

**French Institute  
of Science and Technology  
for Transport, Development  
and Networks (IFSTTAR)**

# **Pavement LCA: a Comparison of American and European Tools**

Champaign, IL - April 12, 2017

João Santos

Marie Curie Postdoctoral Fellow in SUP&R ITN



**Pavement  
LCA 2017**

**IFSTTAR**

# Outline

- Introduction
- Objectives
- Compared tools
- Case study
- Results
- Recommendations



# Introduction

- Road pavements have considerable environmental burdens associated with their construction, maintenance, and use
- Pavement stakeholders community are congregating efforts to mitigate these negative effects



# Introduction

- Collaborative research effort between LCE4ROADS (EU) and NSPC Transportation Pooled Fund (US) was established:
- To improve the current trends in terms of enhancing sustainability in pavements



**FIRST JOINT MEETING- Washington.**  
March 2014



**SECOND JOINT MEETING- Madrid.**  
September 2015

# Objectives

- Provide the pavement stakeholder community with insights on the potential differences in the life cycle impact assessment results of road pavement LCAs resulting from applying American and European LCA tools



# Compared tools

**PaLATE** 

**DUBO**  
*Calc*



thinkstep  
**GaBi**

 **VirginiaTech**  
Transportation Institute



UNIVERSIDADE DE COIMBRA

**ECORCE M**



**IFSTTAR**



**Cerema**

# Compared tools

Feature		GaBi	Palate	DuboCalc	VTTI	ECORCE
Country		Germany	USA	Netherlands	USA	France
Primary Data Source		Literature and industrial data; databases	Carnegie Mellon University EIO-LCA software; Transp. Energy Data Book	National data	Literature data	Literature & industrial data
Impact Category	Abiotic depletion	-	-	Y	-	-
	Climate change	Y	Y	Y	Y	Y
	Ozone depletion	Y	-	Y	-	-
	Photochemical ozone creation	Y	-	Y	Y	Y
	Acidification	Y	-	Y	Y	Y
	Eutrophication	Y	-	Y	Y	Y
	Human toxicity	Y	-	Y	-	-
	Freshwater aquatic ecotoxicity	Y	-	Y	-	-
	Marine aquatic ecotoxicity	Y	-	Y	-	-
	Terrestrial ecotoxicity	Y	-	Y	-	-
	Energy consumption	Y	Y	-	Y	Y
	Human health criteria pollutants	-	-	-	Y	-
	Chronic ecotoxicity	-	-	-	-	Y
Chronic toxicity	-	-	-	-	Y	

# Case study: general description

- Spanish road N° 340
- 1,568 m long, 2 lanes road pavement section
- Analysis period: 20 years

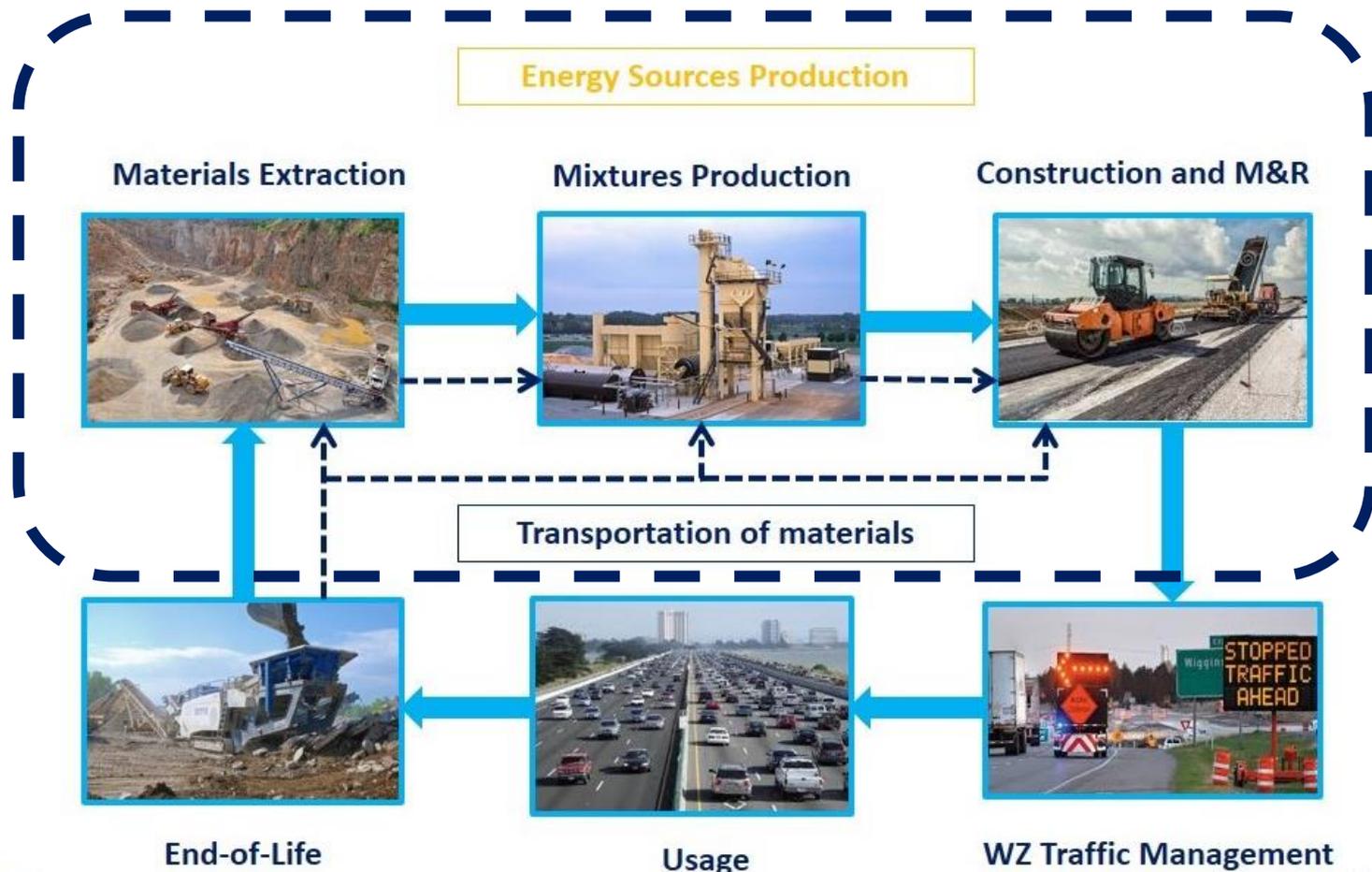


# Case study: general description

- Functional unit: *1 km of mainline pavement and year*



# Case study: system boundaries

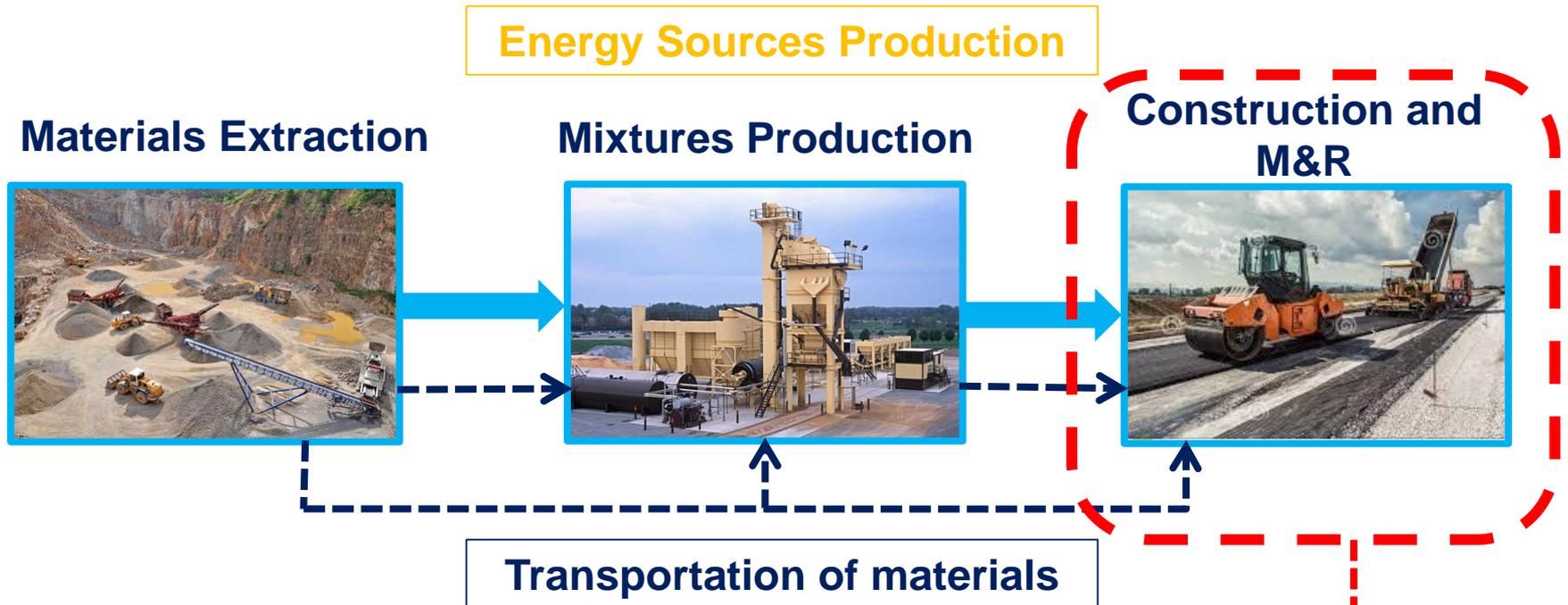


End-of-Life

Usage

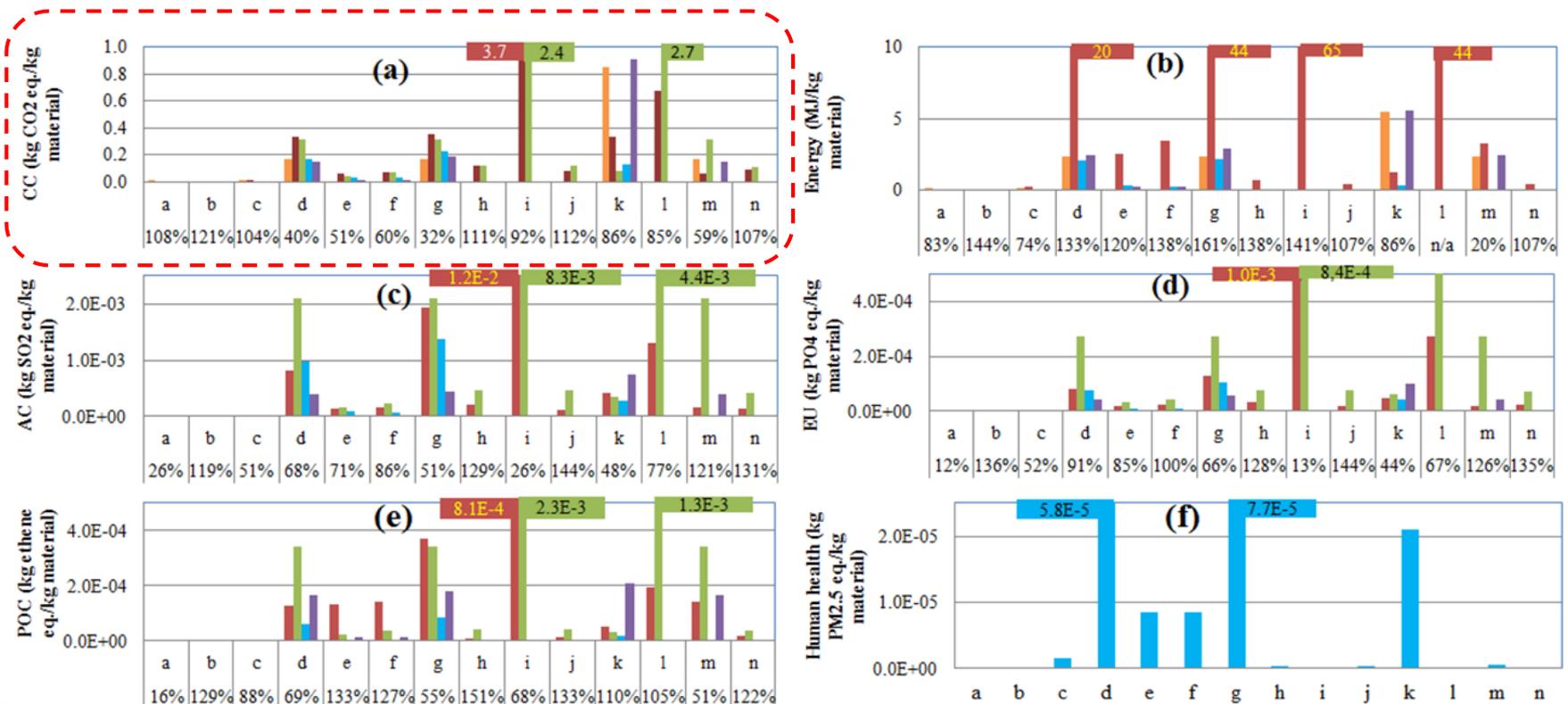
WZ Traffic Management

# Case study: system boundaries



- Stage 1: demolition of the old pavement and fence**
- Stage 2: soil excavation and movement**
- Stage 3: pavement structure construction**
- Stage 4: road sub-structure construction (i.e. drainage system)**
- Stage 5: M&R of the top pavement layer**

# LCIA results: materials level

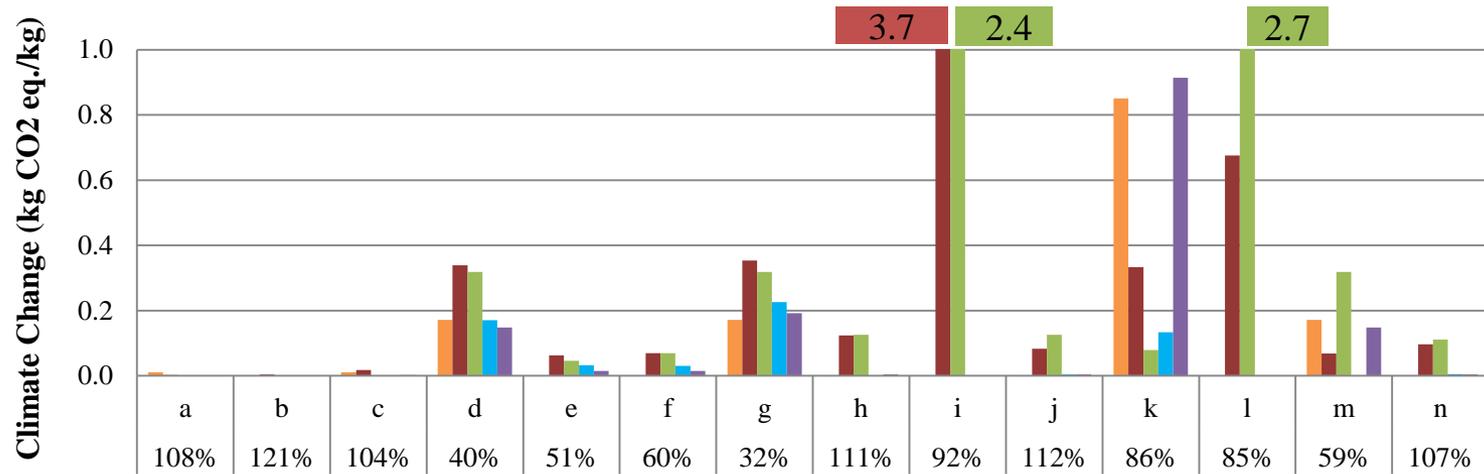


■ Palate 
 ■ Gabi 
 ■ DuboCalc 
 ■ VTTI 
 ■ Ecorce

- a. General fill (soil)
- b. Water
- c. Graded aggregates
- d. Bitumen Emulsion
- e. AC 32 Base G
- f. AC 22 Bin S
- g. PG bitumen
- h. Concrete (brick)
- i. Glass fibres filaments
- j. Concrete C20
- k. Cement
- l. Formwork
- m. Prime coat
- n. Concrete C15

# LCIA results: materials level

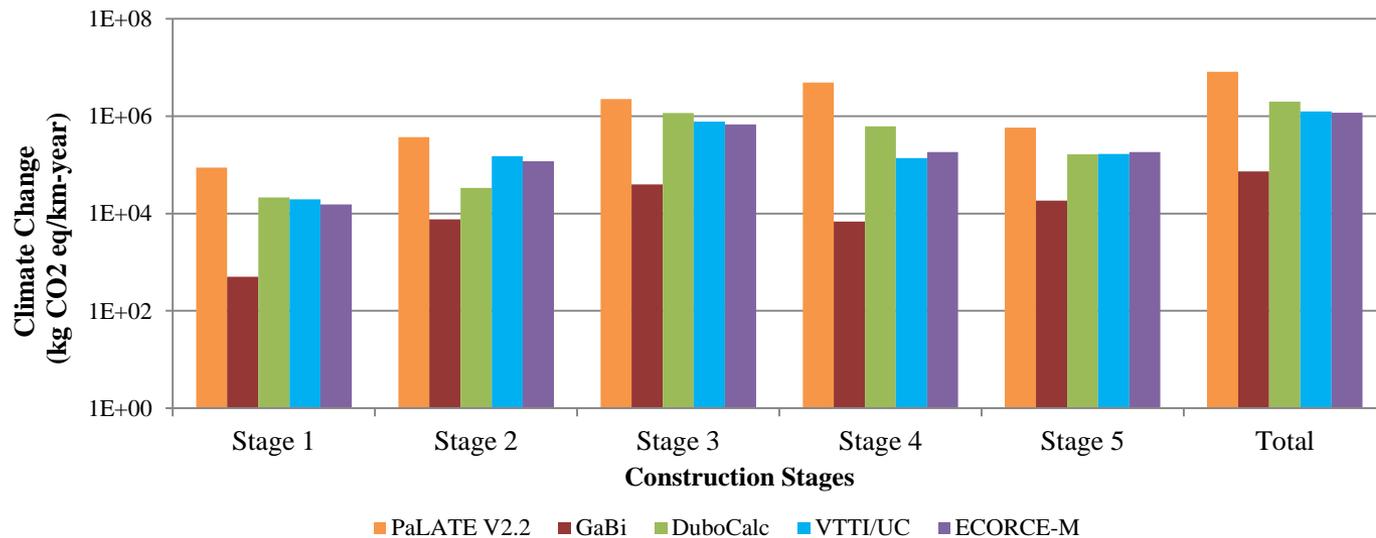
- Climate Change Score



- Palate
 ■ Gabi
 ■ DuboCalc
 ■ VTTI
 ■ Ecorce
- a. General fill (soil)
- b. Water
- c. Graded aggregates
- d. Bitumen Emulsion
- e. AC 32 Base G
- f. AC 22 Bin S
- g. PG bitumen
- h. Concrete (brick)
- i. Glass fibres filaments
- j. Concrete C20
- k. Cement
- l. Formwork
- m. Prime coat
- n. Concrete C15

# LCIA results per construction stage

- Climate Change Score



**Stage 1: demolition of the old pavement and fence**

**Stage 2: soil excavation and movement**

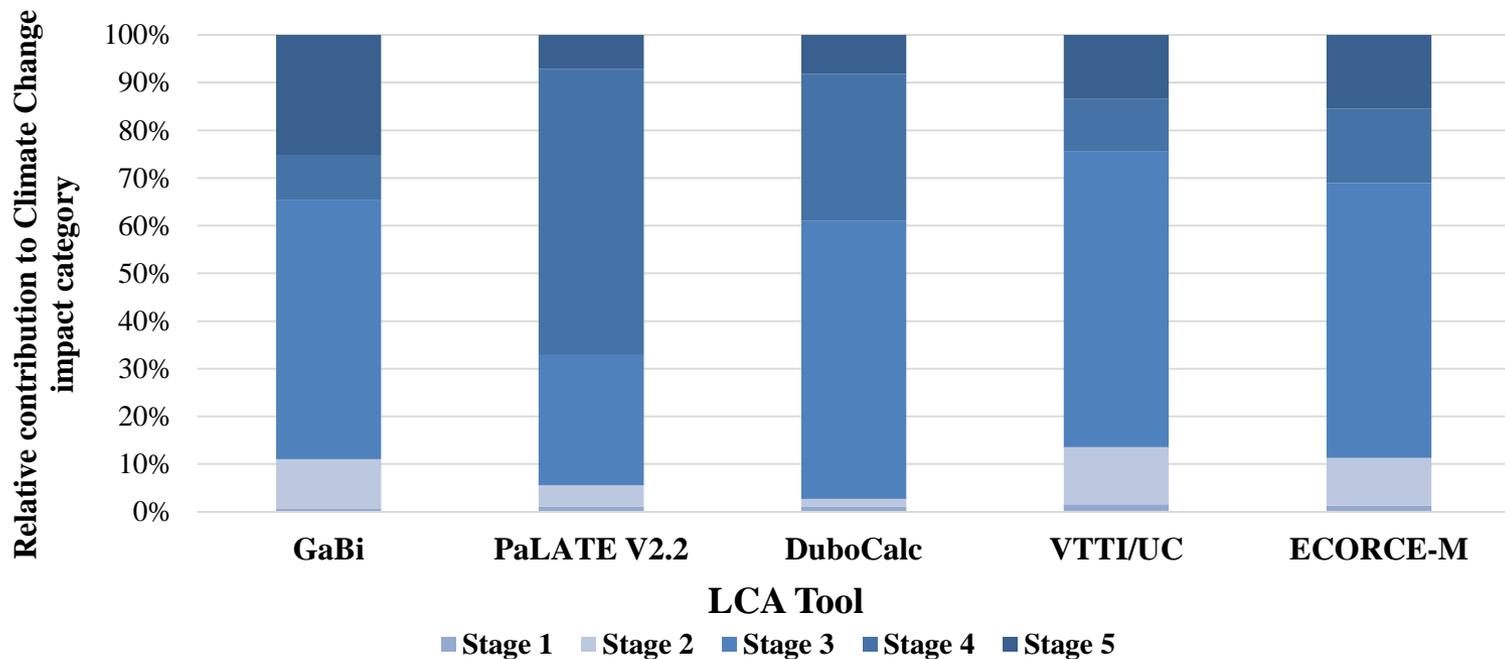
**Stage 3: pavement structure construction**

**Stage 4: road sub-structure construction (i.e. drainage system)**

**Stage 5: M&R of the top pavement layer**

# Relative impacts per construction stage

- Climate change impact category



**Stage 1: demolition of the old pavement and fence**

**Stage 2: soil excavation and movement**

**Stage 3: pavement structure construction**

**Stage 4: road sub-structure construction (i.e. drainage system)**

**Stage 5: M&R of the top pavement layer**

# LCIA results: explaining the differences

1. Database comprehensiveness
2. Level of detail of inventory data
3. LCA approach: economic input-output vs. process-based data
4. Temporal, technical, & geographical representativeness
5. System boundaries & allocation methods
6. Process modelling approach



# Recommendations

- To develop a consensual framework and Product Category Rules (PCR) for pavements
- To develop local databases that comply with (inter)national standards. They should be built by international cooperation of diverse parties
- To tailor datasets to the impact assessment methods and flows intended to be tracked
- To perform sensitivity and uncertainty analyses



# Acknowledgements

- **Senthilmurugan Thyagarajan**, Turner Fairbank Highway Research Center
- **Elisabeth Keijzer**, TNO
- **Rocío Fernández Flores**, ACCIONA, S.A. Corporate Division
- **Gerardo Flintsch**, Virginia Tech Transportation Institute
- **Nadarajah Sivaneswaran**, Turner Fairbank Highway Research Center



# Acknowledgements

- The LCE4ROADS consortium (FP7 European Union-funded project Grant Agreement n° 605748)
- The U.S. National Sustainable Pavements Consortium- Transportation Pooled Fund
- Marie Curie Initial Training Network (ITN) action, (FP7 European Union-funded project Grant Agreement n° 607524)



# Thank you for your attention

**João Santos**

**Marie Curie Postdoctoral Fellow in SUP&R ITN**

[joao.oliveira-dos-santos@ifsttar.fr](mailto:joao.oliveira-dos-santos@ifsttar.fr)



[https://www.researchgate.net/profile/Joao\\_Santos28](https://www.researchgate.net/profile/Joao_Santos28)



<https://pt.linkedin.com/in/santosjmo>



[http://superitn.eu/wp/?page\\_id=1782](http://superitn.eu/wp/?page_id=1782)

