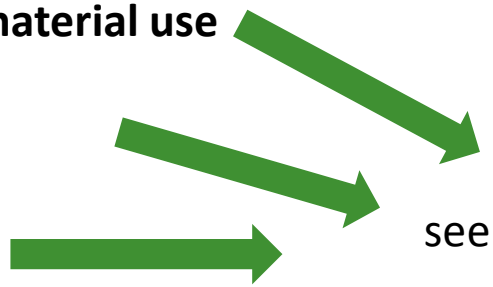
Reduced **rolling resistance (RR) of** pavements:

- In general the largest contribution to CF from roads is a result of the fuel used by the traffic.
- But, the relation of RR to the surface properties of a pavement is not completely understood.
- Research ongoing.
- **Indications** : Importance of maintenance and the influence of MPD.

Assessment of innovations reported to reduce CF

- **Dry stockpiles for asphalt production**
- **Warm mix asphalt (WMA)**
- **Re-used, Recycled and secondary material use**
- **Two-layer concrete**
- **Technologies for construction**

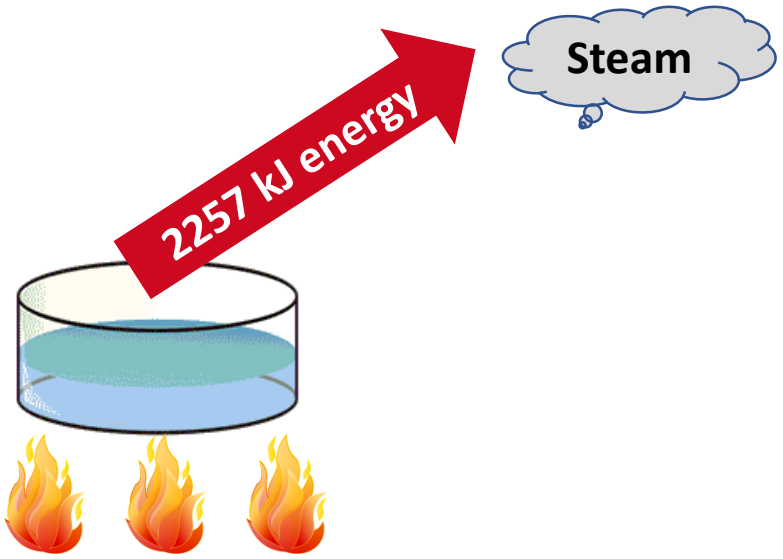
in detail here



see report

Dry stockpiles for asphalt production

Classic laws of physics…



1 litre of water

Humidity Aggregates [%]	Energy requirement burner per tonne of HMA [kWh]
2	51
5	75
6	84

Source: Peinado, D. et al.: Energy and energy analysis in an asphalt plant's rotary dryer : Applied Thermal Engineering 31 (2011), p 1039 – 1049

Assessment (benefits) of Warm Mix Asphalt (WMA)

- **Working environment**

  Emissions of vapor and aerosols significantly reduced

- **Energy use**

  Benefit ! But drying process of aggregates still necessary

- **Workability**

  Improved ! But pay attention to the congealing point of the additives

- **CO_2-Reduction**

  Fair calculation needed:

  Type of energy, moisture content, carbon footprint of additives

Conclusions

- **System boundaries and allocation methodology**
  - Important key to any evaluation of CF
  - must be transparent and understood
  - include the life-cycle stages from raw material acquisition through to pavement construction.

- **Innovations to reduce CF**
  - a number of innovations have been reviewed
  - CF only one aspect, others like use of resources also affected
  - measurement of the innovation against a base case necessary
  - in many cases little objective evidence presented to demonstrate a reduction in CF.

- **Carbon Footprint is not the only important sustainability criterion**

Recommendations

- **Incentives needed to encourage the adoption of lower CF pavements**

- **The 'in-use' phase of the life-cycle contributes significantly to the lifetime CF of pavements**

  A well maintained, smooth pavements can reduce the fuel consumption of the traffic using the pavement due to low rolling resistance

- **Long-life pavements**

  Durable pavements reduce the consumption of raw materials, reduce traffic delays and interventions for maintenance. Long life pavements are aiming at a greater availability of the road, over a longer period with fewer repair and maintenance.

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Thank you!

Contact: ripke@bast.de

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