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Low Carbon Materials in the Built Environment

Industry Showcase 2026

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Photo by Ignus Dreyer

Low Carbon Materials in the Built Environment

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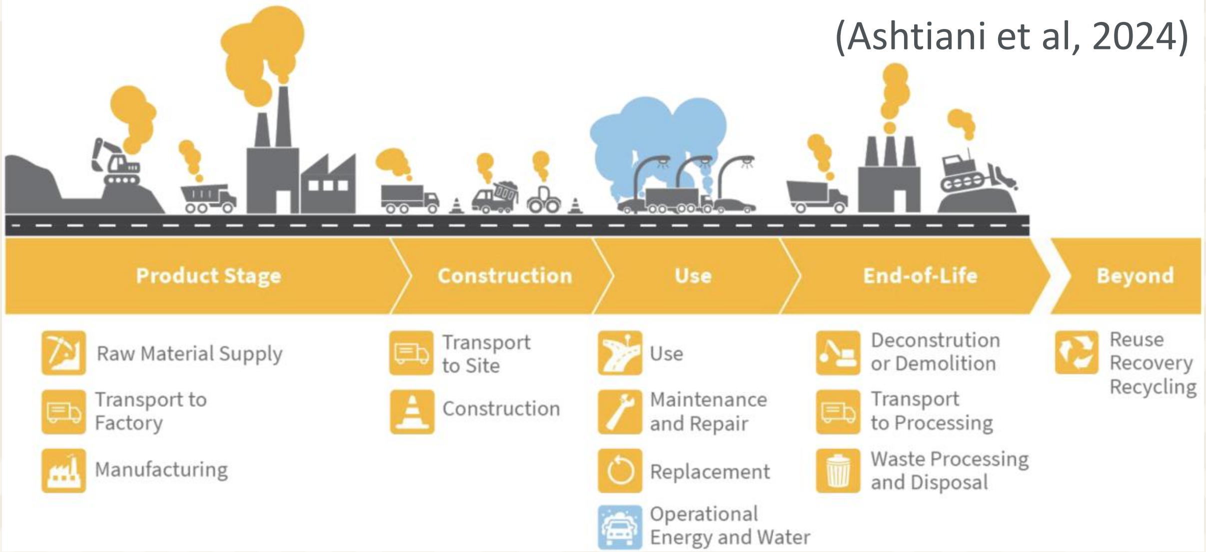
Content

- Why low-carbon materials matter
- What do we mean by low-carbon materials?
- Pavement Engineering at Stellenbosch University
- Innovations and Engineering Trade-Offs
- Collaborations and Opportunities

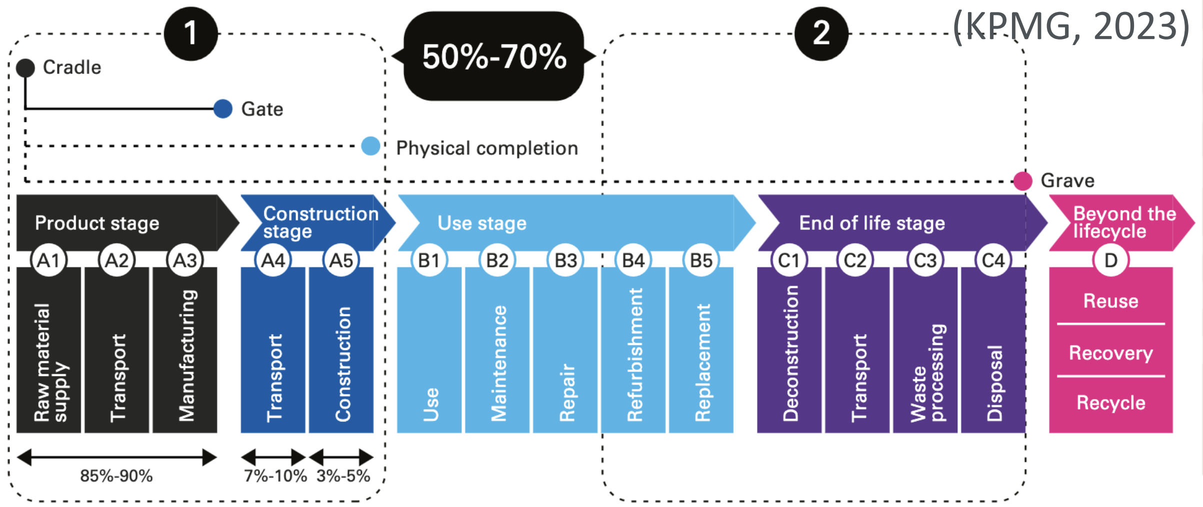
Framing the Problem

Why Low-Carbon Materials Matter

- BE contributes ±40% of global CO_2 emissions
- Infrastructure is particularly material-intensive
- Shift from operational → embodied carbon



(Ashtiani et al, 2024)



(KPMG, 2023)

What do we mean by low-carbon materials?

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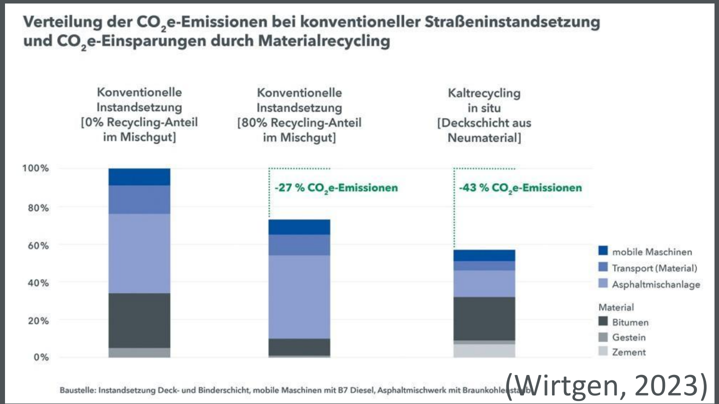
Avoid →
Reduce →
Substitute →
Offset

- Materials with reduced embodied carbon across lifecycle
- Three broad strategies:
  - Material substitution – e.g. clinker replacement, bio-based binders
  - Material efficiency – doing more with less (optimised design, thinner sections)
  - Circularity – reuse and recycling (RAP, reclaimed aggregates, waste streams)

What do we mean by low-carbon materials?

Adopted practice is SA

- Reduce material intensity, lower processing energy, or extend service life
- High acceptance
  - Cement and lime stabilisation
  - Rubber-modified bitumen
  - Reclaimed asphalt (RA)
  - In-situ recycling



(Wirtgen, 2023)

- Context-dependent acceptance
  - Warm mix asphalt (workability)
  - High modulus asphalt (quality control, design experience)
  - Recycled concrete aggregate (variability, guidelines)

Pavement Engineering at SU

SANRAL Chair

- Pavement and Geotechnical Research Laboratory
- Take a virtual tour on the Department of Civil Engineering's website

Pavement Engineering at SU

What are we doing about sustainability in the BE?

Binders:

- Modelling Rheology
- Bio-based Extenders
- Valorisation for Modification

Aggregates and granular materials

- Alternative Aggregates
- Marginal Materials

Stabilisation

- *Cold in-place recycling*
- *Low-carbon Cement Alternatives*

System-level

- *LCA*
- *Best-practice guidelines*

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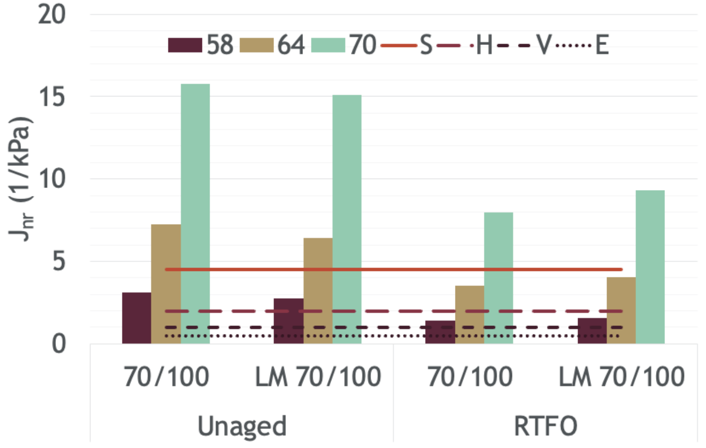
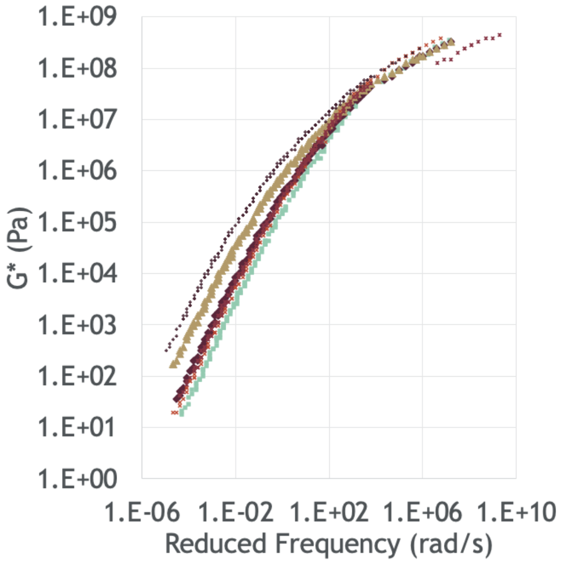
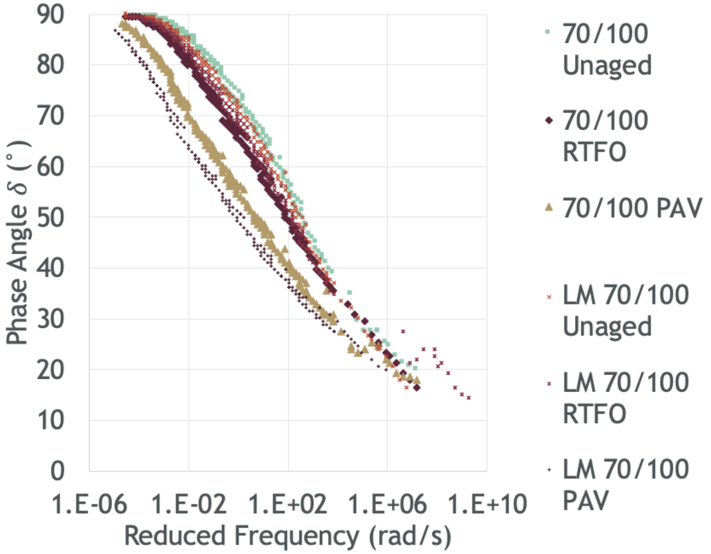
Binder Rheology

Description		R-Value
70/100	Unaged	1,86
	RTFO	2,01
	PAV	2,71
Lignin-Modified 70/100	Unaged	2,01
	RTFO	1,55
	PAV	3,22







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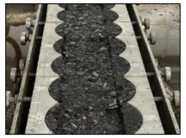
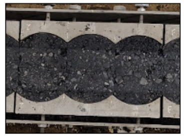
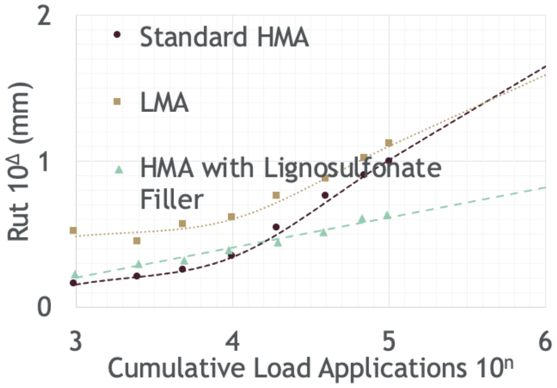
Bio-Binder Extenders

	Optimum Binder Content (% m/m)	Average Total Rut (mm)	Visual Appearance of Asphalt Briquettes after 100 000 MMLS Cycles	
			Top View of Middle Section	Top View of Middle Section Wheel Path
HMA	4.98	10.97		
LMA	5.59	15.35		
HMA-LF	5.06	5.49		



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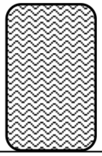
Alternative Aggregates

Monotonic Triaxial Results		
Exposure Type	Friction angle (°)	Cohesion (kPa)
Immediately Tested	48	240
Water exposed	41	352
Carbon Dioxide exposed	44	260

RCA Granular and Stabilised Subbase with Granular Base



Layer	Material	Thickness (mm)	Initial Stiffness (MPa)	Modular Ratio Applied	Critical Parameter	Analysis Point
Surfacing	N/A	10	3500		ε_3	
Base	G2	100	600	2.0	σ_1, σ_3	
		100	400		σ_1, σ_3	
Subbase	RCA	100	400		σ_1, σ_3	
		100	200 / 2500		σ_1, σ_3 / ε_3	
Selected	G7	150	120	1.7	ε_1	
	G9	150	70	1.4	ε_1	
Subgrade	G10	∞	50		ε_1	

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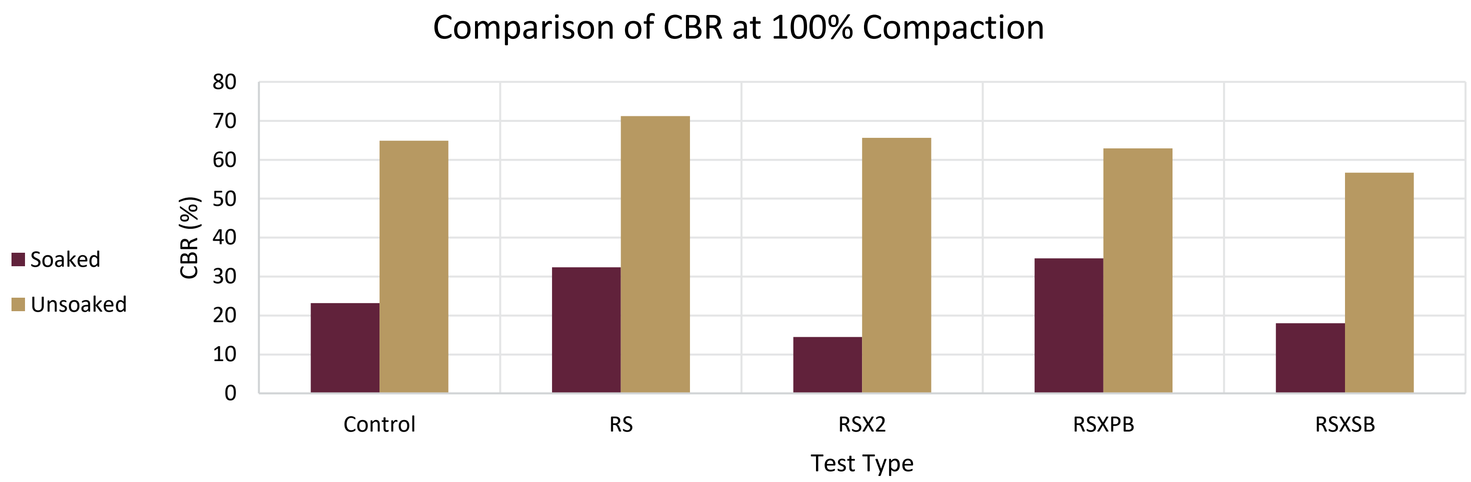
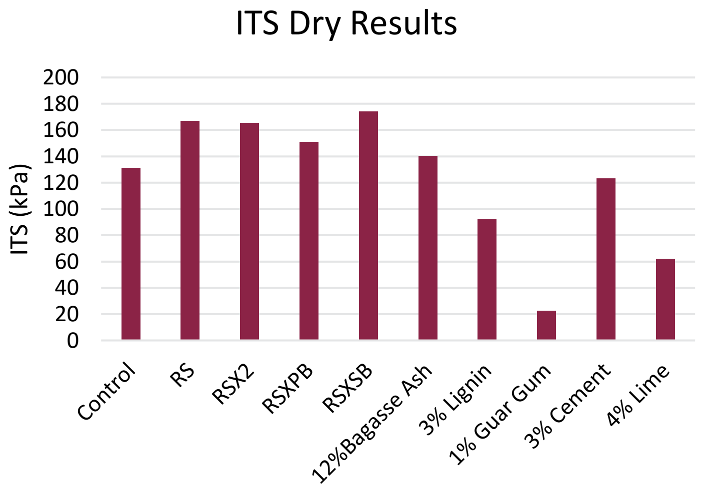
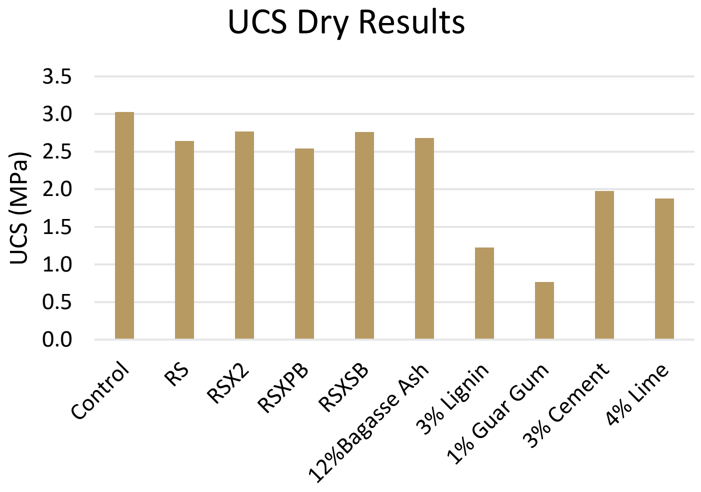
Marginal Materials & Alternative Stabilisers







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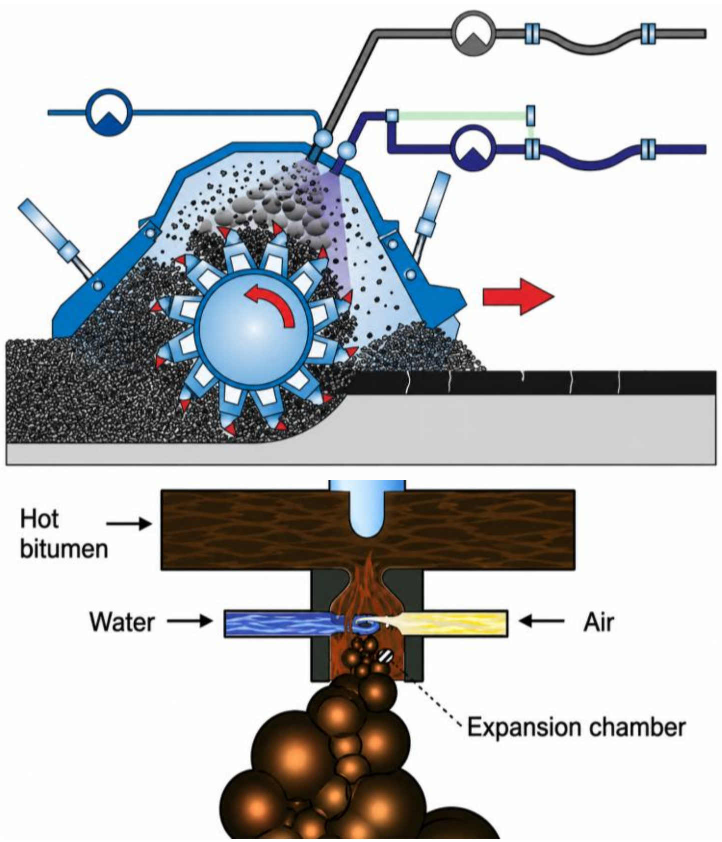
Cold In-place Recycling



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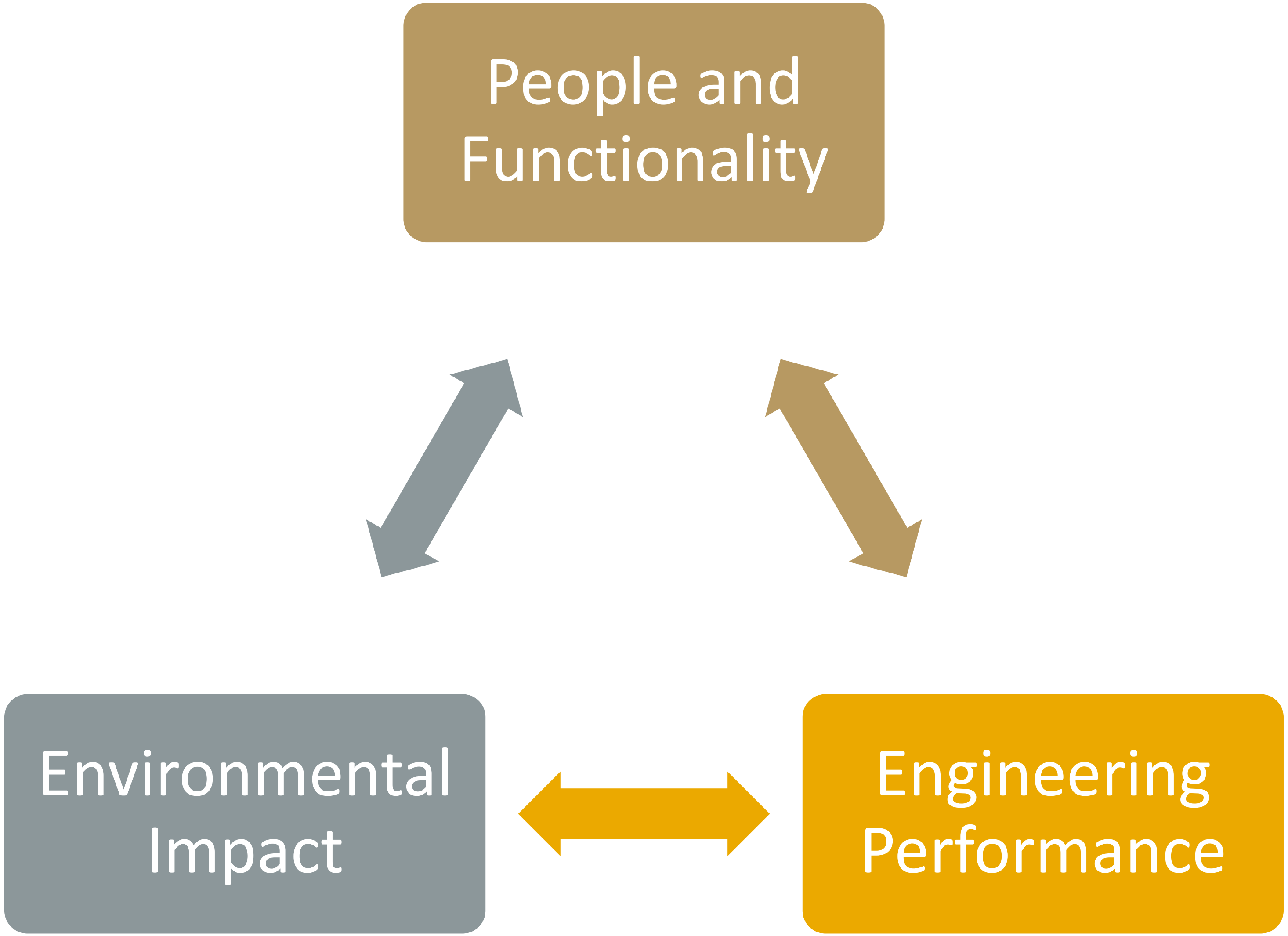
Social Life-Cycle Costing



Collaborations and Opportunities

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Past, Present and Future

- International Society for Asphalt Pavements
  - University of Nottingham
  - University of Antwerp
  - TU Delft
  - TU Wien
- Industry Partners
  - SANRAL
  - SABITA
  - Much Asphalt
  - BVi Consulting Engineers
  - … and many more

Photo by Stefan Els

Thank you · Enkosi · Dankie

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