



Hrvatsko asfaltno društvo



Croatian asphalt association

*Armiranje asfaltnih kolnika
geomrežama od staklenih vlakana*
*Reinforcement in asphalt pavements
with fiberglass geogrids*

Xavier CARBONNEAU – CST COLAS



Međunarodni seminar ASFALJNI KOLNICI 2019
International seminar ASPHALT PAVEMENTS 2019

Opatija, 04.-05. 04. 2019.

AN « OLD STORY »

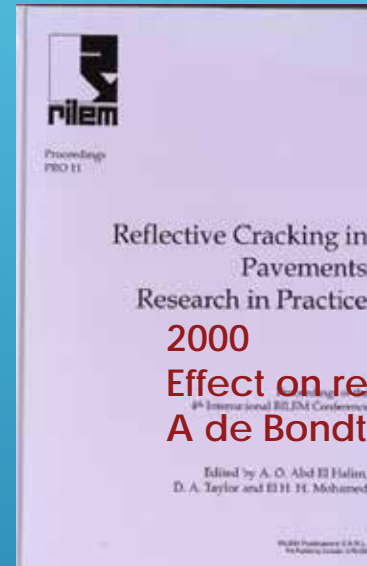
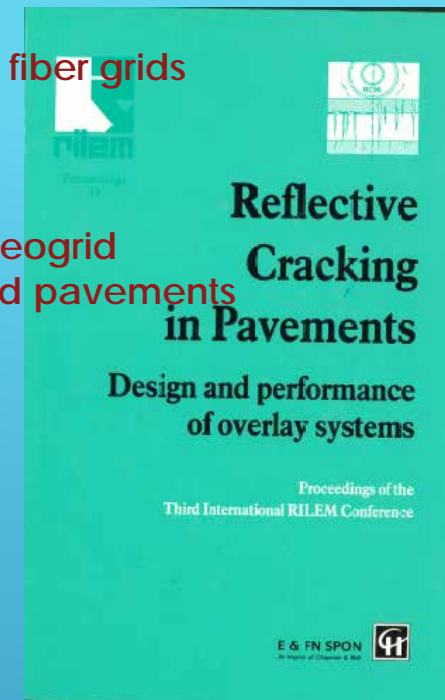
Difficult to evaluate :

- Fibers,
- Geogrids,
- How to select grids
- Effect on crack propagation,
- Effect on bonding,
- Effect on pavement lifetime ...

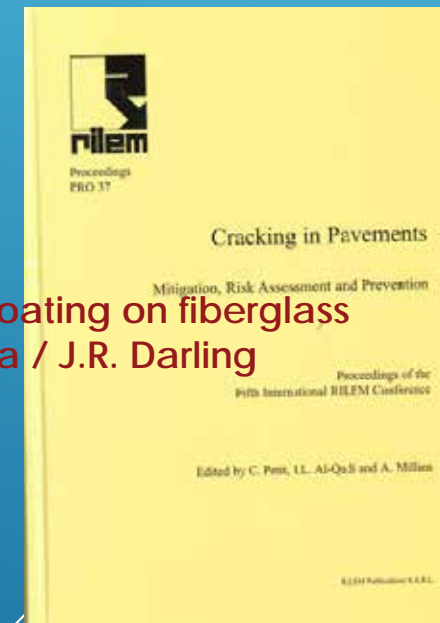
Research since ~1980
Lot of jobsites & trials sections

1996
Fatigue improvement with glass fiber grids
D Doligez MHM Coppens

Design method for plain and geogrid reinforced overlays on cracked pavements
AAA Molenaar M Nods



Effect on reinforcement
A de Bondt



2004
Effect of coating on fiberglass
C.M. Aldea / J.R. Darling



Delft 2012
Still research.....

COLAS METHODOLOGY

Beginning 1990
Knowledge of grids

Mechanical contribution of grids
Cooperation with NPC (Lab in Netherlands)

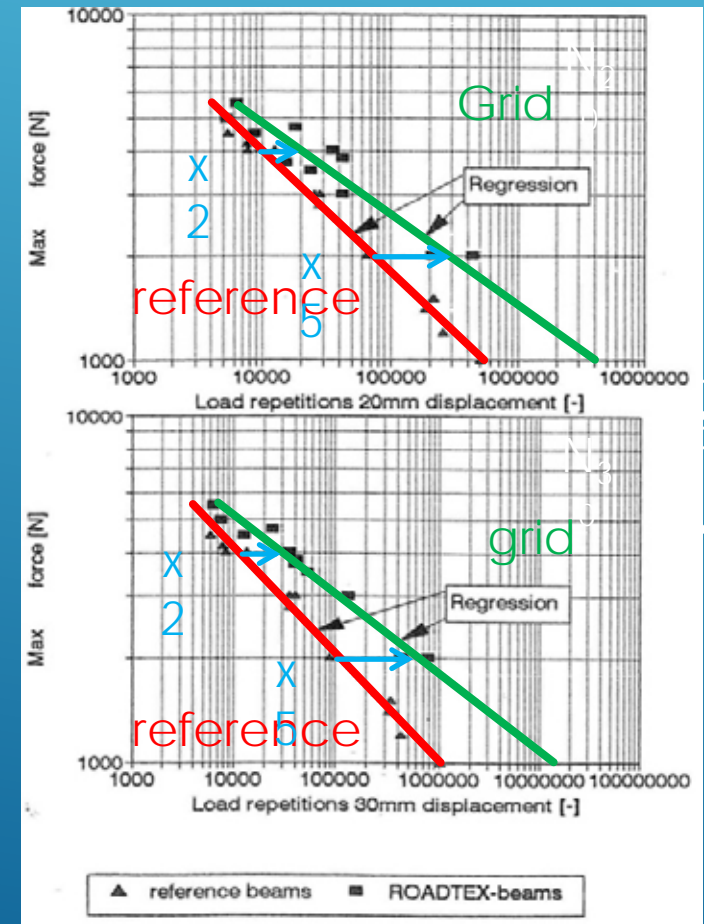
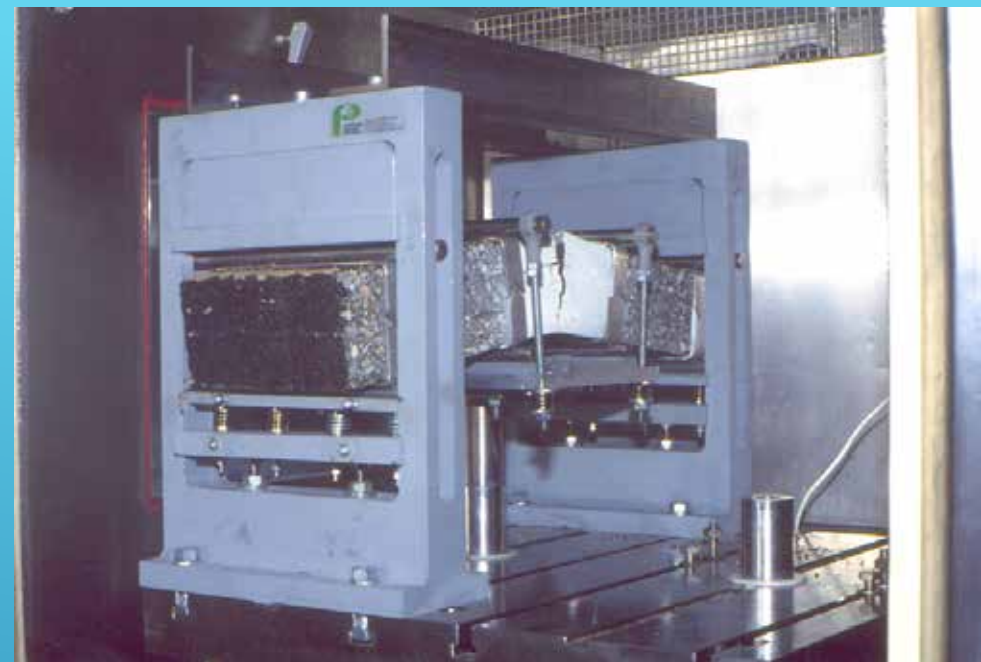
4PB Test 15°C 10Hz

Increase in lifetime
Strain reduction

Pavement design including effect of geogrids

Long term feedback from monitored jobsites

Colgrill Solution



15 YEARS SURVEY

RD 624 Castelnaudary 1998

Old wearing course/ Cracked (fatigue)

4-7 cm AC Mix + surface dressing

cracking, **ressuage** , **rutting**

Traffic 400 trucks/day (increase 4%/year)

Reinforcement designed for 15 years

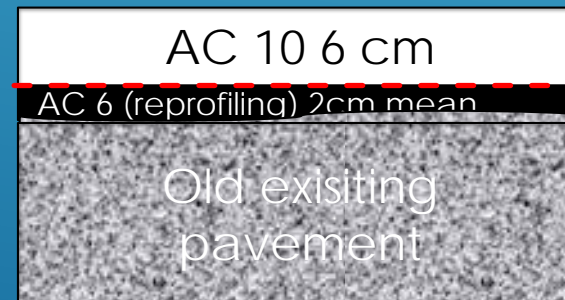
Survey / administration (SETRA)



Reference section



Innovative trial section



Glassfiber grid

Saving 8 cm of AC Mix !

15 YEARS SURVEY

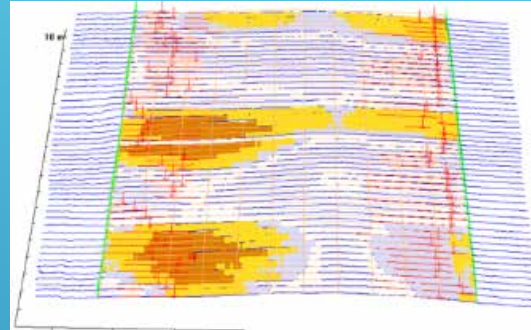
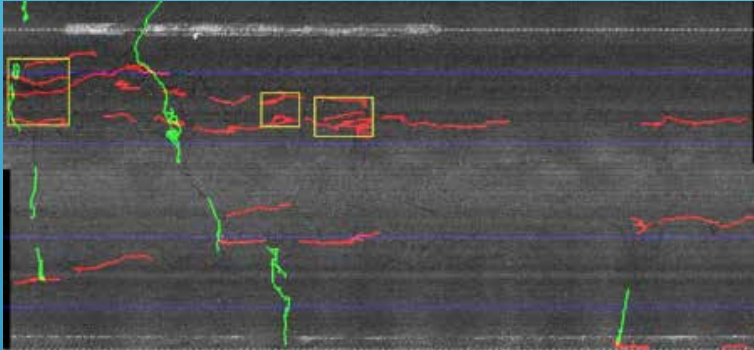
RD 624 Castelnaudary

Survey for 15 years (initial design lifetime) + 5 years



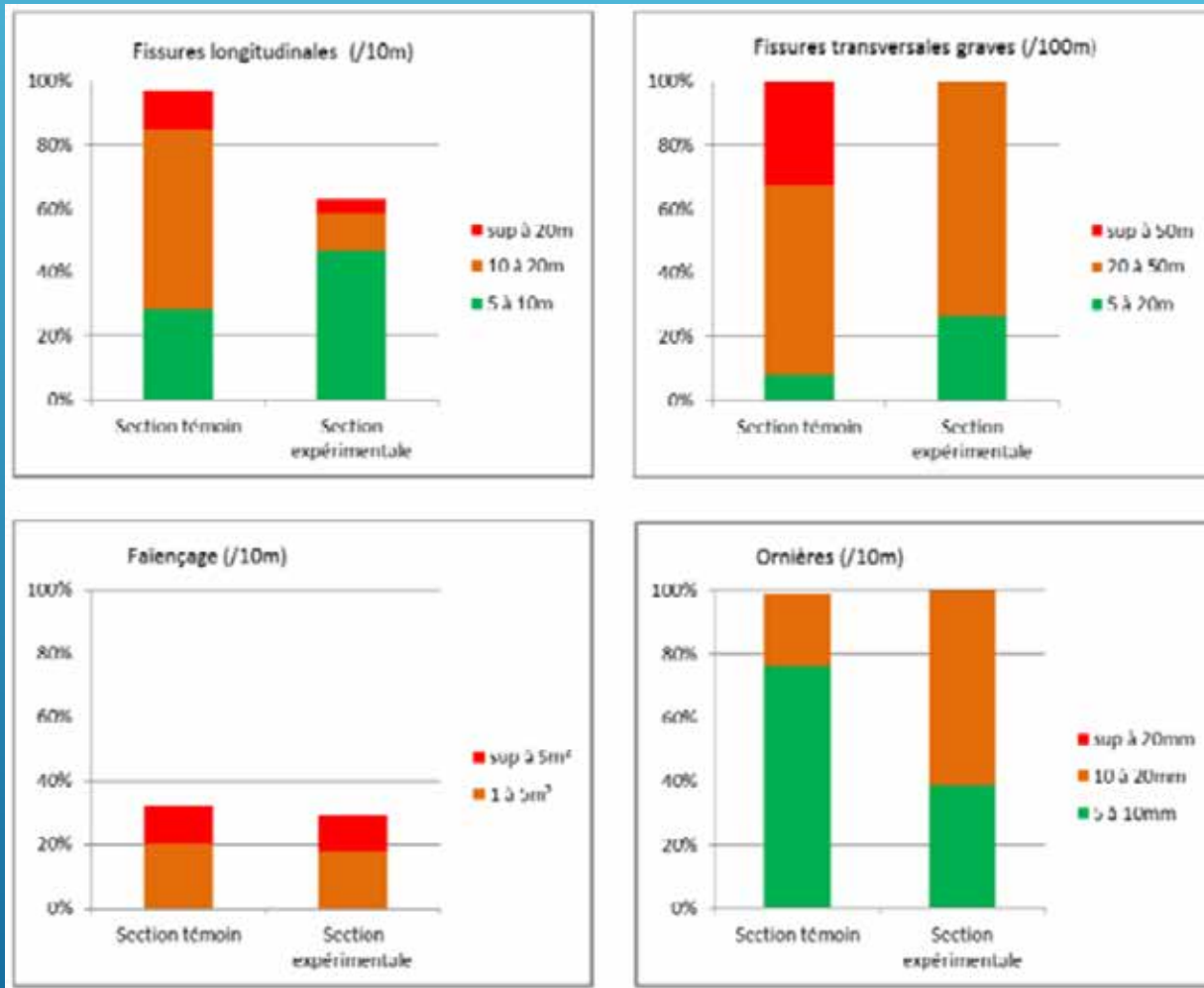
15 YEARS SURVEY

RD 624 Castelnaudary



15 YEARS SURVEY

RD 624 Castelnaudary



Cracking better in trial section

Assumptions in pavement desing validated

Environmental evaluation (SEVE software from Road association)

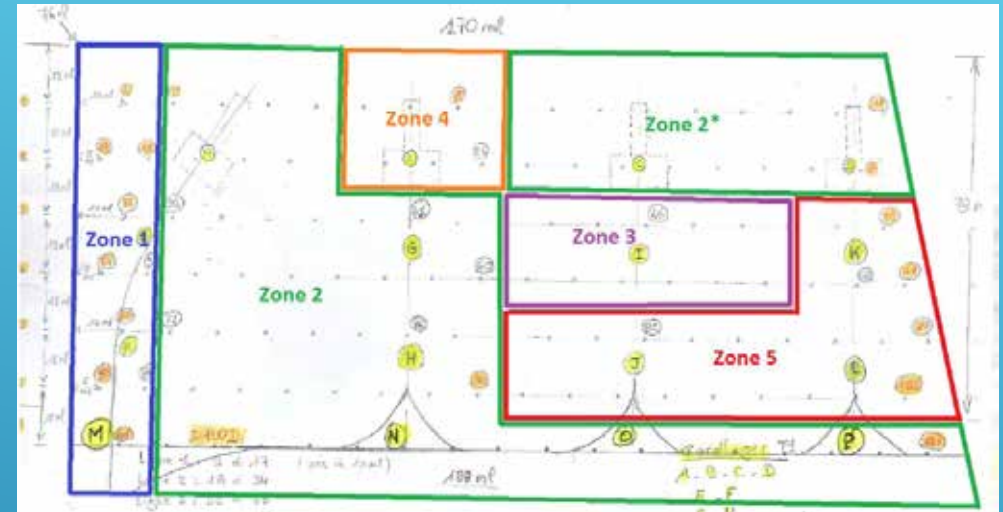
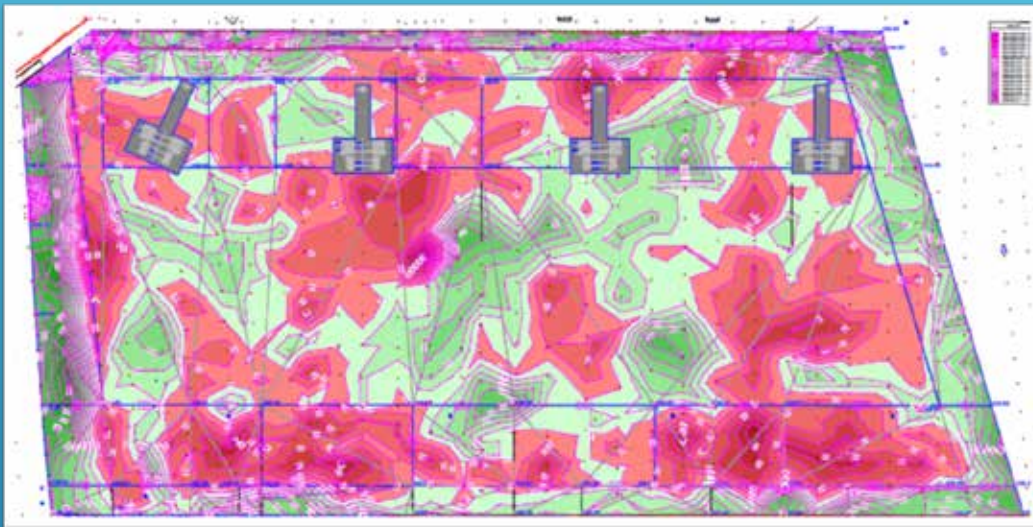
energy consumption -46%
greenhouse gaz emission -47%
Aggregates 50%

Results after 15 years

RECENT EXAMPLES BEAUVAIS AIRPORT PARKING T1

2014

- § ON SITE MEASUREMENTS : DEFLECTIONS, CORES
- § MORE THAN 10 ≠ PAVEMENT DESIGN



PARKING T1	
Initial solution	Excavation 20%
High Modulus AC 5cm	High Modulus AC 5cm
AC 10 8 cm	AC 10 8 cm
	AS dug gravel 100cm

PARKING T1		
Alternative	Zone 4 – 5	Excavation 100m ²
High Modulus AC 6cm	High Modulus AC 6cm	High Modulus AC 6cm
Colgrill R	Colgrill R	Colgrill R
	Optibase 9/11cm	Optibase 2x 10cm
		As dug gravel 45 cm

32000 m² of colgrill R

RECENT EXAMPLES BEAUVAIS AIRPORT PARKING T1



RECENT EXAMPLES : NOSI BE & IVATO AIRPORTS



2017-2018

Fiberglass geogrids + 6 cm BBA Runway

Fiberglass + 6 cm High modulus AC

Total surface 220 000 m²
150000 Ivato & 70000 Nosi Bé)

Saving of ~ 8 cm of AC



RECENT EXAMPLES : A40 (2017)

Delay heavy maintenance works



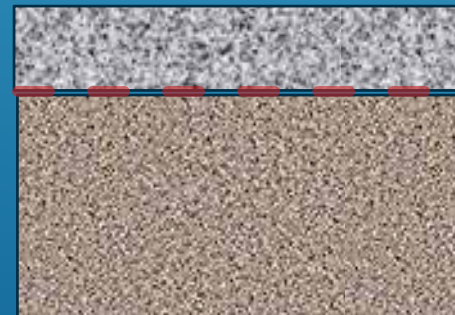
Milling depth

12 cm

4,5 cm

AC 10 3,5 cm

AC 10 8,5 cm

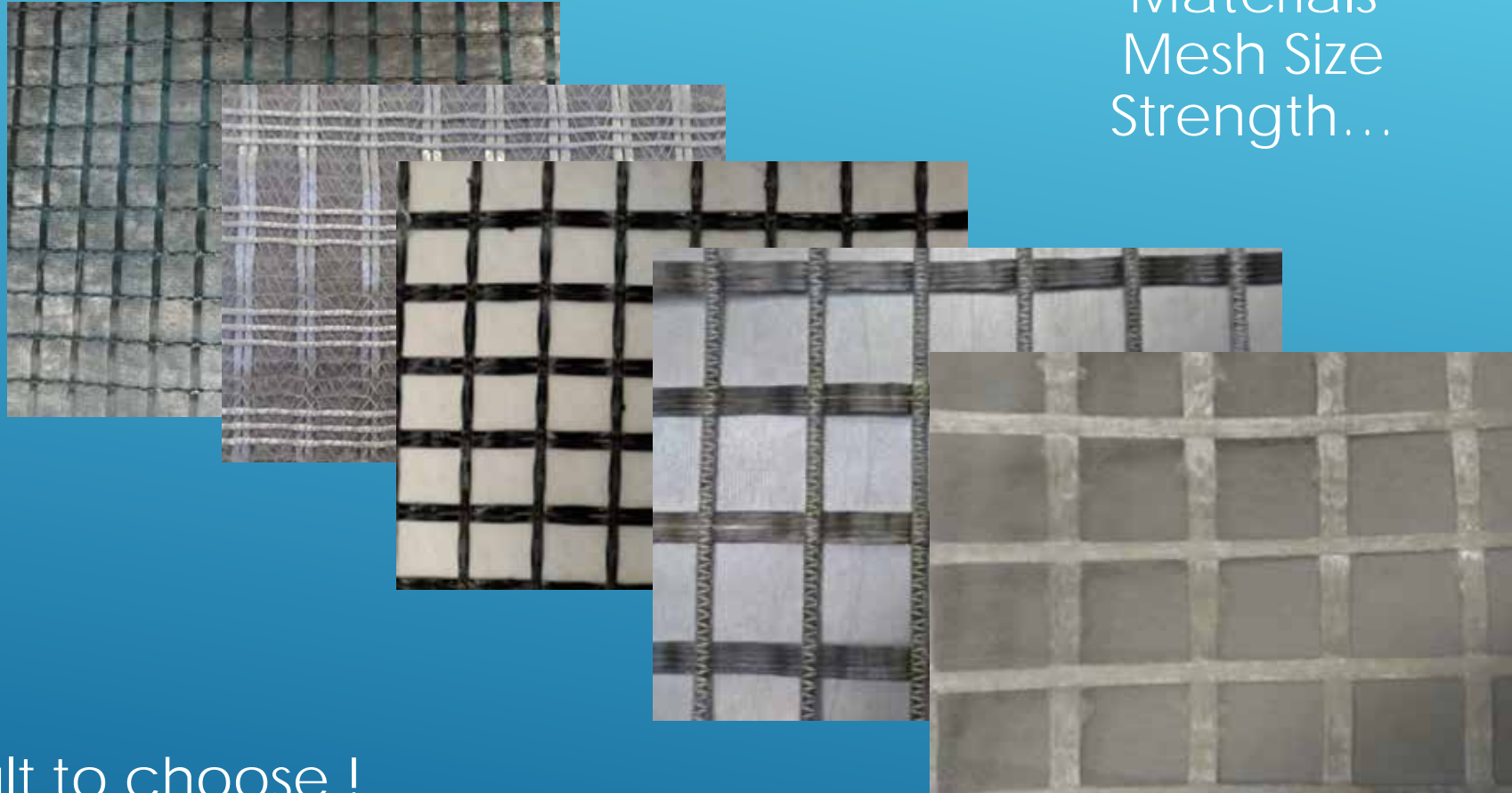


Rugocompact 4,5 cm

Colgrill R

NEED FOR EVOLUTION

Lot of new Suppliers
Products
Materials
Mesh Size
Strength...



Difficult to choose !
No agreed way of evaluation &
implementation in road design

RESEARCH PROJECT SOLDUGRI

Project Leader



- „ Epsilon Private R & QC laboratory for civil works
- „ 6 D Solutions Fiber glass grids supplier
- „ Colas Construction & Maintenance transport infrastructure



„ Ifsttar

„ INSA ICUBE



„ ICS



Starting 01/01/2015 For 60 months
Budget : 2 M€

STATUS – DAMAGING OF GEOGRIDS

- „ Evolution of the grids with AC Laying and compaction

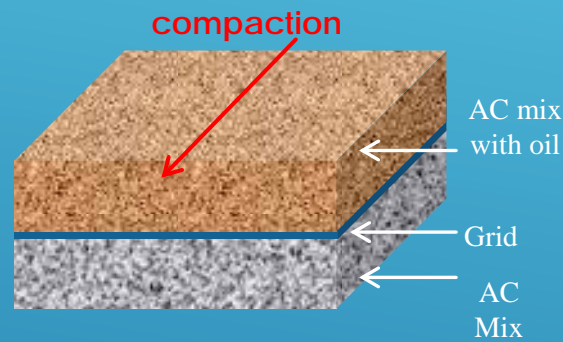


How the grids evolve ?
Tools to simulate and select grids

STATUS – DAMAGING OF GEOGRIDS



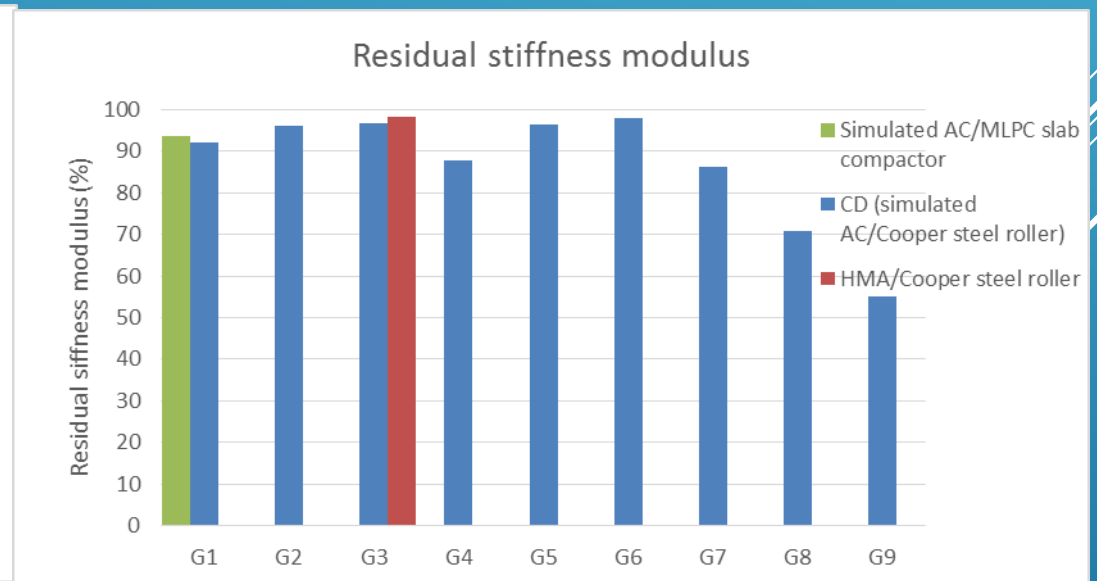
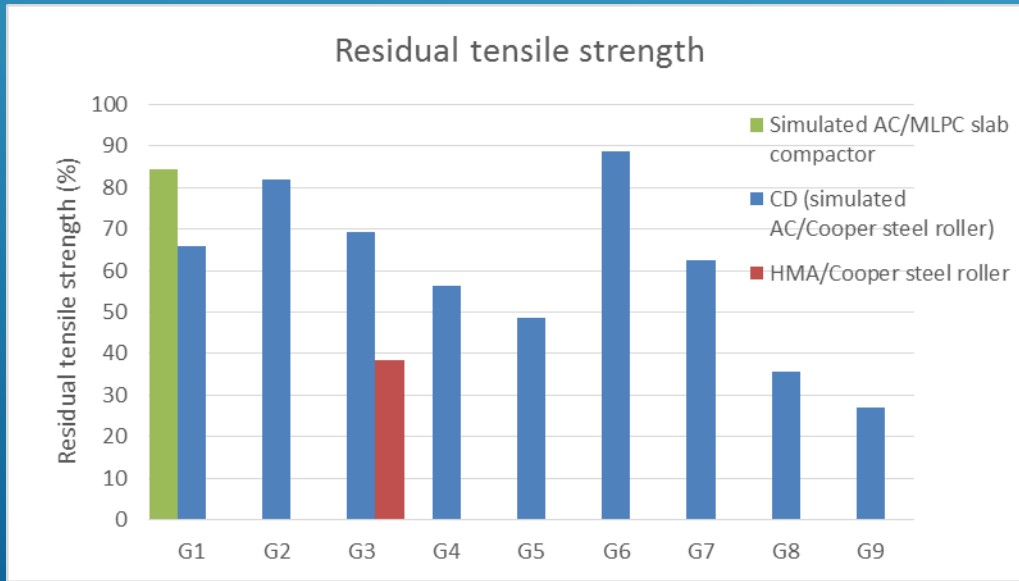
Effect of the traffic
Grids over AC mix
large rutting device
500 cycles



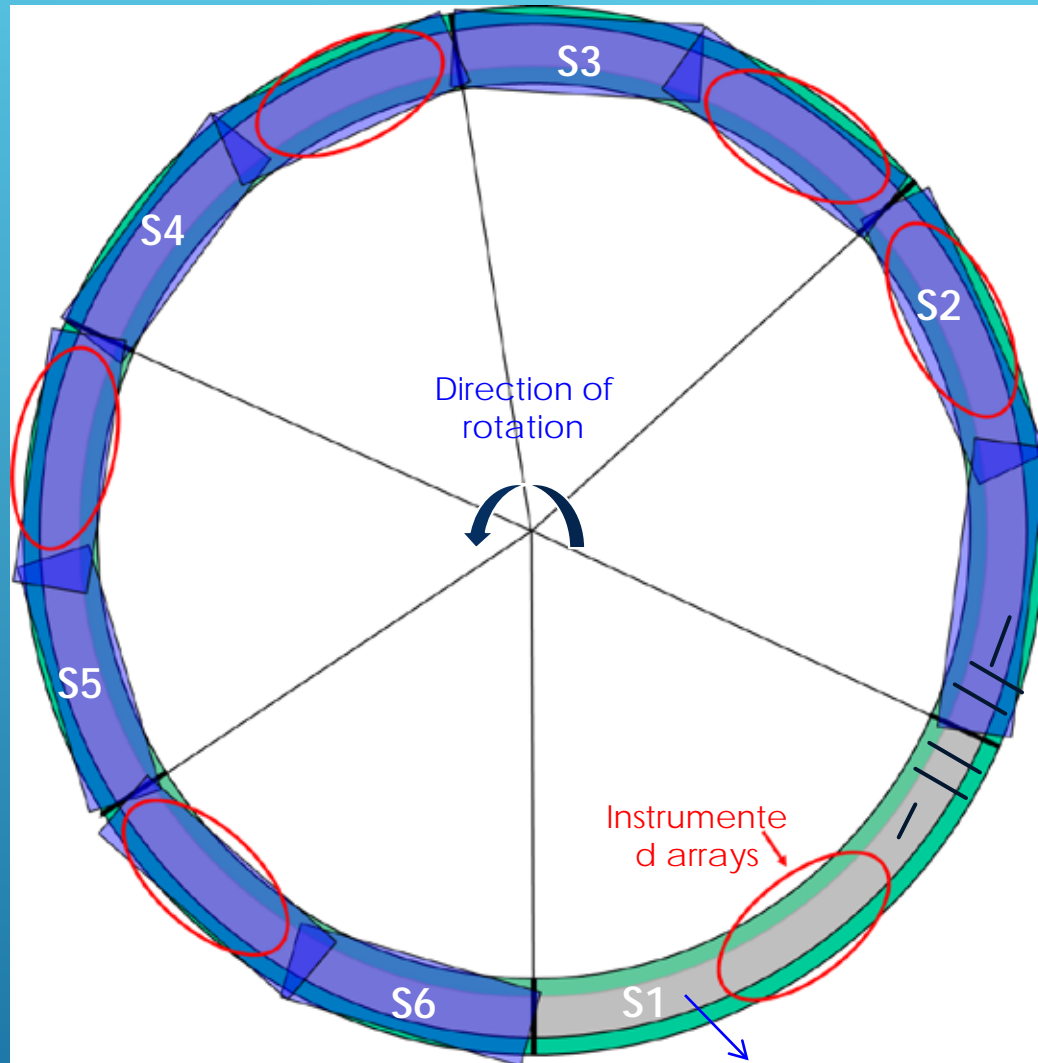
Simulation of compaction
Compacted @ room temperature
Grids available for characterization

STATUS – DAMAGING OF GEOGRIDS

Measurement of residual mechanical characteristics



STATUS FULL SCALE EXPERIMENT FATIGUE CARROUSEL



S1	BBSG référence	11 cm
S2	BBSG + grid A	5+6 cm
S3	BBSG + grid B	5+6 cm
S4	BBSG + grid C	5+6 cm
S5	BBSG + grid D	5+6 cm
S6	BBSG Warm +grid A	5+6 cm

Grid A

Cracks in
AC Mix layer

Traffic lane
1,6 m width

STATUS FULL SCALE EXPERIMENT FATIGUE CARROUSEL

1,5 Millions loadings @ 70 km/h /January – June 2018



Strains in AC mix , in grids, vertical strain basement, temperature

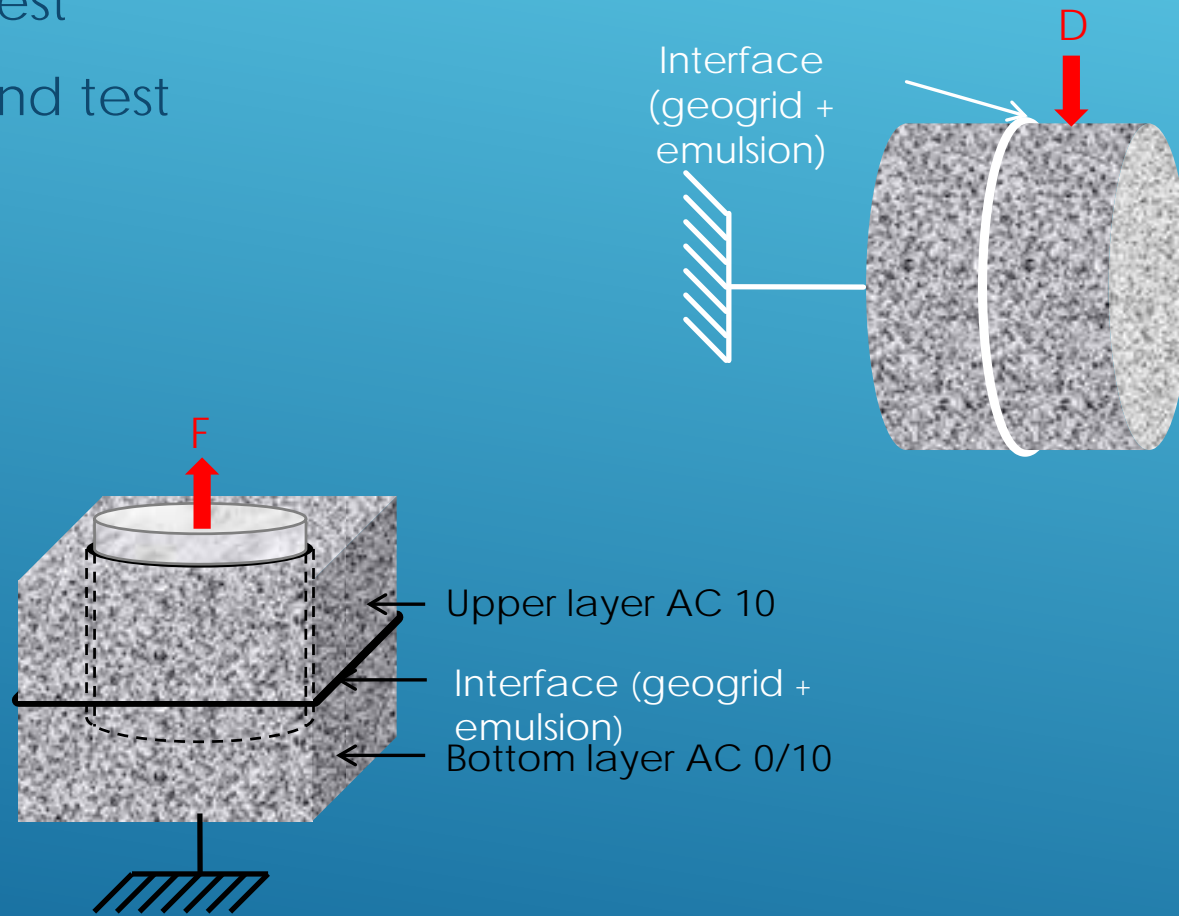
Comparison between Modeling and Carrousel results
Deconstruction environmental measures (dust)

STATUS : BONDING BETWEEN LAYERS

„ According to EN 12697-48

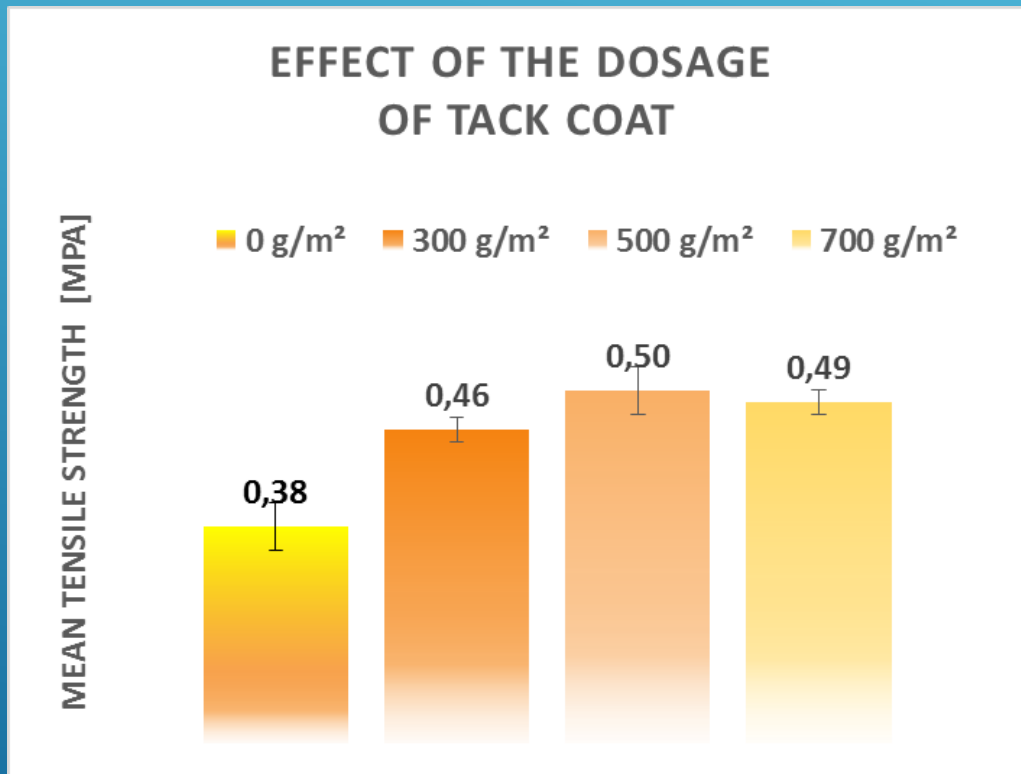
„ Tension Test

„ Shear Bond test

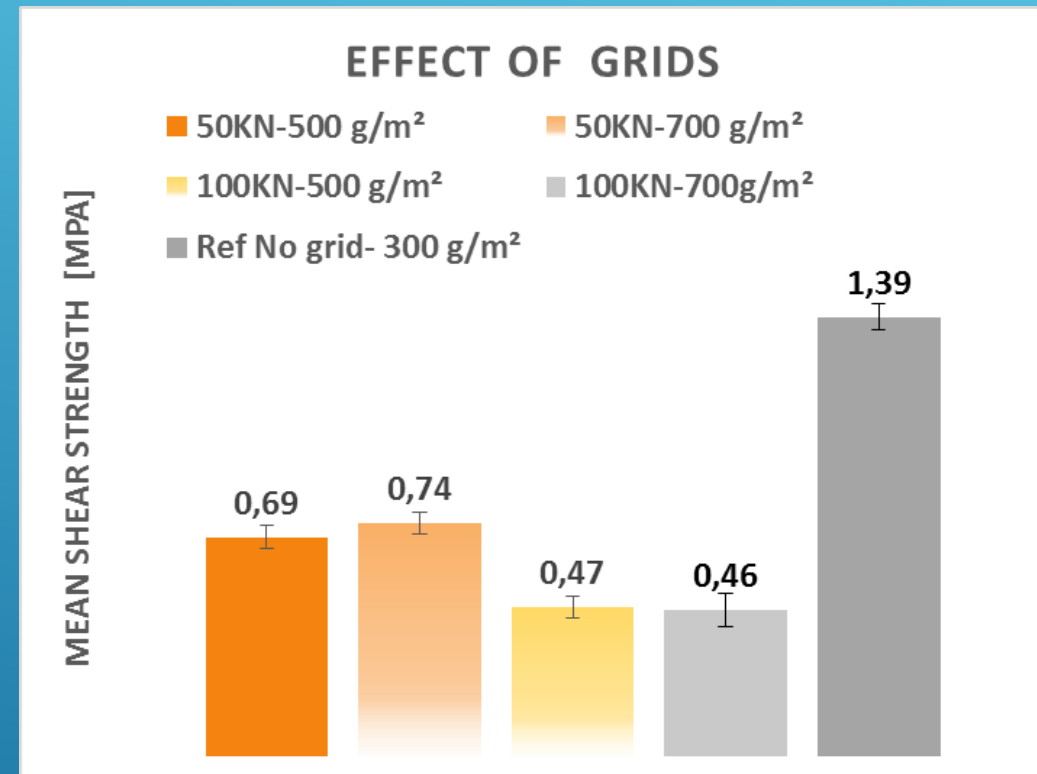


STATUS : BONDING BETWEEN LAYERS

Tensile test



Shear Test



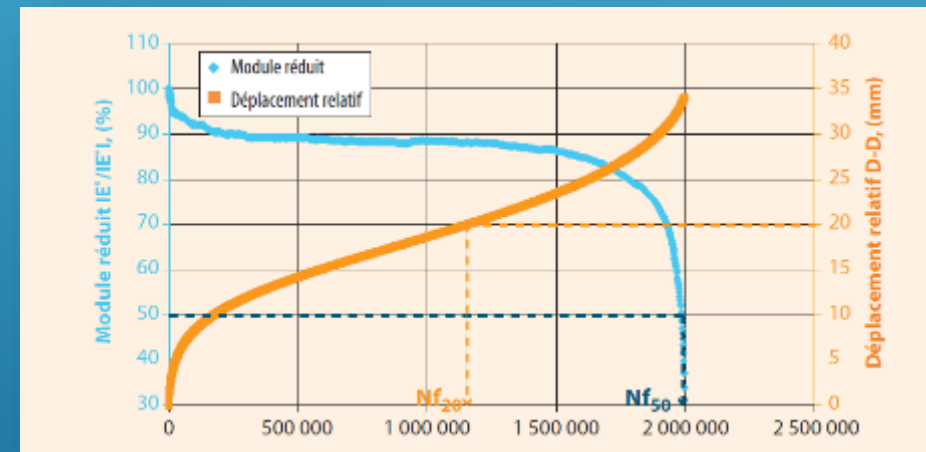
GRIDS CONTRIBUTION TO MECHANICAL IMPROVMENT OF THE PAVEMENT

New 4 PT BD

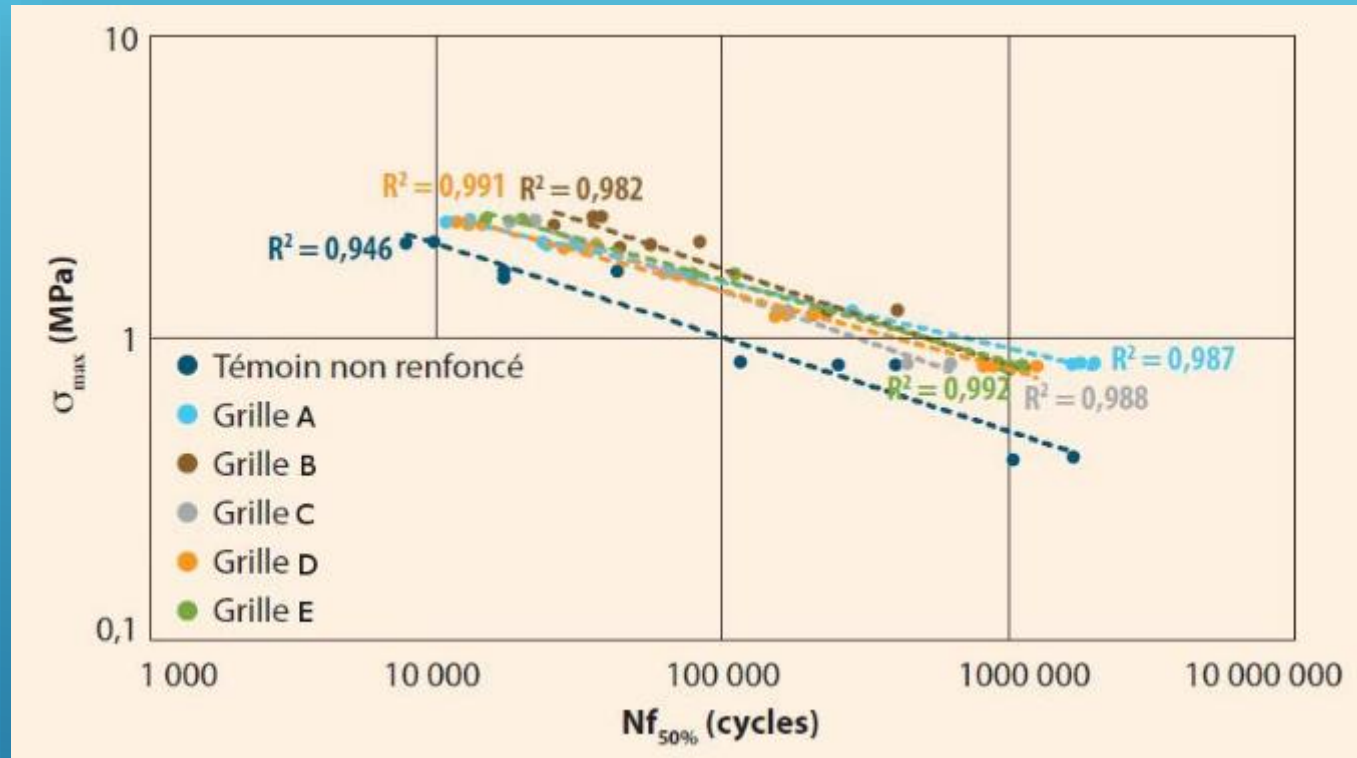
- „ Test conditions
 - „ Loading F between 0 à F_0
 - „ AC 10
 - „ 10 Hz, 15°C



- „ Nf_{50} : Number of cycles to reduce Modulus of 50%
- „ Nf_{20} : Nombre de cycle to reach a permanent strain of 20 mm




GRIDS CONTRIBUTION TO MECHANICAL IMPROVMENT OF THE PAVEMENT



Référence	Grille	$\sigma_6 / \sigma_{6\text{témoïn}} (Nf_{50\%})$	$\bar{N}f_{20} / \bar{N}f_{20\text{témoïn}}$
A		1,87	4,59
B		1,65	4,31
C		1,36	2,99
D		1,60	2,97
E		1,69	4,8

Confirmation of mechanical improvement of the structure compared to results from NPC

TO CONCLUDE

- Ø Reinforcement with fiber geogrids :
 - Ø Interesting solution
 - Ø Saving materials & energy
 - Ø Design for Colgrill R validated and confirmed
 - Ø New tools to qualify grids
 - Ø Still a Long Way to get a agreed validation process
 - Ø New tools available
 - Ø Methods for measuring Damage
- 

MORE DETAILS IN :

- „ Godard Eric, Chazallon Cyrille, Hornych Pierre, Nguyen Mai Lan, Doligez Daniel, Pelletier Hervé, Pour une solution durable du renforcement des infrastructures par grilles en fibre de verre, RGRA, 949, Octobre 2017, p24-33
- „ C Chazallon, T.C. Nguyen, M.L.Nguyen, P. Hornych, D. Doligez, L. Brissaud, E. Godard, “In situ evaluation of geogrid used in asphalt concrete pavement” BCRRA 2017 Athens
- „ M. Gharbi, M.L. Nguyen, A. Chabot « Experimental evaluation of the interface fracture energy for composite pavements » EATA 2017, 12-14 juin Dubendorf, Switzerland
- „ M. Gharbi, M.L. Nguyen, S. Trichet, A. Chabot « Characterization of the bond between asphalt layers and glass grid layer with help of a Wedge Splitting Test » BCRRA 2017 Athens
- „ C. Chazallon, C Barazzutti, H. Pelletier, M.L. Nguyen, P. Hornych, D. Doligez « Laboratory evaluation and reproduction of geogrid in situ damage used in asphalt concrete pavement” ISAP 2018
- „ M. Gharbi A. Chabot « Characterization of debonding at the interface between layers of heterogeneous materials coming from roads » CFM 2017