NATIONAL ACADEMIES *Sciences Engineering Medicine*

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Anticipated Truck Loadings in Pavement Design—Part II

December 19, 2024

12:00 – 1:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

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AICP Credit Information

1.5 American Institute of Certified Planners Certification Maintenance Credits

You must attend the entire webinar

Log into the American Planning Association website to claim your credits

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Purpose Statement

This webinar will facilitate proactive considerations to changes in pavement loading due to advancements in truck technology. These advancements impact current pavement design methods for durable and resilient pavements in the future.

Learning Objectives

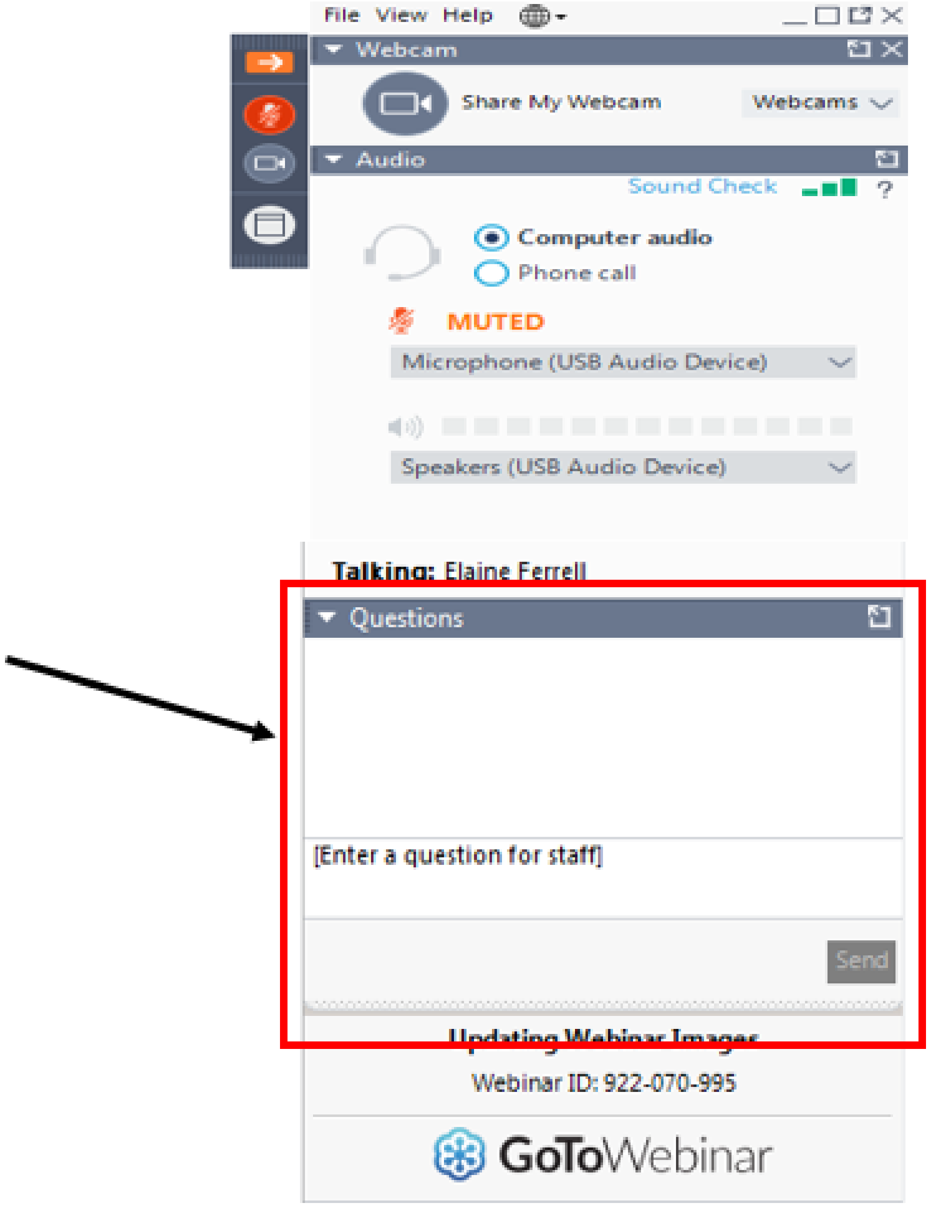
At the end of this webinar, you will be able to:

(1) Speak to the impacts that emerging truck technologies have on highway pavement loading such as weight and frequency

(2) Identify considerations in pavement design methods and rehabilitation strategies due to anticipated changes in highway loading

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters

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Design and testing of pavements with integrated charging systems for electric vehicles
Recent studies in France

Université Gustave Eiffel

Introduction

To limit global warming France's objective is to be carbon neutral by 2050.
For transport, this means **complete decarbonization of land transport by 2050**.

In France, the sector of transport is responsible for **31 % of CO_2 emissions**

94 % of transport emissions come from road transport
Therefore to reduce $C0_2$ emissions, it is **vital to decarbonize road transport**

For **heavy-duty vehicles (HGVs),** solutions for decarbonization are biofuels, battery electric, hydrogen or **Electric Road Systems (ERS).**

ERS consist in supplying electricity continuously to vehicles on the road, to improve the range of the vehicles without the need of very heavy and expensive batteries

→ **Impact of these new ERS technologies on pavements ?**

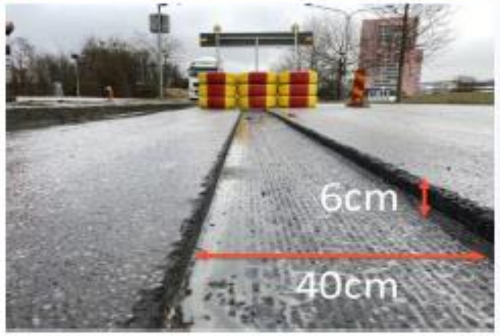
Electric Road technologies

3 ERS technologies		Advantages	Limitations
Conductive charging by catenaries		- High charging power - Compatible with different pantographs - Large experience in the rail sector - No impact on pavements	- Non interoperable - Risk of fall of cables - Need of regular cable maintenance - Visual impact
Conductive charging by rails		- High charging power - Interoperable between different vehicle types - No visual impact	- Less mature technology - Road safety - Robustness of the current collector - Rail cleaning and Winter maintenance - **Impact on pavement durability**
Inductive charging		- Interoperability - Electrical safety - Low maintenance cost - No visual impact	- Lower charging power - Electromagnetic field exposure - Distance and alignment between primary and secondary coils - Heat dissipation - **Impact on pavement durability**

Next important challenge : demonstrating feasibility of road deployment

- Choice of solutions for road integration
- **Design/modelling of these solutions and validation**

Road construction method



Effects of temperature and water

Resistance to trafic

Maintenance

Winter Maintenance

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Modelling and design of inductive solutions
INCIT-EV Project

Road integration of inductive charging systems

Main integration challenges :

- Material selection for ensuring protection of the charging system and electromagnetic compatibility (no metal)
- Resistance to traffic loads with systems embedded at low depth
- Heat losses of the charging system – Impact on pavement materials
- Resistance to temperature variations

Need to develop new Models for :

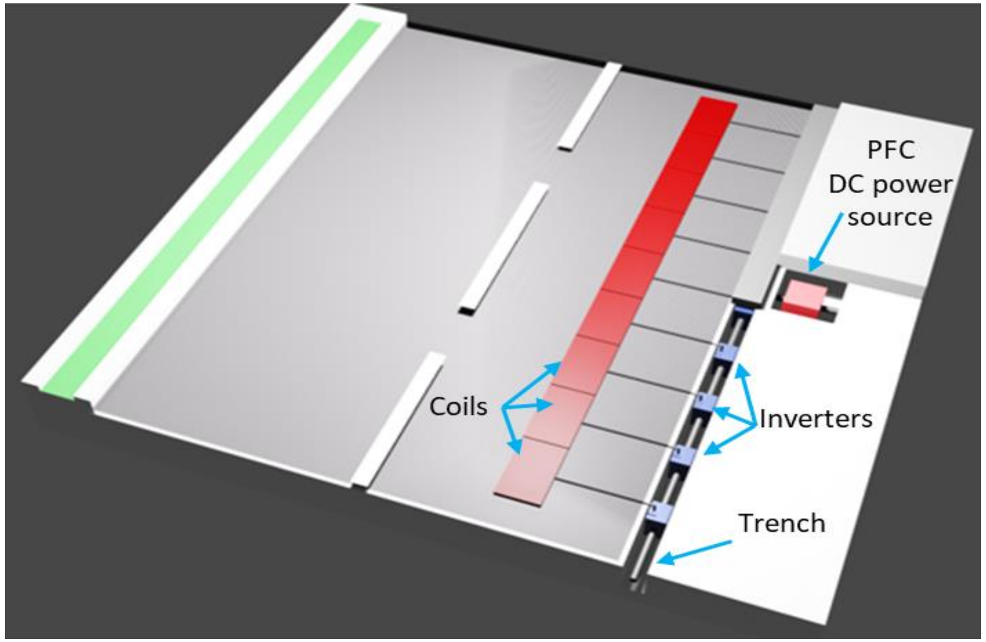
Mechanical behaviour under traffic loads

Thermal behaviour : heat dissipation in the inductive coils

Different modelling approach from classical pavements, due to embedded charging systems → **Finite element modelling**

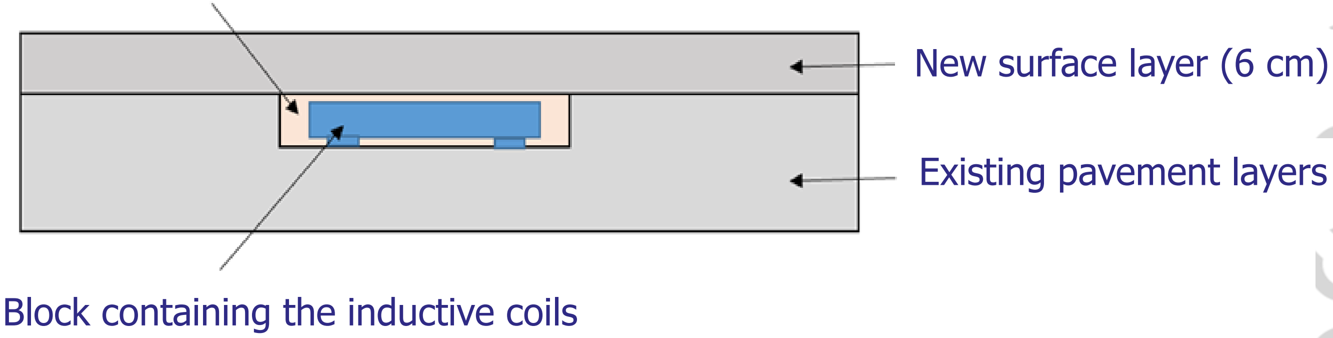
INCIT-EV Project - development of inductive charging demonstrator

System layout

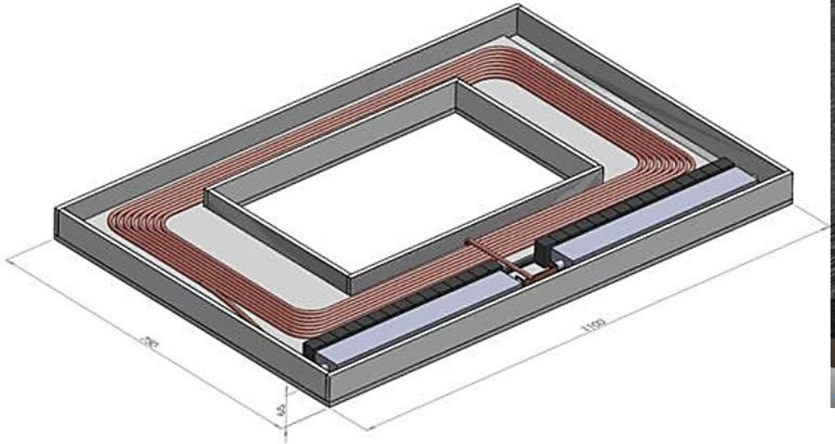


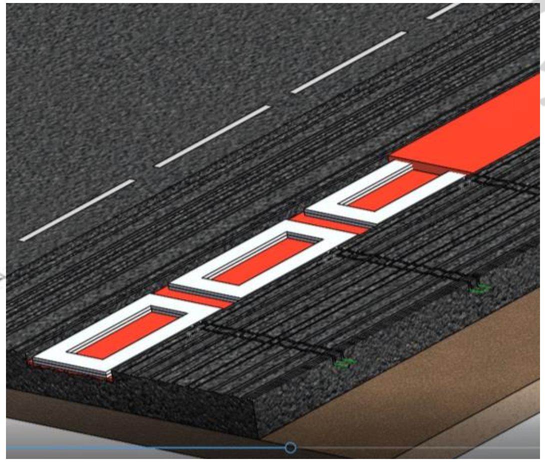
Solution for pavement integration

Trench + sealing resin → importance of good bonding



Coil block





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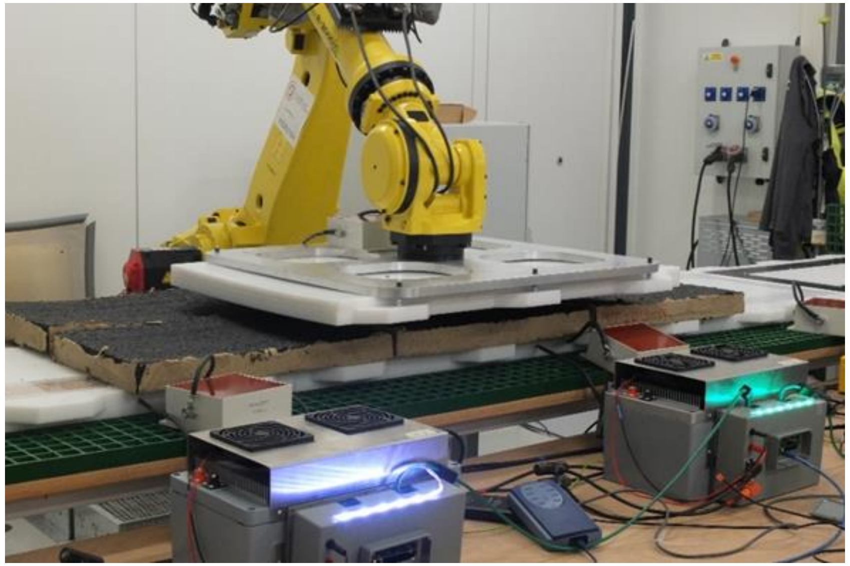
Laboratory testing of the charging system

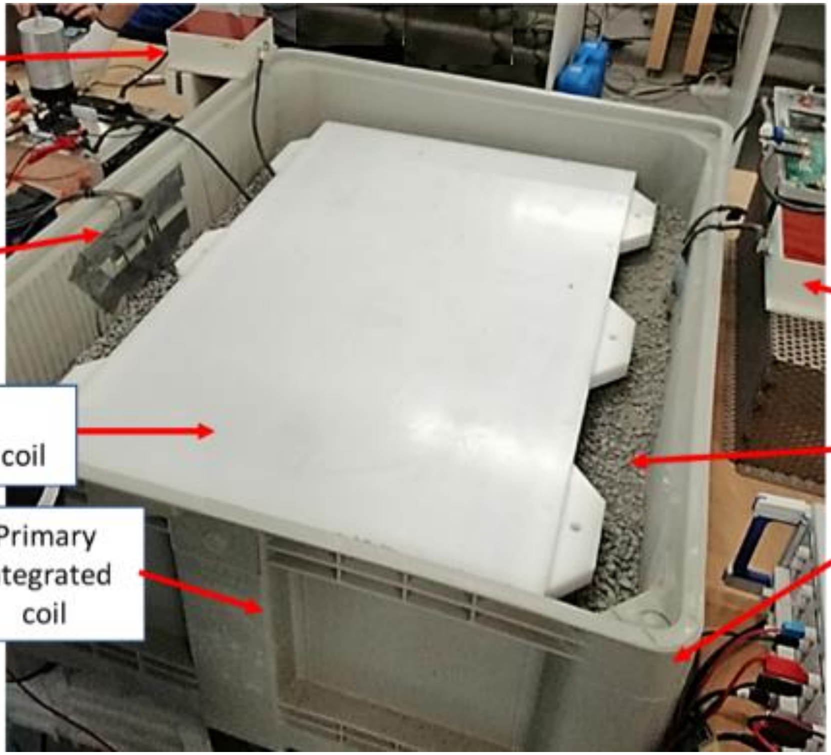
⇨ **Need to develop specific tests to determine the performance of the charging system in the road**

Testing of charging efficiency
With coils embedded in asphalt material



⇨ Optimisation of charging system

Measurement of heat losses during charging
with coils embedded in granular material



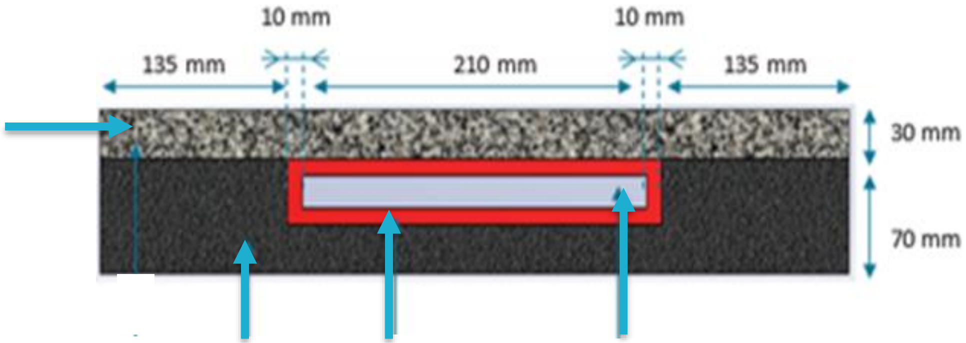
Laboratory testing of solution for road integration

Wheel tracking tests on small scale specimens with embedded coil blocks

Wheel tracking test at 60 °C

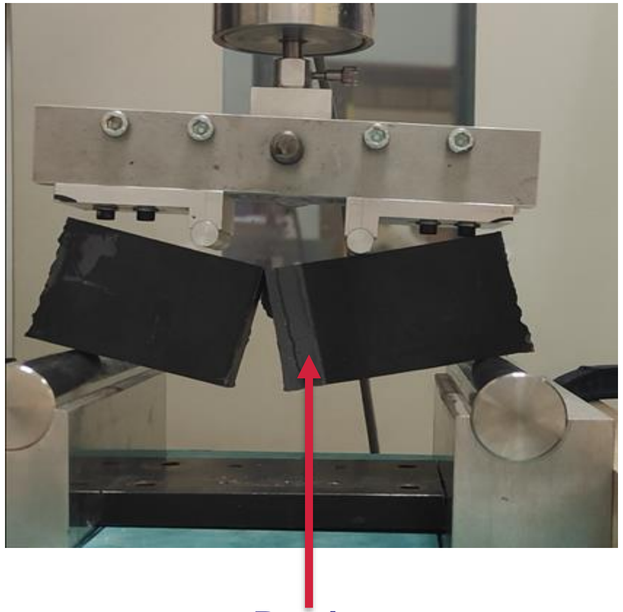
Study of rutting resistance under 30000 load cycles

Specimen geometry



Testing of bonding between coil block and sealing resin

4 point bending tests



⇨ Selection of suitable coil materials and sealing resins

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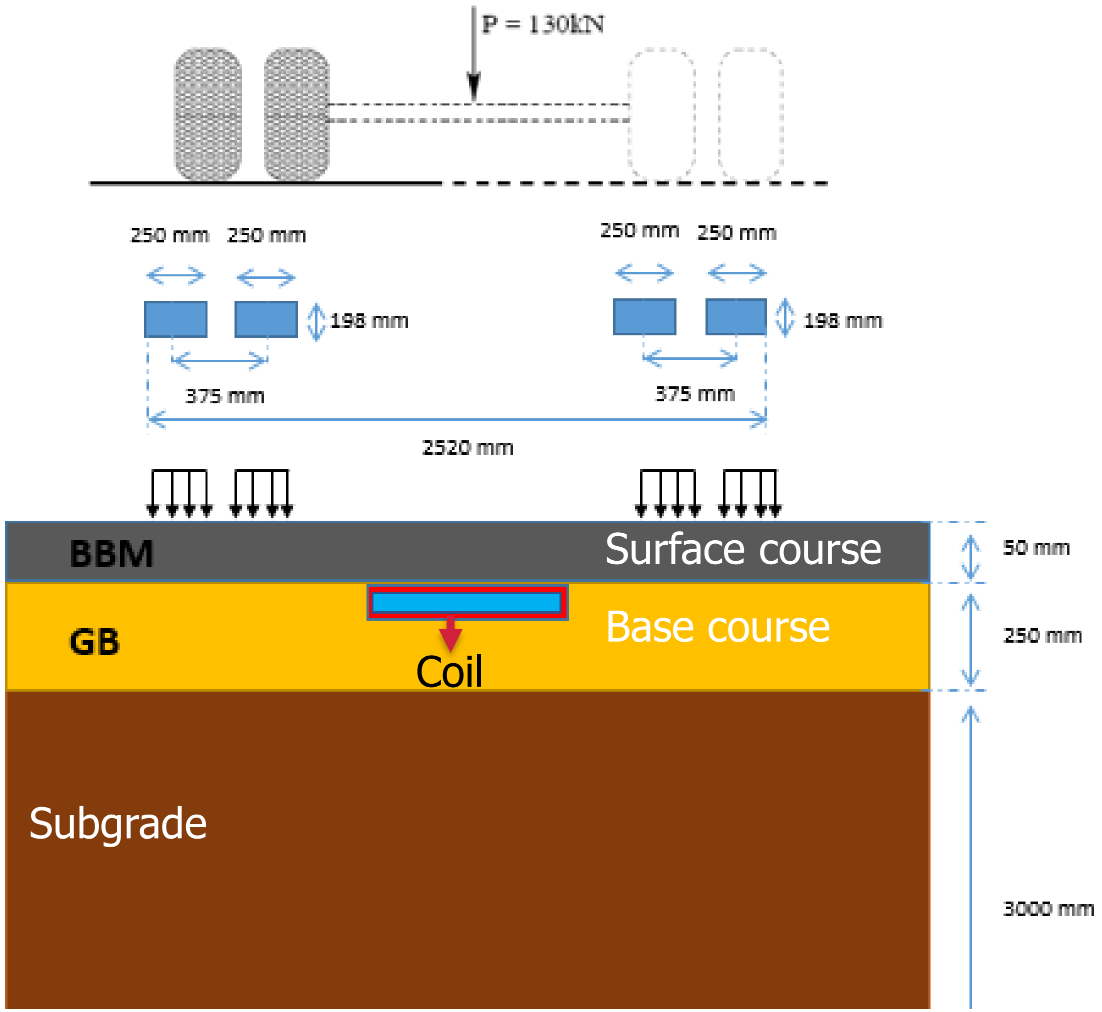
Modelling of mechanical behaviour

Finite element calculations (in 3D)

Pavement structure and loading



Material characteristics (linear elastic , at 15 °C)

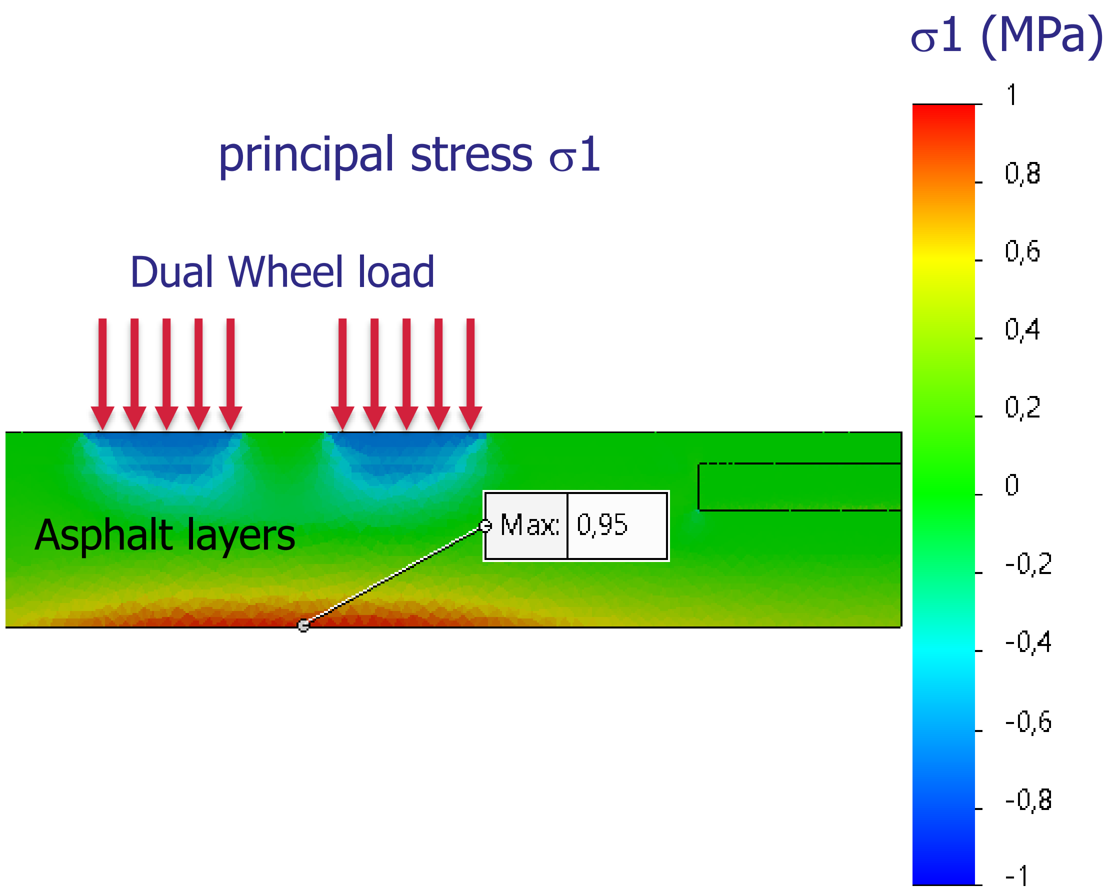
Material	E (MPa)	ν	ρ (kg/m³)
Resin 1 Resin 2	500 MPa 5660 MPa	0.45	1830
Coil block (PUR)	2300 MPa	0.40	950
BBM	5400 MPa	0.35	2350
GB	9300 MPa	0.35	2350
Sol PF2	50 MPa	0.35	2000

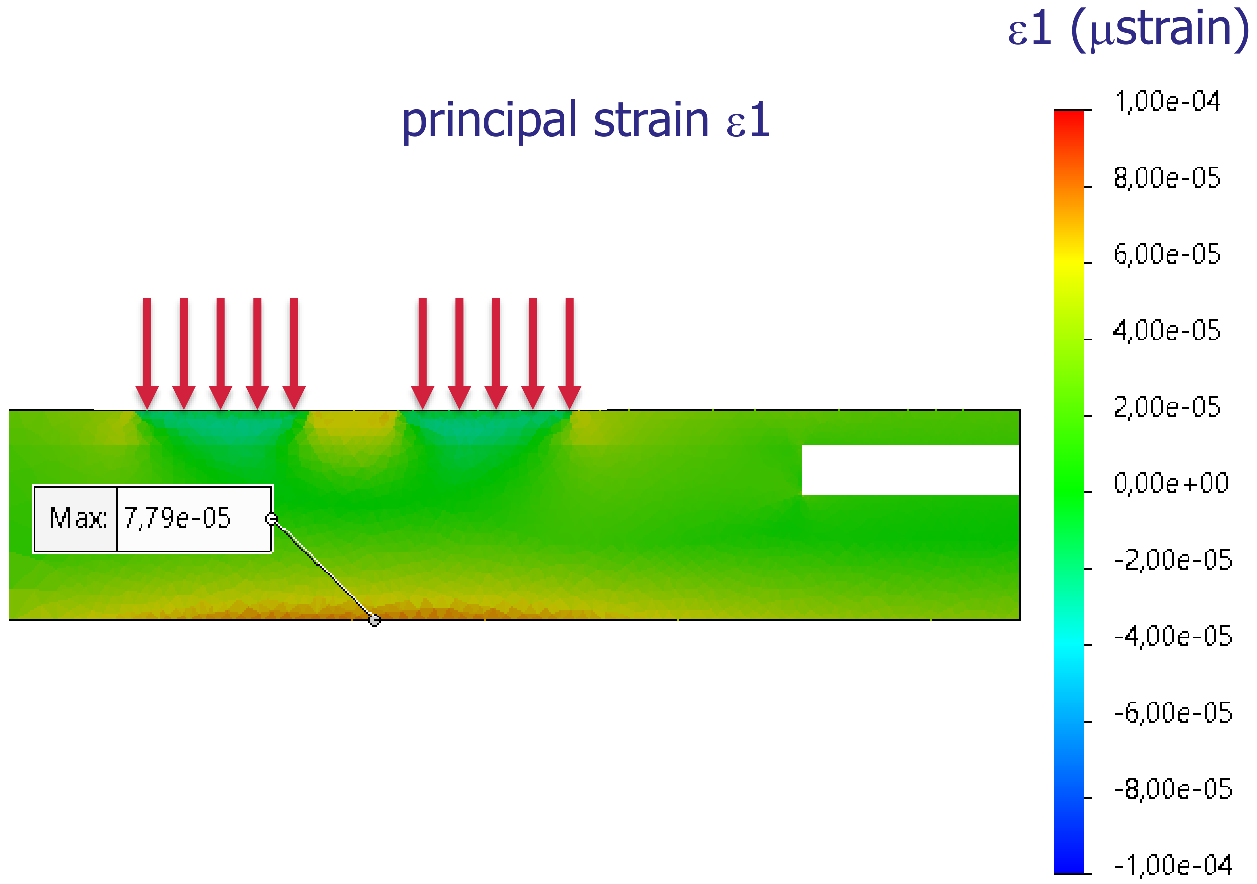
⇨ **Calculation of critical stresses and strains** under heavy vehicle axle loads for 3 different load positions

Modelling of mechanical behaviour

Stresses and strains in Electric Road System under wheel loading

Position 1 – coil in the middle of the wheel path





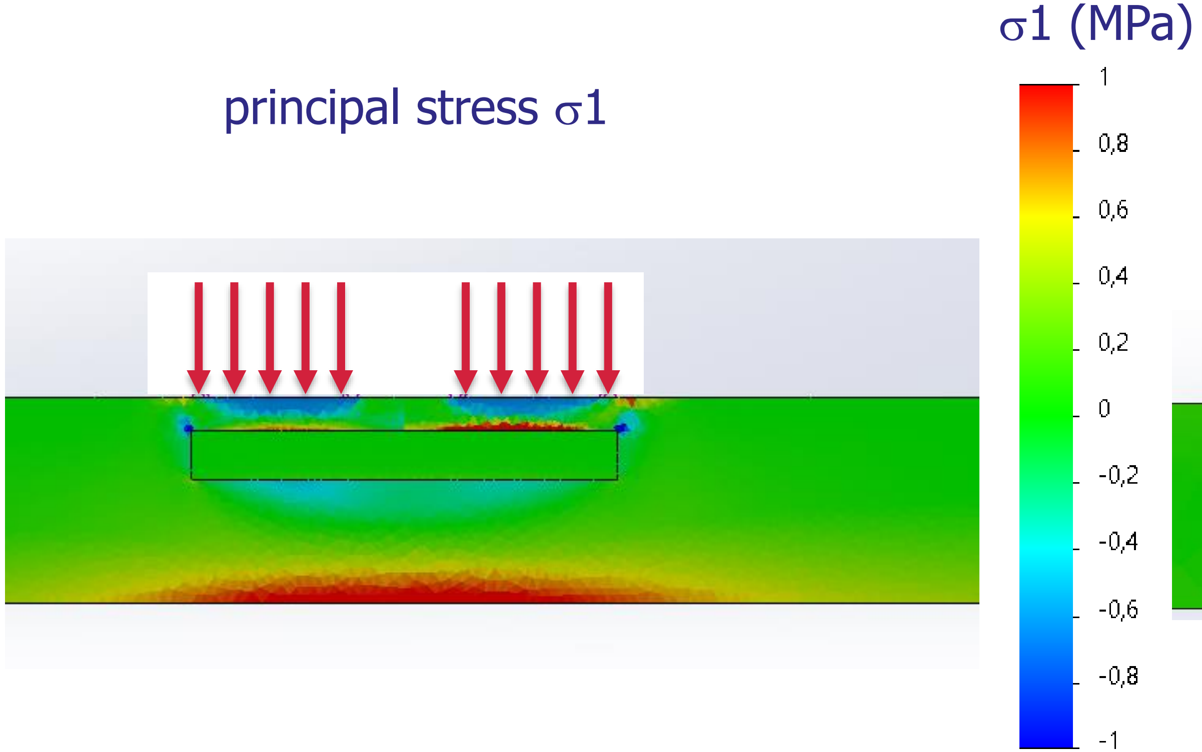
Position 1 : No significant stresses and strains applied on the coils

Modelling of mechanical behaviour

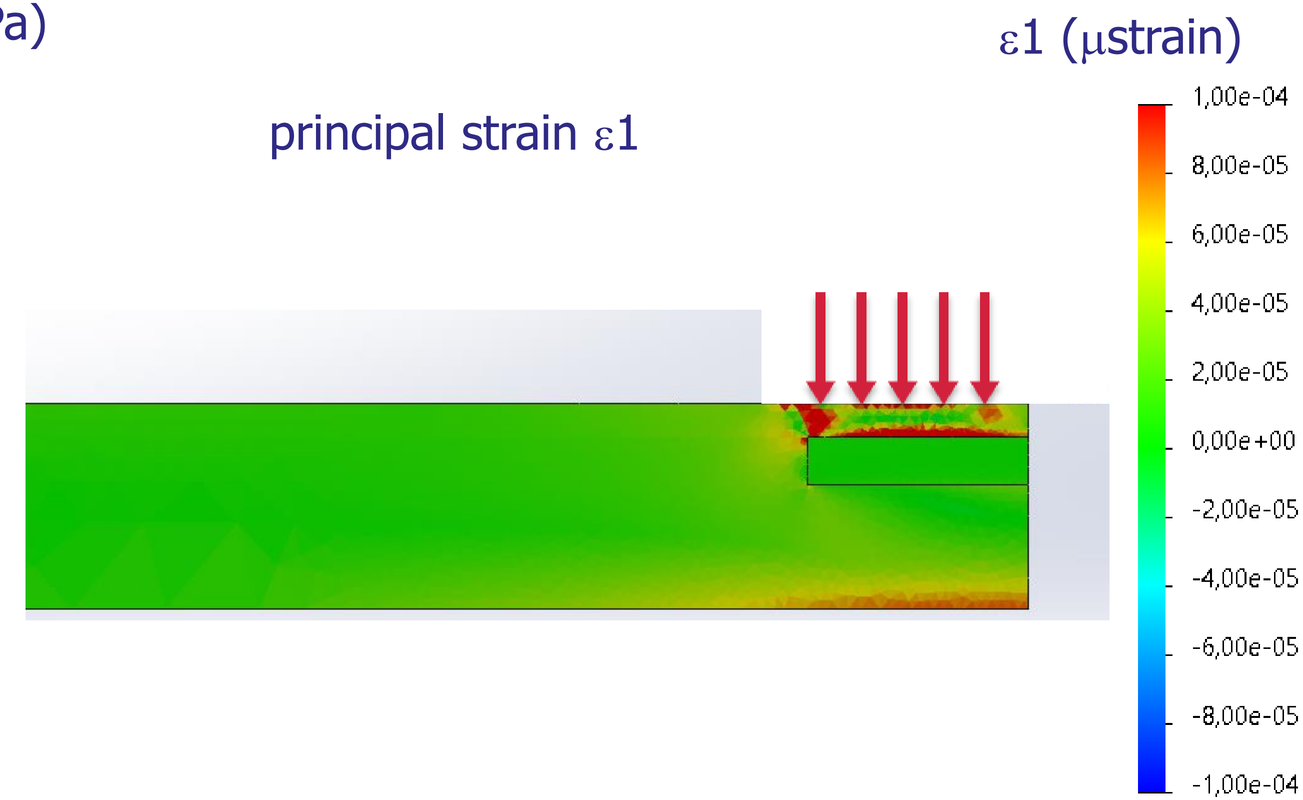
Stresses and strains in Electric Road System under wheel loading

Position 3 – wheels centered on the coil

principal stress σ1



principal strain ε1



Position 3 : Significant tensile stresses and strains above the coils
Possible risk of cracking or debonding

Modelling of mechanical behaviour

Maximum stresses and strains for different wheel positions

Position 1 – coil in the middle of the wheel path
Position 2 – wheels at the edge of the coil
Position 3 – wheels centered on the coil ⟶ Critical position

Critical stresses and strains with resin 1

Loading case	Position 1	Position 2	Position 3
σ_1 : Max principal tensile stress in AC (MPa)	0.954	1.03	2.85
ε_z : maximum vertical strain in subgrade (µstrains)	-287	-313	-349
ε_1: **maximum** extension strain in AC (µstrains)*	80.0	130	865

Critical stresses and strains with resin 2

Position 1	Position 2	Position 3
0.95	0.95	1.01
-274	-280	-301
77	77	80

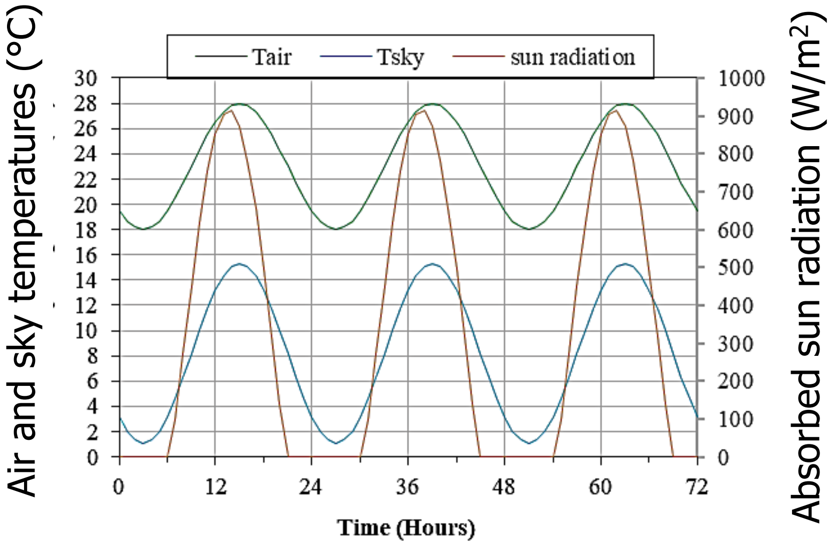
Values in red ⇨ Risk of failure due to high stress or strain levels

Simplified approach, based on elastic calculations, with classical pavement fatigue failure criteria

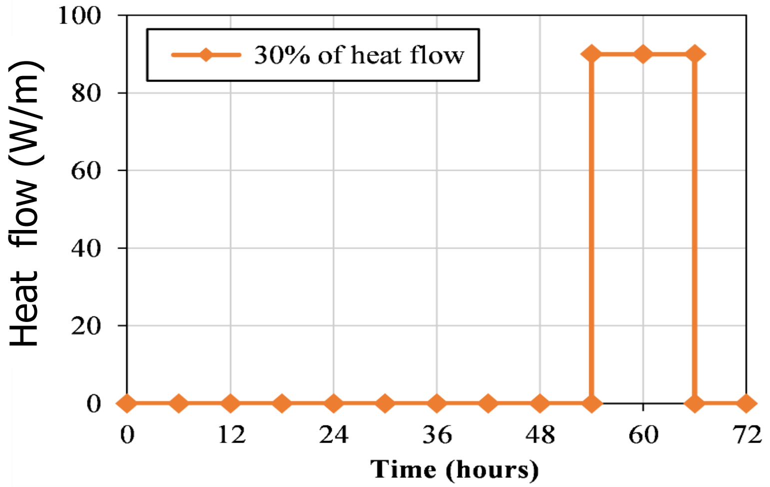
Need to define more appropriate failure criteria for ERS components

Modelling of thermal behaviour- 2D finite element calculations

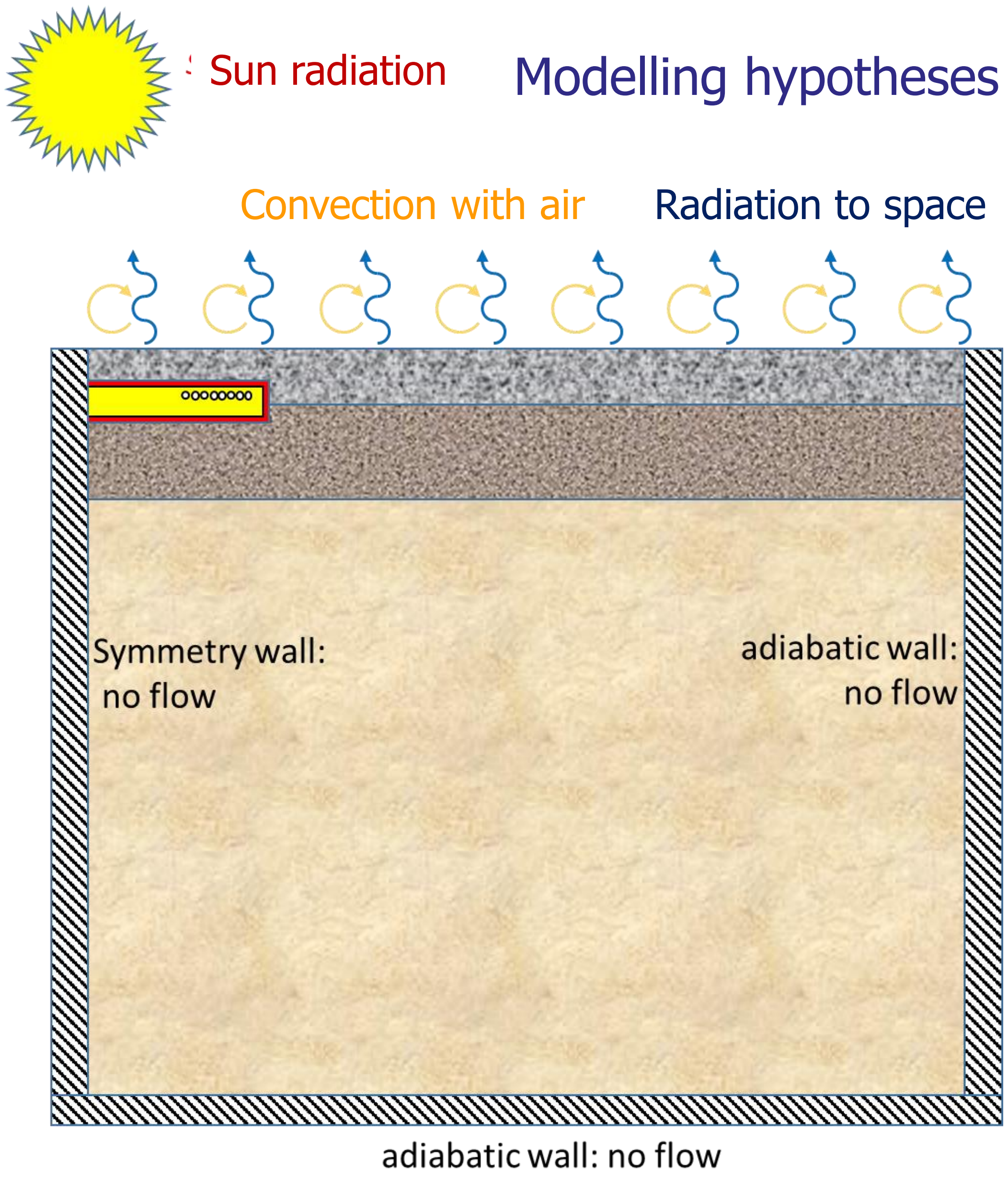
Air temperature and sun radiation (daily variations – summer conditions)



Heat loss in charging system

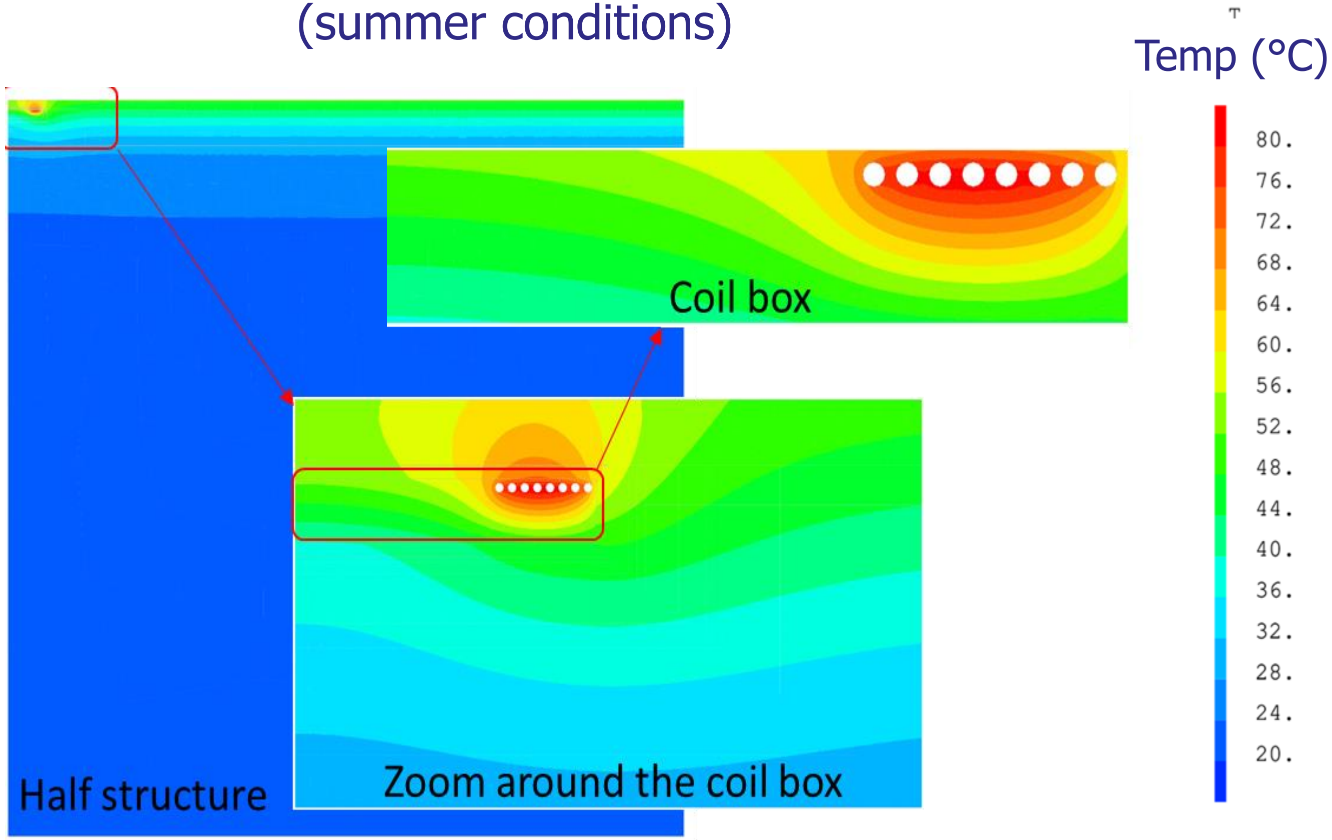


Modelling hypotheses



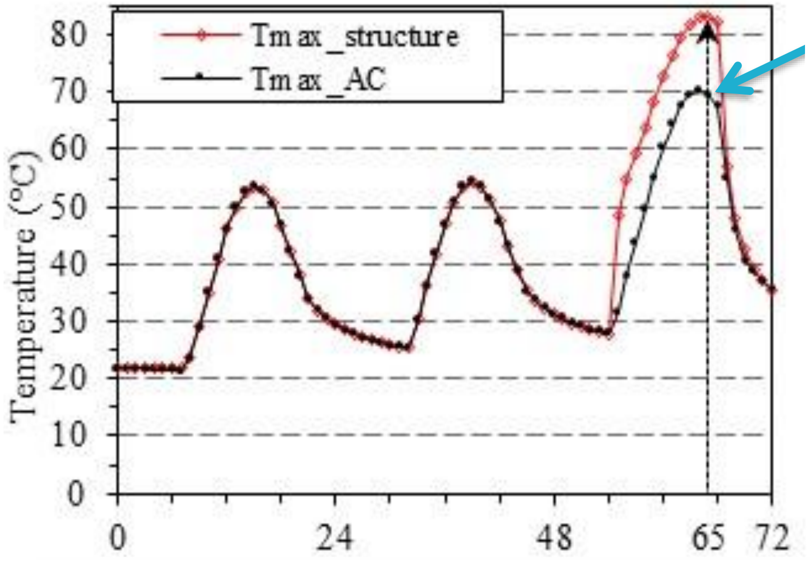
Modelling of thermal behaviour

Maximum calculated temperatures
(summer conditions)

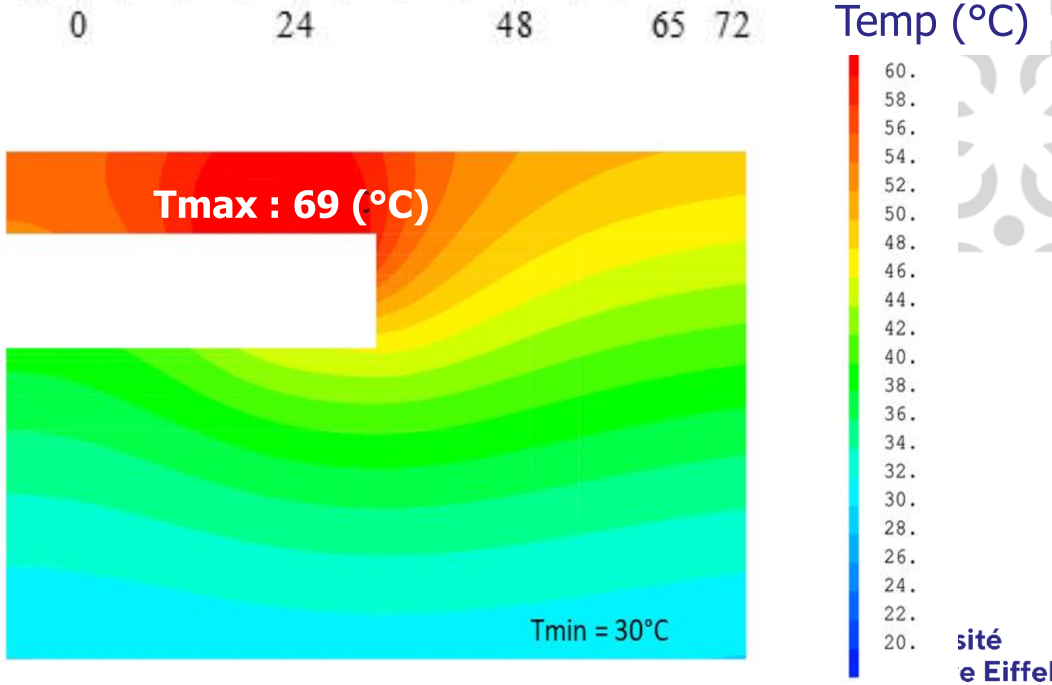


Temperature increase of about 15 °C due to
heat losses in the inductive coils

Daily maximum temperatures in coil and asphalt concrete



Temperature increase due to coil heat loss



Conclusions :

Need to develop specific tests and models to design and evaluate Electric Road systems

Testing :

- Need to select suitable materials for the protection of the coils
- Need to evaluate both mechanical and thermal behaviour
- Importance of interfaces and thermal expansion properties
- Need of tests at different scales (material properties, small scale prototypes, full scale prototypes)

Modelling :

- Need to model mechanical and thermal behaviour
- Difficulty to define appropriate failure criteria, especially for cyclic loading
- Validation of models by appropriate tests is essential

Electric Road systems represent a new research field for road engineers, with lots of challenges to achieve efficient, durable and cost-effective charging solutions !

Accelerated pavement testing
Charge as you Drive project

Project Charge as You Drive (CAYD) (2023 – 2026)

Partners : Vinci, Université Gustave Eiffel, Electreon, Elonroad, Hutchinson

Development of inductive ERS demonstrator (Electreon System)

Challenges

- Demonstrate charging **in real conditions on a motorway**, with 3 categories of vehicles : heavy truck, bus and light utility vehicle
- High speed operation (90 km/h)
- High charging power : 200 kW

2023 – 2024 : Laboratory testing of components and inductive coils design improvements

Large APT test on the Nantes accelerated pavement testing facility

Modelling of mechanical behaviour under traffic loading

2025 : Planned construction of 1.5 km long demonstrator of **inductive solution** on motorway A10 near Paris

CAYD project – Accelerated pavement testing on inductive ERS

Need to validate road intergration solution before deployment on a real road

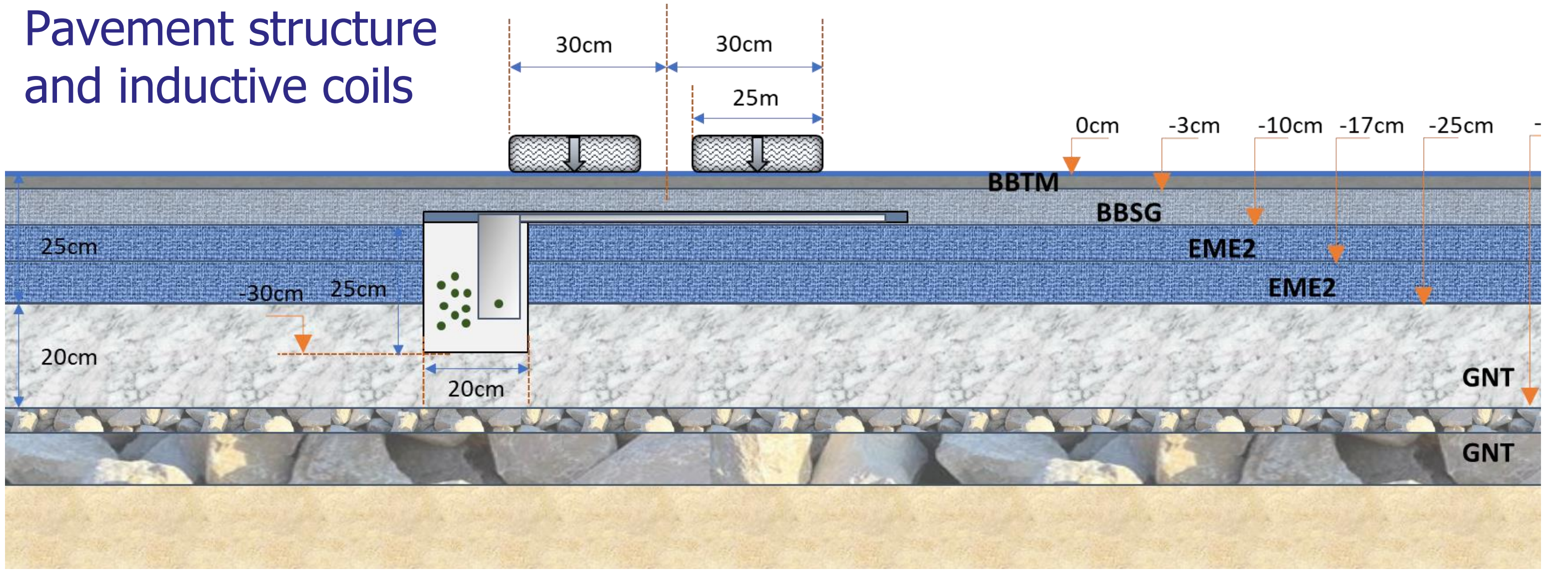
APT facility of Université Gustave Eiffel

Outdoor circular facility

- 40 m diameter (120 m long track)
- Maximum load per arm : 150 kN
- Maximum loading speed 100 km/h
- Lateral wandering (11 positions)
- Maximum loading capacity
  ≈ 500 000 loads / month
- 3 test tracks – mobile machine

CAYD project – APT testing of inductive ERS

Pavement structure and inductive coils



Motorway asphalt Pavement structure

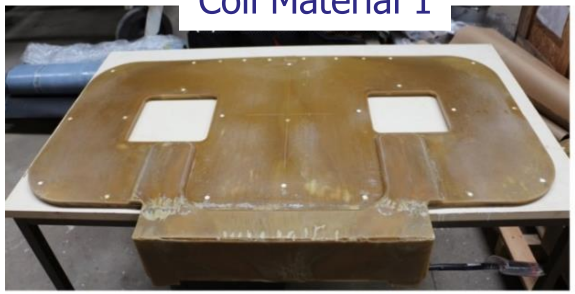
25 cm of asphalt materials over granular subbase

Coils placed at 10 cm depth, sealed with appropriate resin

Testing of 3 coil designs with protective materials of different stiffness

+ 3 bonding solutions : Resins A and B, and bitumen emulsion ⇒ need to ensure good bonding

Coil Material 1



Coil Material 2

Coil Material 3

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7 test sections

Total pavement length : 62 m

Test sections

0 - Reference section without coils

1 (10m) – Material 1 – Resin A

2 (16m) – Material 2 – Resin A

3 (22m) – Material 3 – Resin B

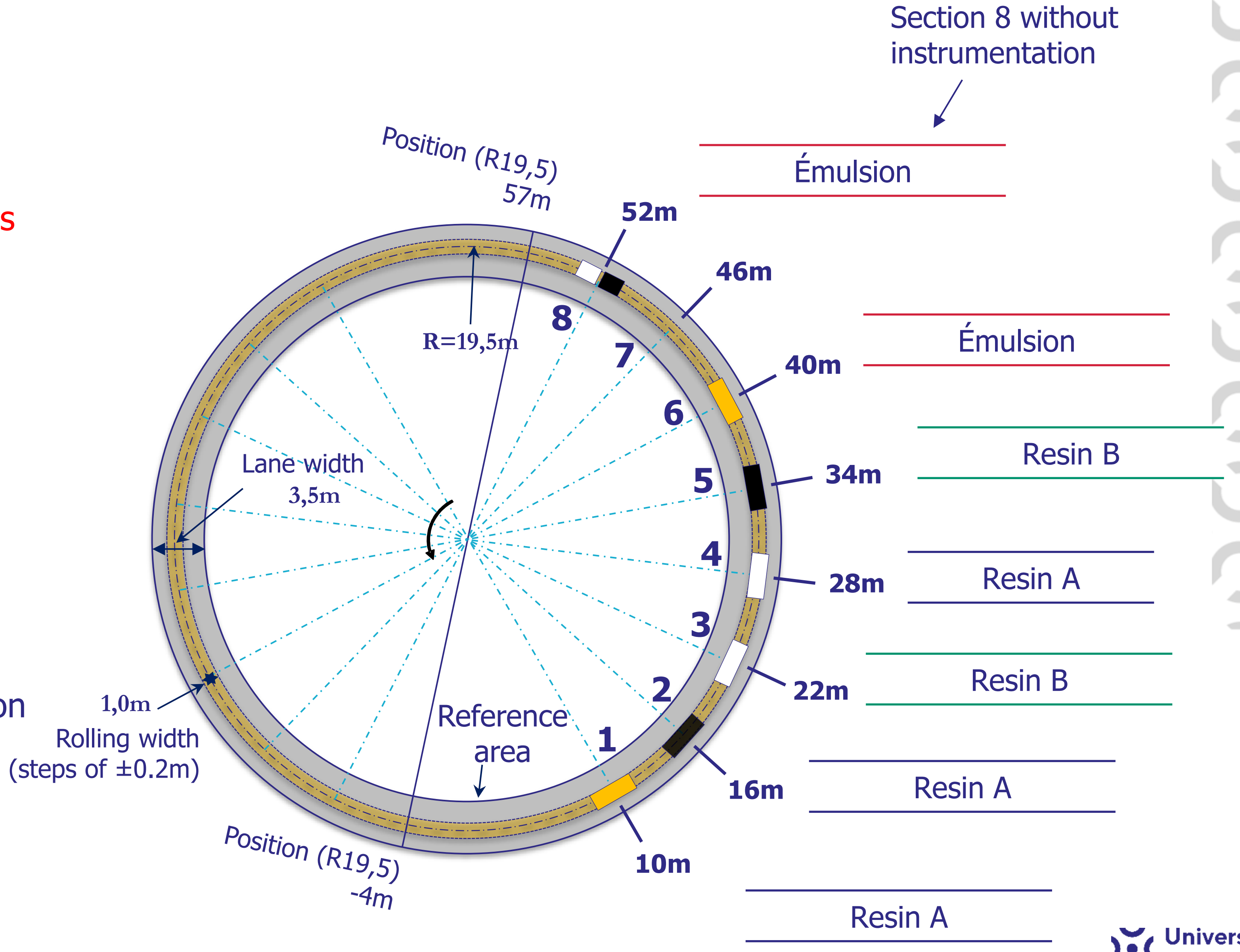
4 (28m) – Material 3 – Resin A

5 (34m) – Material 2 – Resin B

6 (40m) – Material 1 – Emulsion

7 (46m) – No Coils

8 (52m) – Material 2/Material 3 - Emulsion



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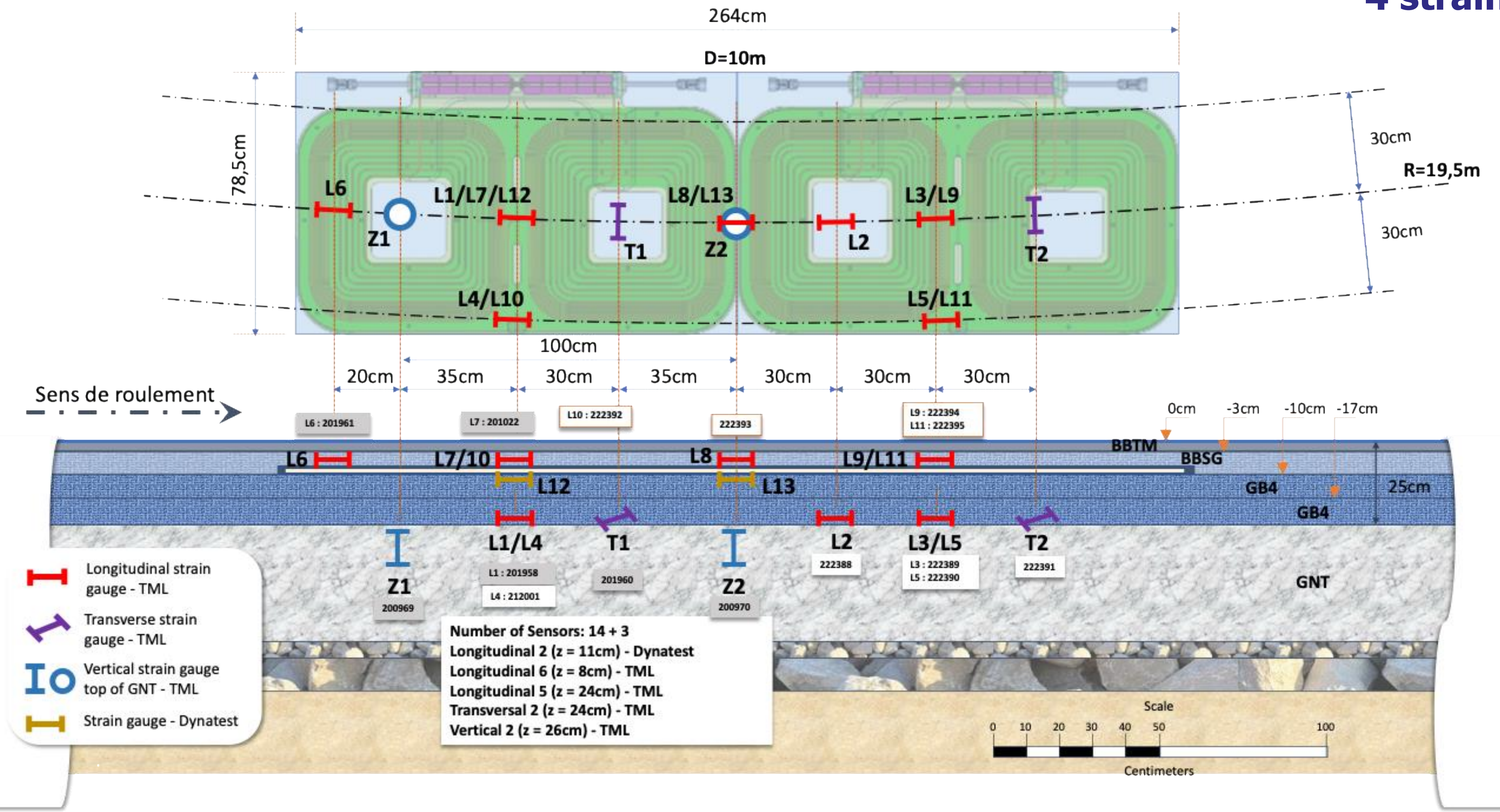
Example of Pavement Instrumentation

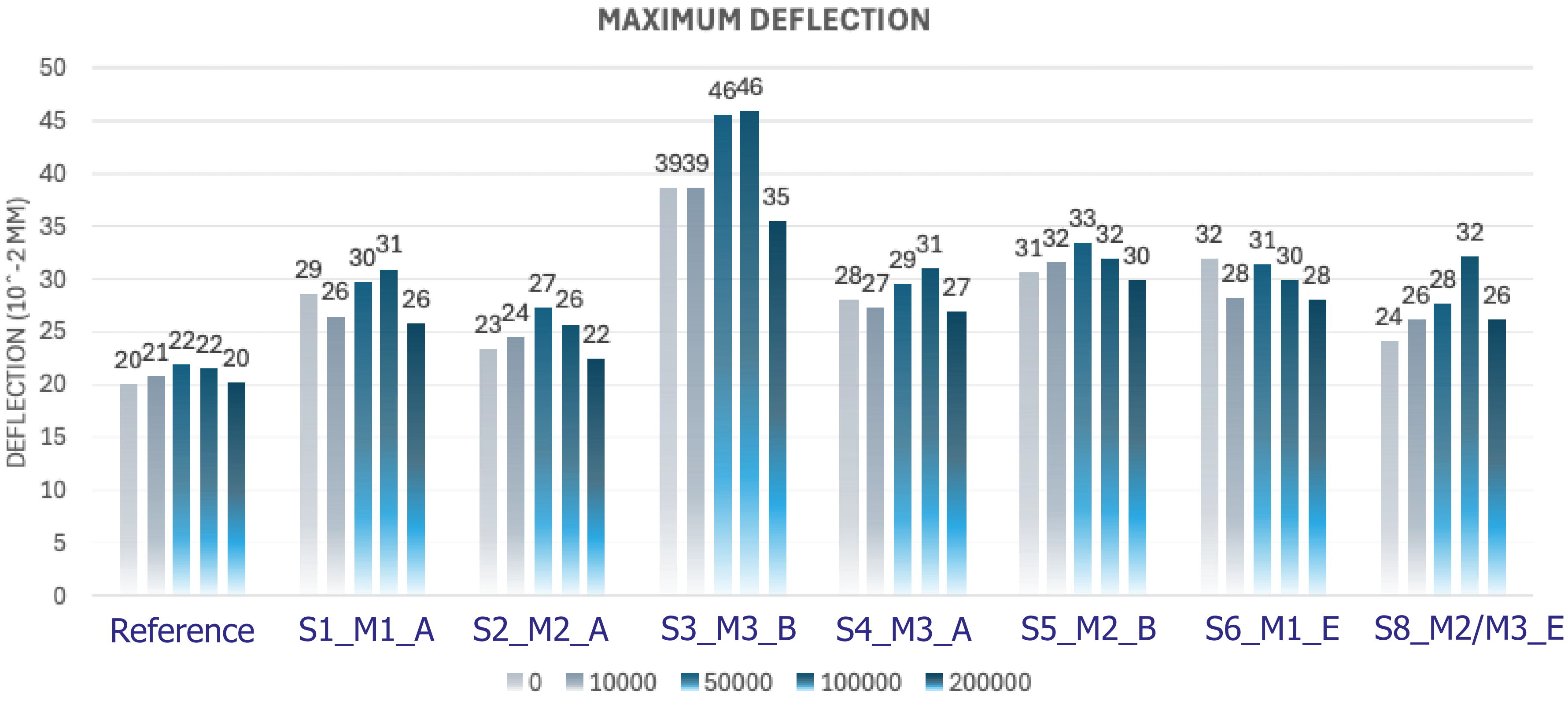


4 strain measurements levels:

- Longitudinal strains above the coils
- Longitudinal strains below the coils
- Longitudinal and Transversal strains at bottom of Asphalt base
- Vertical strains in granular layer

Deflection Measurements (FWD) – 65 kN load pulse

Comparison of maximum deflections (at 20 °C) at different numbers of load cycles



- Deflections increase on all sections with coils
- Deflections are similar on all sections except section 3 with soft protective material which presents higher deflections
- No significant increase of deflections with traffic level ⇨ No significant pavement damage

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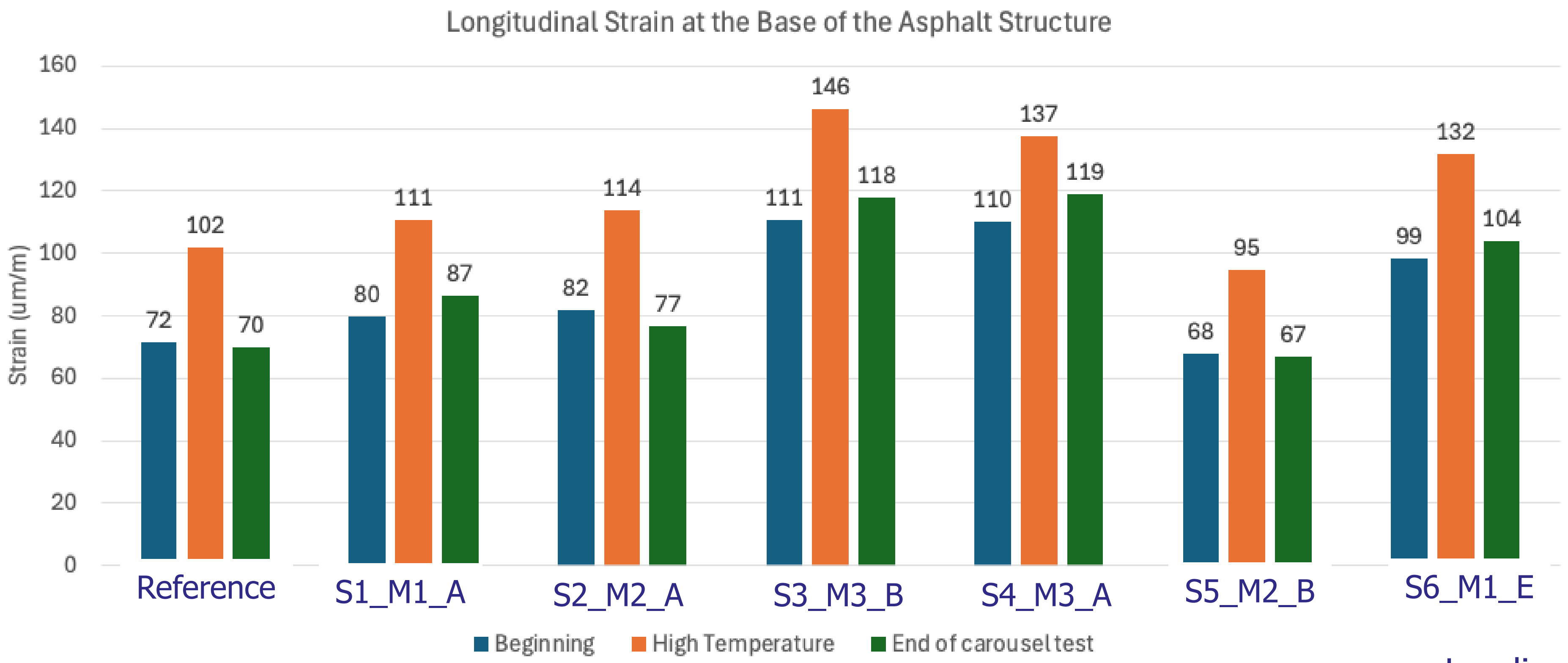
Strain measurements

Maximum longitudinal tensile strains at the bottom of asphalt base layers in all sections



- Significant strain increase at high temperature (48 °C on surface)
- No significant strain evolution with traffic at 25 °C (No damage)
- Higher tensile strains on sections 3, 4 and 6, but no “critical” values

Loading conditions:

- 65 kN
- 59 km/h

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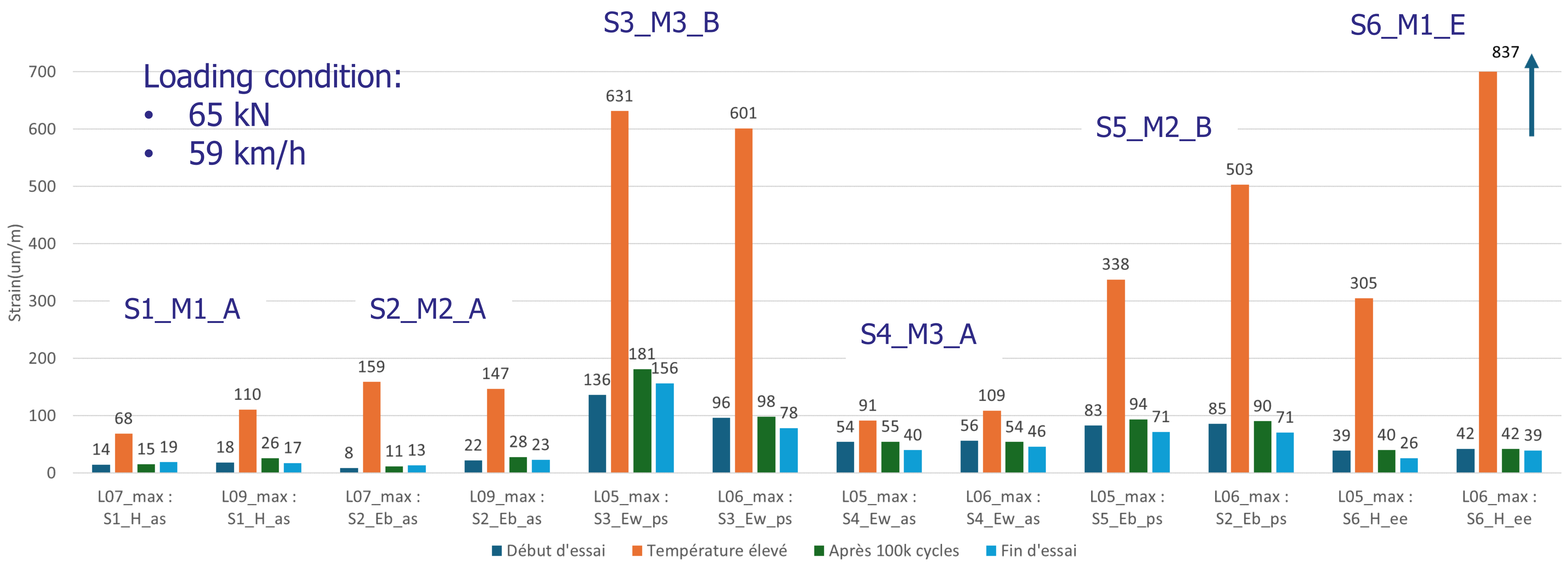
Strain measurements

- Maximum longitudinal strains in extension above the coils on all sections



- Very large (critical) strains in extension at high temperature (48 °C on surface) on sections 3, 5, 6 ⇒ poor performance of resin B and emulsion (**probable debonding**)
- The strains above the coils present the largest differences between sections
- No significant strain evolution with traffic at 25 °C

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CAYD project – Summary of APT test results

Comparison of the performance of the different sections

Criteria	Reference	S1_M1_A	S2_M2_A	S3_M3_B	S4_M3_A	S5_M2_B	S6_M1_E	S8_M2/M3_E
Permanent Deformation - 200k	5,3	3,8	3,9	5,6	3,3	5,6	8,7	6,8
Deflection - Highest values (~100k)	22	31	27	46	31	33	32	32
E_vertical granular layer - 200k (compresive strain)	172	202	214	269	192	242	240	-
E_long. bottom base - 24°C - 200k (tensile strain)	67	83	72	108	102	93	96	-
E_long. bottom base - 29°C (tensile strain)	102	111	114	146	137	141	132	-
E_long. top coil - 24°C - 200k (tensile strain)	-	18	18	117	43	71	32	-
E_long. top coil - 42°C (tensile strain)	-	89	153	616	100	420	571	-

- **Most relevant performance criteria : permanent deformation, deflection, and strains above the coils**
- Sections with emulsion present larger permanent deformations
- Sections with resin B and emulsion present large (critical) tensile strains above the coils (debonding ?)
- Resin A provides by far the best bonding
- **Sections S1 and S2 (materials 1 and 2 with resin A) present the best overall performance**

Thank you for your attention

Pierre Hornych

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Université Gustave Eiffel

NORTH AMERICAN PERSPECTIVE

John E. Haddock, Ph.D., P.E.
Professor of Civil Engineering
Director, Local Technical Assistance Program

PURDUE UNIVERSITY

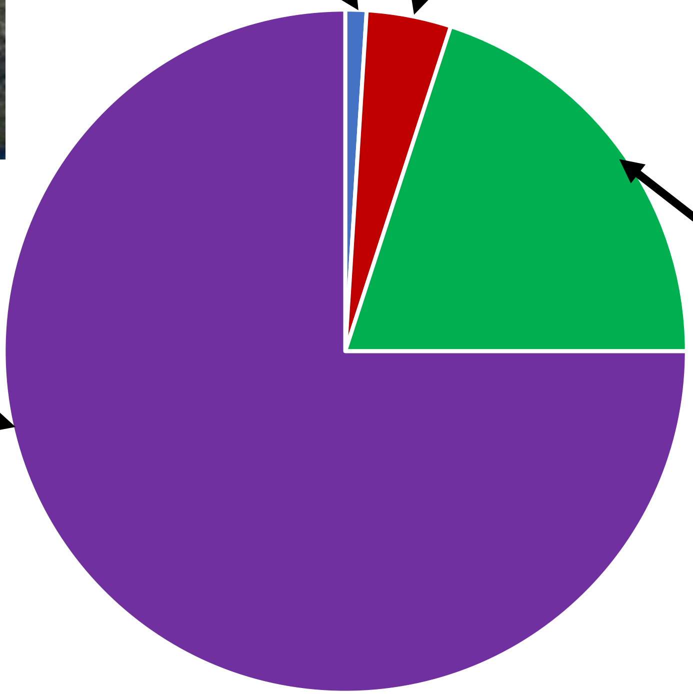
TRB Webinar
Anticipated Truck Loadings In Pavement Design-Part II
19 December 2024

Current Snapshot

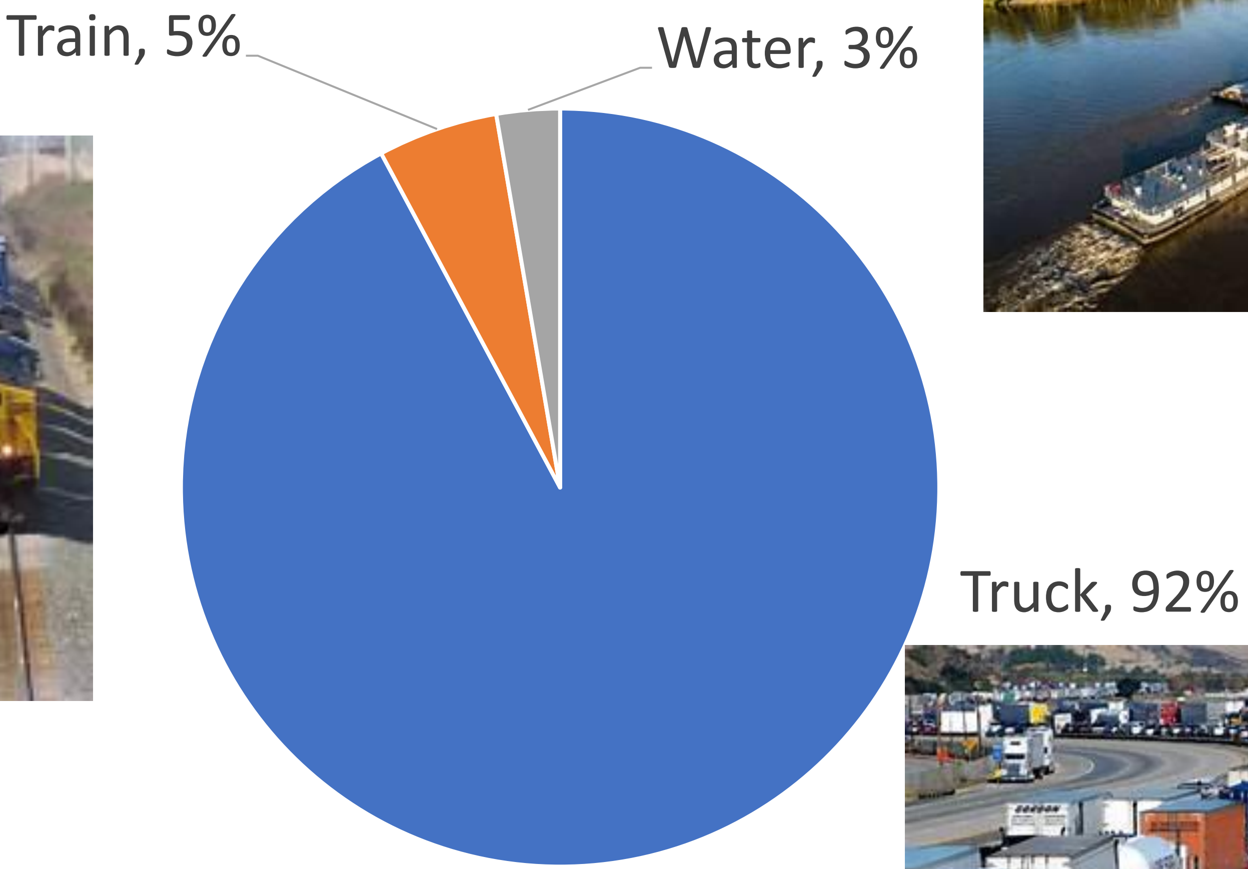
Introduction

- The world has approximately 64 million km (40 million miles) of roads
- Approximately 8.3 million km (5.2 million miles) of those roads, ~13%, are in North America
- Approximately 6.6 million km (4.1 million miles) of North American roads, ~80%, are in the United States

US Road Statistics



US annual freight value, $13.5 trillion



Sustainability

Long-term transportation emission objectives

- Gradual transfer from a fossil-based energy source to other renewable sources
- Promotion of alternative modes of transportation that generate less Greenhouse Gas (GHG) emissions
- Improvement of vehicle and fuel technology

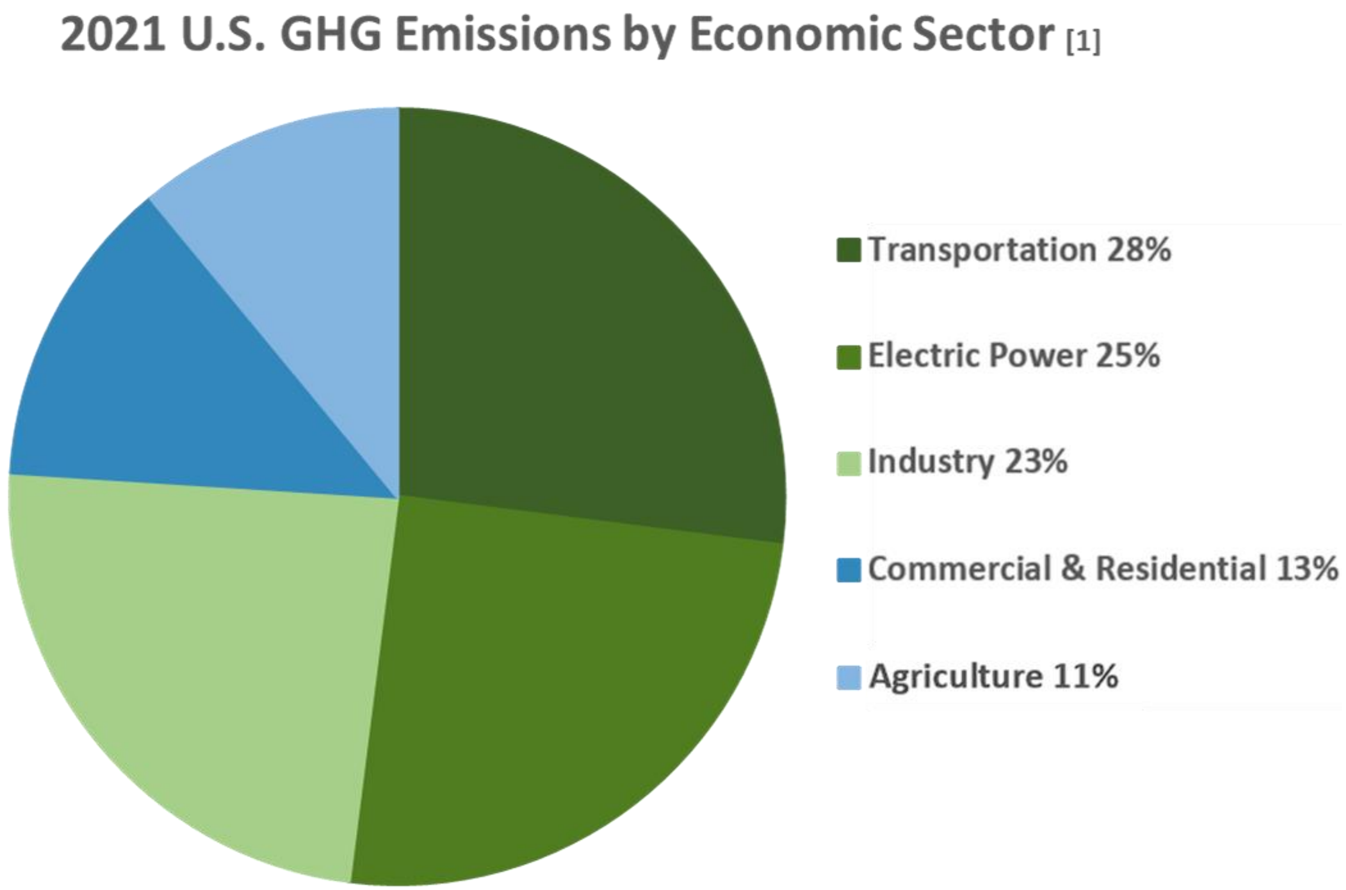
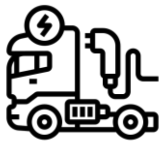


Figure 1. 2021 US GHG emissions by economic sector[1]

Electric Vehicles and Sustainability

- EVs can assist in reducing transportation-generated emissions[2]
- EVs can reduce fuel costs due to the high efficiency of electric-drive components[2]
- Heavy-Duty Vehicles (HDVs) account for approximately 25% of transportation-related GHG emissions, despite making up a small fraction (6%) of the total vehicle fleet[2]
- De-fossilizing HDVs can reduce CO2 emissions as they emit approximately 60% less GHG than diesel-powered fleet[3]

Heavy Duty EV Opportunities



HDEVs require significantly larger batteries than light-duty vehicles to support long distances and high energy demands

Larger batteries add significant weight to HDEVs, leading to higher road stresses, increased wear on infrastructure, and reduced payload capacity

Mining and processing materials like lithium, cobalt, and nickel for larger batteries have environmental and social impacts

Given their higher energy demand, HDVs necessity high-capacity charging station, placing substantial strain on the power grid

HDEV Weight Considerations

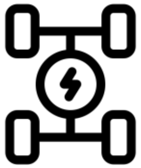
- A battery for a HDEV may weight up to 7,200 kg (16,000 lbs.) which may add between 1,800-2,400 kg (4,000 to 5,300 lbs.) to the overall weight of the HDEV in comparison to a traditional diesel-powered HDV[4]
- Due to heavier weights caused by EV battery sizes, load sizes must be decreased to compensate for existing vehicle weight limits on roads and bridges[5]
- This has led some states to reevaluate the maximum gross weight of vehicles for those powered by alternative fuels[6]

HDEV Weight Considerations

- According to the Department of Transportation, a 900-kg (2,000-lbs) axle weight increase can cause 50% more pavement damage
- Higher axle loads result in increased pavement strain, accelerating damage and overall pavement deterioration[7]
- Damage is concentrated in corridos with the highest freight traffic (urban and major freight routes)
- The need for more frequent maintenance and rehabilitation increases lifecycle costs for pavements exposed to heavier vehicles
- Thin pavements can incur up to 23% higher costs compared to standard pavements[7]

HDEV Opportunities[8]

HDEVs with heavier batteries significantly increase axle loads, leading to higher pavement stress, which accelerates damage and reduces service life



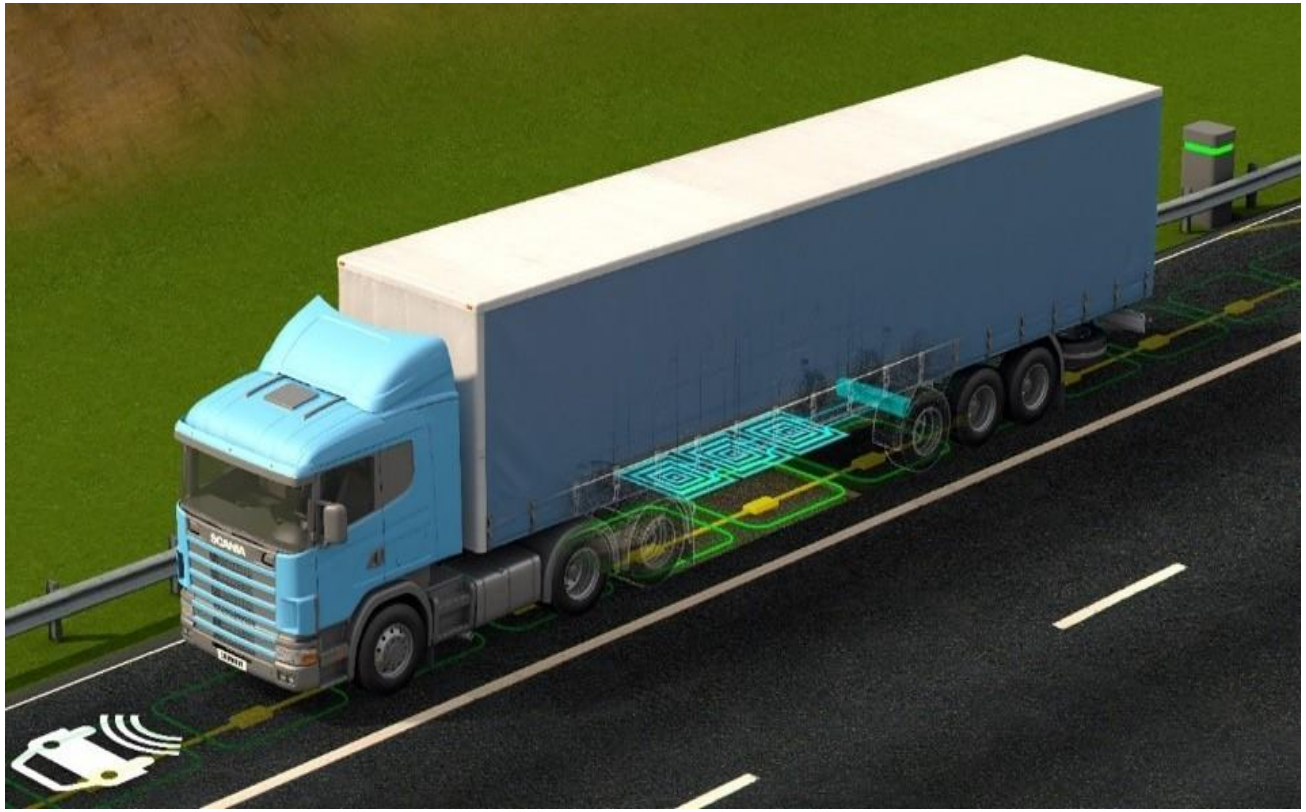
The distribution of battery weight (front, rear, or evenly spread) critically impacts stress distribution and road degradation, with uneven placement causing localized failures

Acceleration and braking in HDEVs amplify transient stresses on pavements, particularly affecting flexible pavements, which are more sensitive to these forces

The larger torque of HDEVs, particularly during acceleration and braking, causes significant longitudinal stresses

Dynamic Wireless Power Transfer

- Reduce battery size and vehicle cost
- Allow trucks to have more useful weight
- Reduce production and transportation costs
- Potentially increase profits



Battery Reduction

- DWPT reduces the need for large batteries in HDEVs by enabling on-the-move charging, improving payload capacity and reducing upfront battery cost, which constitute up to 50% of total vehicle cost in HDEVs[9]
- Downsizing battery requirements through DWPT significantly decreases reliance on costly raw materials like lithium and cobalt
- Continuous charging via DWPT reduces the need for frequent charging stops, improving delivery efficiency and reducing delivery times
- The cost competitiveness of DWPT depends on achieving high utilization ratios[9]

DWPT Feasibility[10]

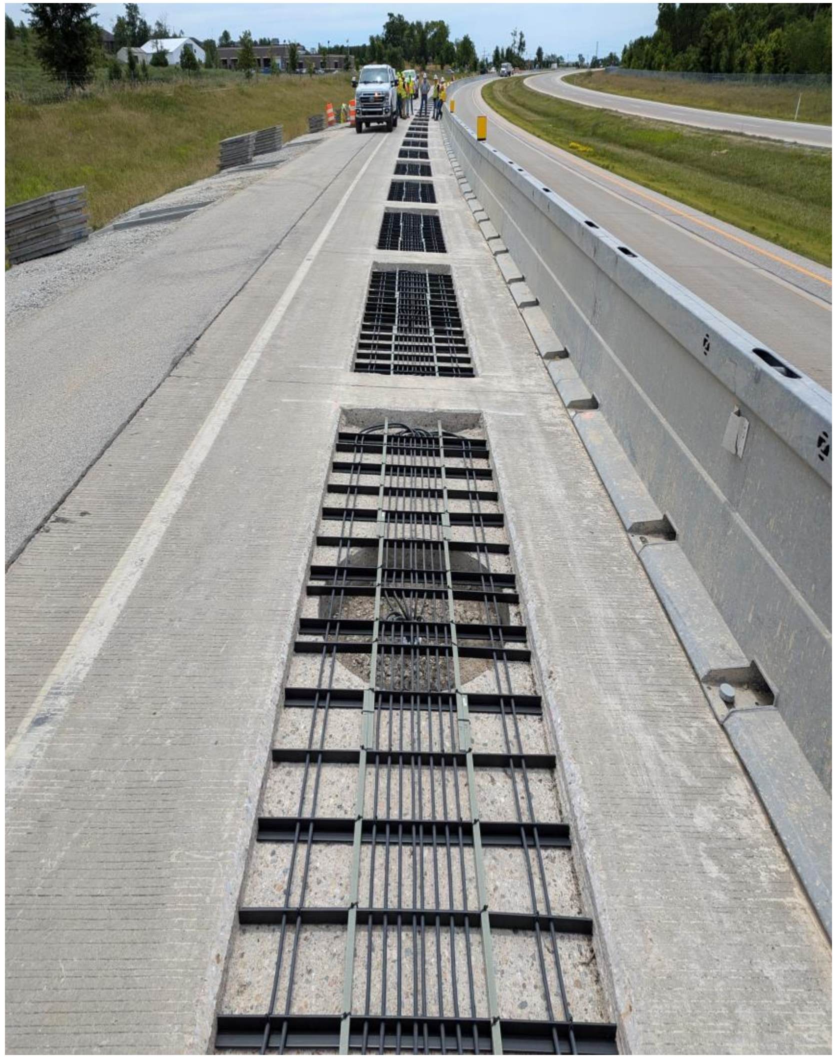
- Systems for HDVs are competitive with conventional diesel trucks at an energy cost of 30 ₵/kWh
- Implementing DWPT on high-traffic routes is feasible, with estimated construction costs ranging from three to four times higher per lane-mile than current construction
- DWPT requires additional substations near highways
- Renewable energy sources might be used to meet energy demands
- Payback periods for an early adoption range between 20 and 25 yeas, largely dependent on the penetration level of EVs adopting DWC technology

Indiana Initial Tests

- Investigate the mechanical and thermal performance of DWPT-pavement
- Two scale pavements with embedded DWPT in accelerated pavement testing
- Conduct testing to assess the pavement performance due to embedded DWPT components

Indiana Pilot

- DWPT testbed, 400 m (¼ mile) US 52/US 231
- Transition the embedment of DWPT technology from a controlled test setting to implementation on a real roadway structure
- Enable the research team (Purdue/INDOT/Contractors) to develop methods to efficiently install coils within a practical roadway
- Explore methods to lower installation costs



Michigan Pilot

- 1.6 km (1 mile) wireless Electric Road System (ERC) in downtown Detroit
- The goal of the pilot will be to showcase the viability and effectiveness of wireless dynamic charging on public roads for multiple vehicle types and use cases in a real-world scenario, such as, but not limited to, transit buses, passenger shuttles, and last-mile delivery trucks

Central Florida Expressway

- SR 516 will be equipped to recharge batteries of electric cars and trucks as they drive along the tollway
- System will provide charging at up to 200 kW (for HDEVs)

20-Year Roadway-Electrification Roadmap

2023
Phase 1 Pilots
(1/4 - 1/2 mile)

2026
Extended Pilots
(1 - 2 miles)

2030
Road Segments
(5 - 10 miles)

2035
Corridors
(50 - 100 miles)

2040
Interstate Highways

2023: Electric Roadway pilots installed in Utah, Indiana, and Florida.

2026: Initial learnings extended as supply chain is built out.

2030: Installing roadway segments in key locations across the US.

2035: Electric Roadway corridors established.

2040: Electric Roadways expand from metro areas.

THANK YOU

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Anticipated Truck Loadings in Pavement Design and Potential Impacts on Road Network Performance and Operation: An Australian Perspective

Tyrone Toole, NTRO National Practice Leader, Asset Performance

Scope of presentation

1. Anticipated changes in loading and potential impacts on road networks and users
   - Focus on most common pavement types (unbound granular with thin bituminous surfacings)
2. Pavement and surfacing assets – What does it mean?
   - Components of pavement wear
   - Status of performance models
3. Future pavement management systems and strategic analysis
4. Summary and Next steps

The drivers and associated loading changes

- Emissions reductions targets & timescales
  - 43% below 2005 levels by 2030
  - Net zero by 2050
  - Anticipated power trains for low and zero emissions vehicles (LZE) increase pavement loading considerably
- Transport productivity
  - Drive for increased payloads and less trips
  - Ministerial support for country-wide change
- Likely vehicle loading changes for LZE HV
  - From 6t to 7.5t possibly up to 9t on steer axle (25% to 50% higher)
  - From 16t to 18t – 20t on (twin) drive axles (12% to 25% higher)
- Pavement loading consequences – and our knowledge and experience base
- Identifying and addressing areas of greatest uncertainty. NB: sprayed bituminous seals on granular road bases represent 85% of the Australian network.




Components of pavement wear – what we believe we know, or do not know so well

Deformation
Flexural fatigue

Surfacing

Base & Subbase

Subgrade

Flushing/bleeding
Stripping
Embedment
Debonding
Plastic flow
Cracking

Deformation

Status of performance models

Deformation & Fatigue

- **Primary load issue**: Vertical load
- **Distress modelling**: Have performance models
- Models related to load, ESAs/ SAR concepts, Reference loads
- **Extrapolation**: Some needed,
- **Analysis forecast risk** not excessive relative to underlying research

Surfacing distresses

- **Primary load issue:** Vertical & horizontal
- **Distress modelling:** No performance models
- **Extrapolation:** **I**mpossible – no models
- **Approach:**
  - Consider changes in treatments and/or service lives of treatments AND criticality of locations, alignment etc.
  - Re-examine vehicle loading / dynamic loading models

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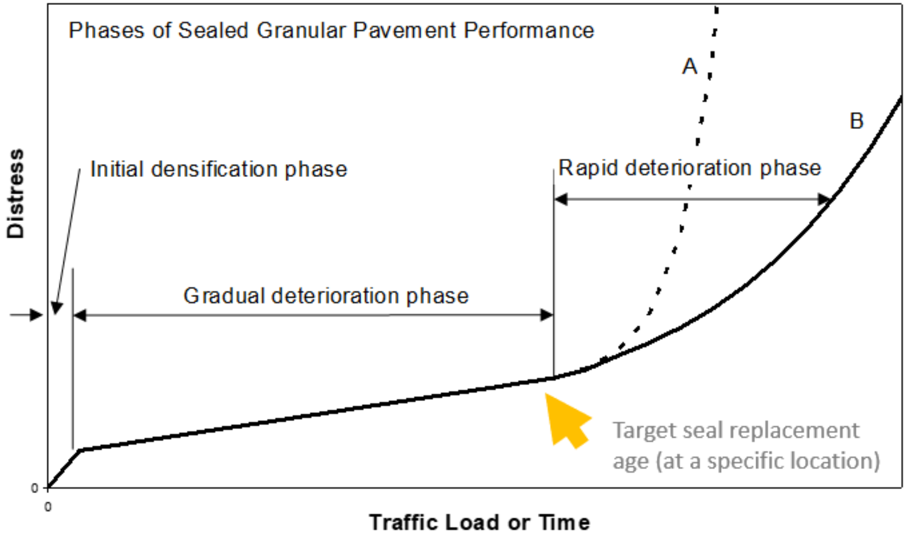
What might it mean for surfacings?

- All sites
  - Shorter lives
  - Heavier more costly future treatments
  - Most at risk
    - ‘Fresh’ surfacings
    - ‘Mature’ Surfacings – increasing issue with low budgets

- Highly stressed sites
  - All of the above, but more

- A word of caution
  - Our design process is largely empirical within known limits, conditions – **<u>The latter will change</u>**



Current target lives are ‘oxidation-based’ under typical conditions, how will distress initiation and progression change?

Future pavement analyses

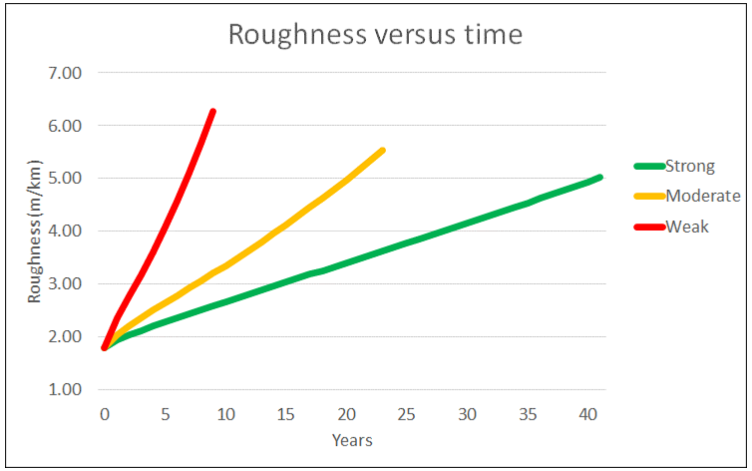
- Will they be the same with some differences or what? **YES, mostly the same but address pavement & surface effects**
- Foundational investment principles – **<u>THEY STILL APPLY</u>**
  - The 'Goldilocks' principle – finding the combination of treatment strategies that minimise future costs
  - 'Stitch-in-time' – a fit for purpose pavement still needs timely preventive maintenance
- Use cases and uptake scenarios – what might they be?
- Vehicle types and configuration

Pavement damage: Relationships for network level application

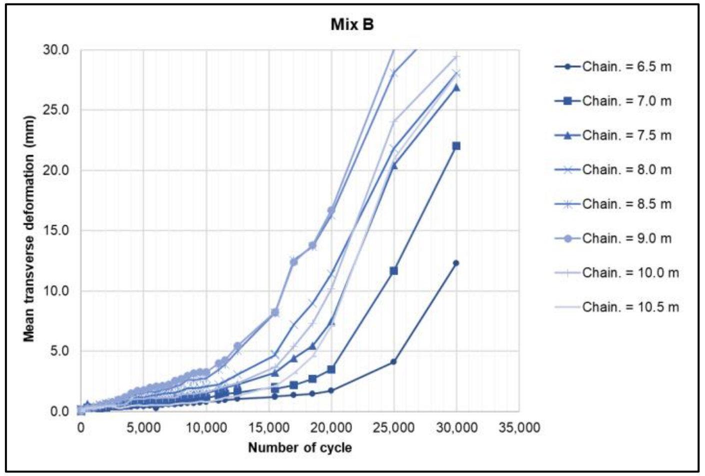
Use of deterministic models from observational studies

- Change in pavement surface condition
  - Cracking
  - Rutting
  - Roughness (Ride quality)
- Change in structural condition
  - Increase in pavement deflection
  - Reduction in pavement (modified) structural number
- Key independent, contributing variables
  - Pavement type and structure
  - Traffic loading, Initial in-service strength, Climate
  - Other factors such as drainage quality, road configuration (widths, sealed shoulders etc)

Impact of pavement strength



ALF: Impact of deliberate pavement wetting



Pavement damage: Accounting for pavement loading configuration in ‘thin’ flexible pavements

- ESA = Equivalent standard (80 kN) axles

- For a single vehicle proportional to

$$sum = \sum_{n=x}^{1} (Axle\ or\ Group\ Load/Ref)^{LDE}$$

Ref = Reference load for axle/ axle group and tyre dimensions which contributes the same damage as a standard 80kN axle load.

LDE = load damage exponent, typically 4 (Seal with granular base (SS), 5 (Asphalt base), 12 (Cemented base)

AGPT02-17

Table 7.7: Loads on axle groups with dual tyres which cause same damage as a Standard Axle

Axle group type	Load (kN)
Single axle with dual tyres (SADT)	80
Tandem axle with dual tyres (TADT)	135
Triaxle with dual tyres (TRDT)	182
Quad-axle with dual tyres (QADT)	226

Table 7.8: Loads on axle groups with single tyres which cause same damage as a Standard Axle

Axle group type	Nominal tyre section width	Load (kN)
Single axle with single tyres (SAST)	Less than 375 mm	53
	At least 375 mm but less than 450 mm	58
	450 mm or more	71
Tandem axle with single tyres (TAST)	Less than 375 mm	89
	At least 375 mm but less than 450 mm	98
	450 mm or more	119
Triaxle with single tyres (TRST)	Less than 375 mm	121
	At least 375 mm but less than 450 mm	132
	450 mm or more	162
Quad-axle with single tyres (QAST)	Less than 375 mm	150
	At least 375 mm but less than 450 mm	164
	450 mm or more	201

Yeo 2008

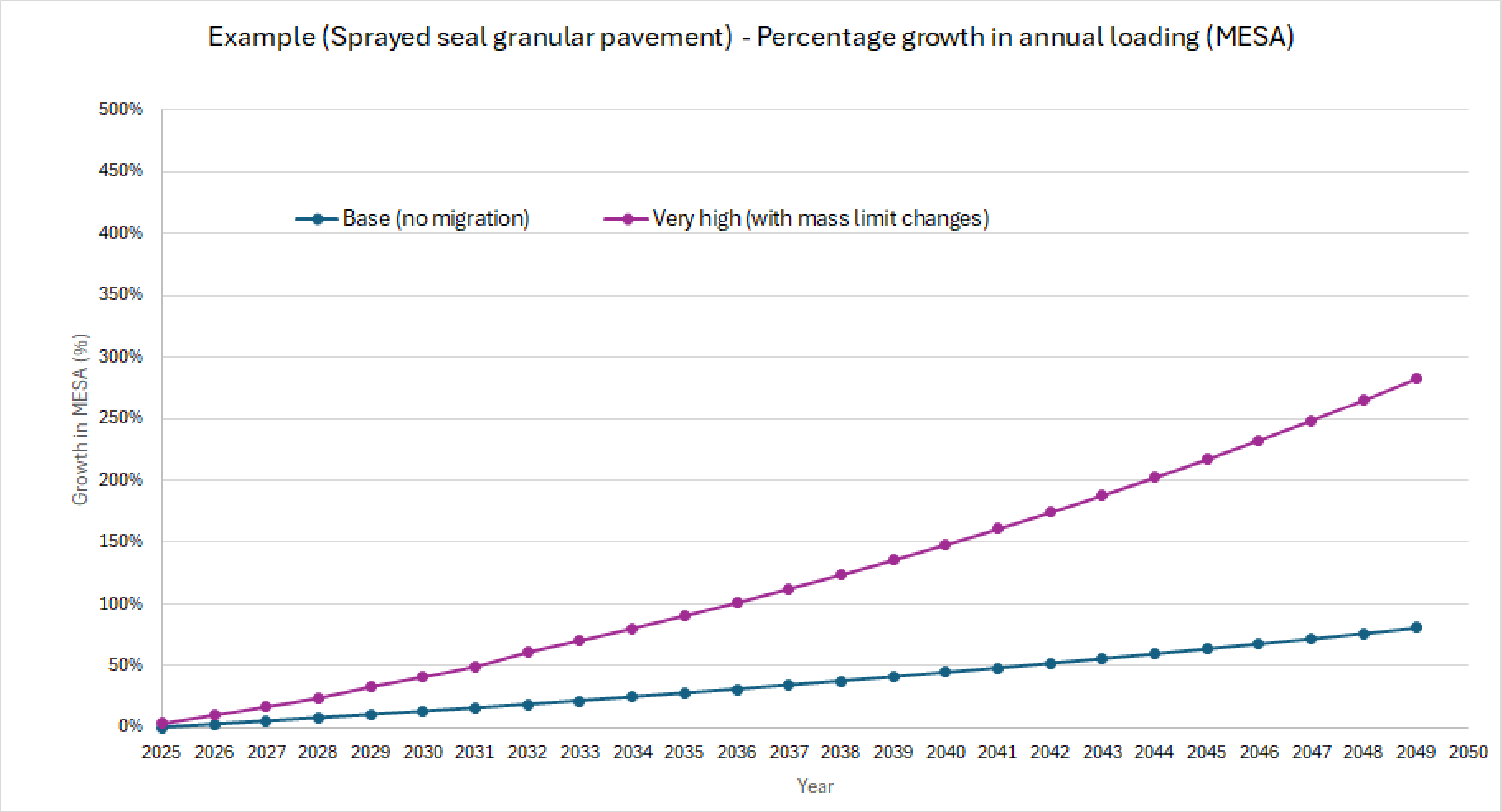
Super single – Ref Load, 73 kN
Ultra wide single, Ref Load 77 kN

Future uptakes and potential loading

- Future loading will vary
  - Back to base
  - Line haul
- Uptake rates uncertain
  - Important to test scenarios – low to high, and impacts on design / pavement management strategies
- Uncertain but likely sources of additional costs
  - Costs not directly proportional to additional loading (typically less, but we are pushing the limit and budgets are tight)
  - The Sleeper – the reality of less-than-optimal funding means risks are high and comprehensive analysis required and is in progress.

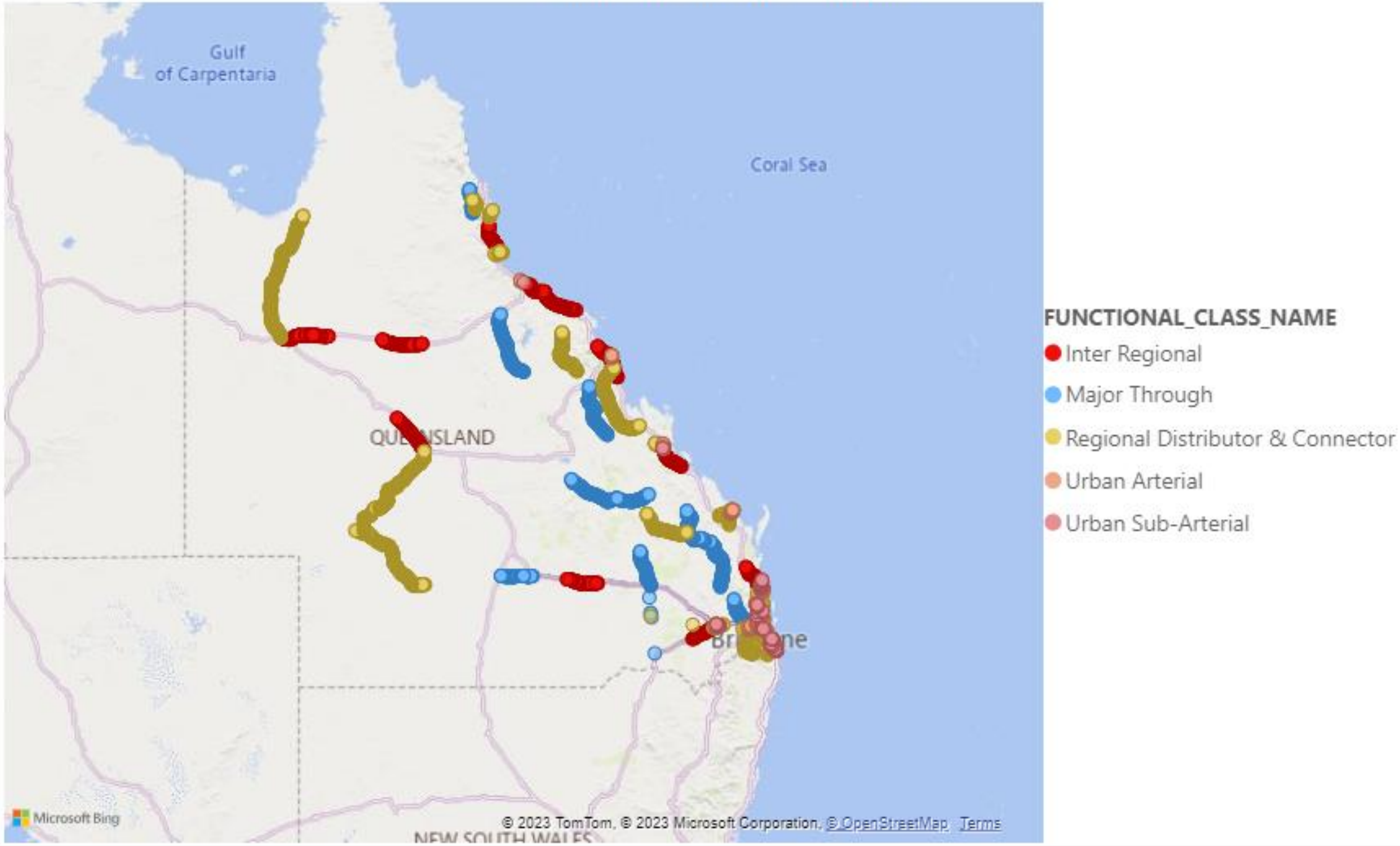



Example proportional ESA change over time by uptake scenario and pavement type



Queensland research: Analysis of sample of network (100m segments)

Location of the analysis segments



FUNCTIONAL_CLASS_NAME	Segment Count
Inter Regional	9942
Major Through	12533
Regional Distributor & Connector	19199
Urban Arterial	3433
Urban Sub-Arterial	1142
Total	**46249**

ROAD_NAME

- ANGUS SMITH DRIVE CONNECTION ROAD
- BEAUDESERT - BOONAH ROAD
- BEAUDESERT - NERANG ROAD
- BEENLEIGH - REDLAND BAY ROAD
- BEERBURRUM ROAD
- BELLS CREEK ARTERIAL ROAD
- BOONAH - RATHDOWNEY ROAD
- BOWEN DEVELOPMENTAL ROAD
- BRIGHTON - REDCLIFFE ROAD
- BRISBANE VALLEY HIGHWAY
- BRUCE HIGHWAY

Analysis framework and scope

Analysis Scope and Rules

- 30-year analysis period
- Traffic volumes and loading reflect uptake scenarios
- 3 pavement types (SS, AC, CS)
- Optimisation – maximisation of pavement condition (Improvement in PCI) with ‘ideal’ funding for target LOS and under budget constraint

Analysis set up

- Intervention levels and treatment selection based on traffic levels
- Accounting for structural condition through tracking DEF/SNC based on TSD / IPAVE data and accounting for non-structural treatments
- Use of NTRO developed Austroads 2010 Road Deterioration models

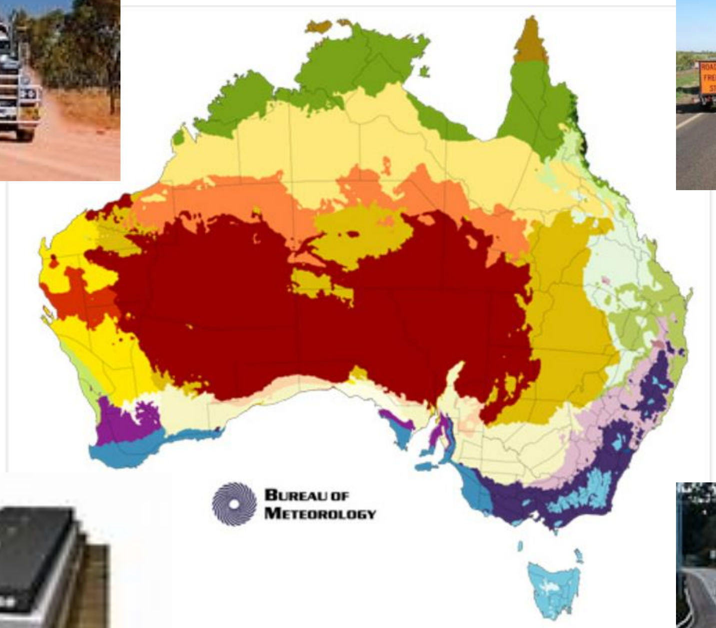
Reporting

- Costs (by year, treatment type etc)
- Condition (common measures of cracking, rutting and roughness, structural parameters)
- Tabular and graphical, PowerBI

Proposed whole of network representation

- **Physical sections**
  - Best representation of actual conditions
  - Results can be reviewed directly and on site
  - Provide input to stereotypes
  - Requires detailed data with analysis being bigger (longer in time)

- **Representative sections or stereotypes**
  - Illustrative of conditions and needs
  - Some review possible
  - If designed well could provide a sufficiently accurate estimate at a network level



Functional class	Pavement Types	Other factors
M	SS	Climate
A	AC	Locale
B	CS	Traffic level
C	Concrete	Condition
Local	Unsealed	History

Summary and Concluding Remarks

1. The challenge

    - Rate of consumption of existing assets will accelerate based on the scale of changes in loading

    - Treatment demand and retreatment costs will be higher

2. What will the future hold and what to do

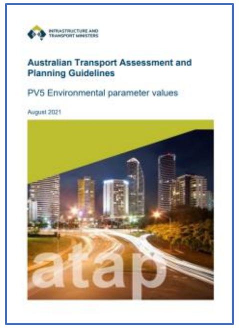
    - Forecasts will continue to be uncertain

    - Addressing areas of greatest performance uncertainty and highest risk/impact is vital

3. Better to be ready and acknowledge that nothing comes free – our greener future needs investment and communication / coordination. Let’s share.

Our existing knowledge base and current studies

- Current sources (Austroads)
  - Road deterioration and works effects models
  - Pavement design, surfacing and rehabilitation guides
  - Sustainable use of available materials
  - Framework for asset preservation and renewal
  - Accelerated loading studies
- Australian Transport Assessment and Planning guidelines
  - PV2 – Road parameter values
  - PV5 – Environmental parameter values
- Agency supported studies



- **Ongoing studies**
  - **NACOE A68 - Impact Assessment of the Introduction of Low and Zero Emission Heavy Vehicles on Road and Transport Infrastructure**,
  - **Other NACOE and WARRIP studies**
    - Marginal cost of additional load related road wear
    - Sustainability assessment tool (SAT4P)
    - Changes to HV masses and dimensions and effect of wide tyres
  - **Austroads NEF6392 - Future Freight Vehicles and Buses Implications for Road Managers – Pavement Analysis**
    - Review of pavement loading and available modelling
    - Applying uptake forecasts to inform case studies of pavement impacts and investment needs

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Thank you

Our NTRO team and partners
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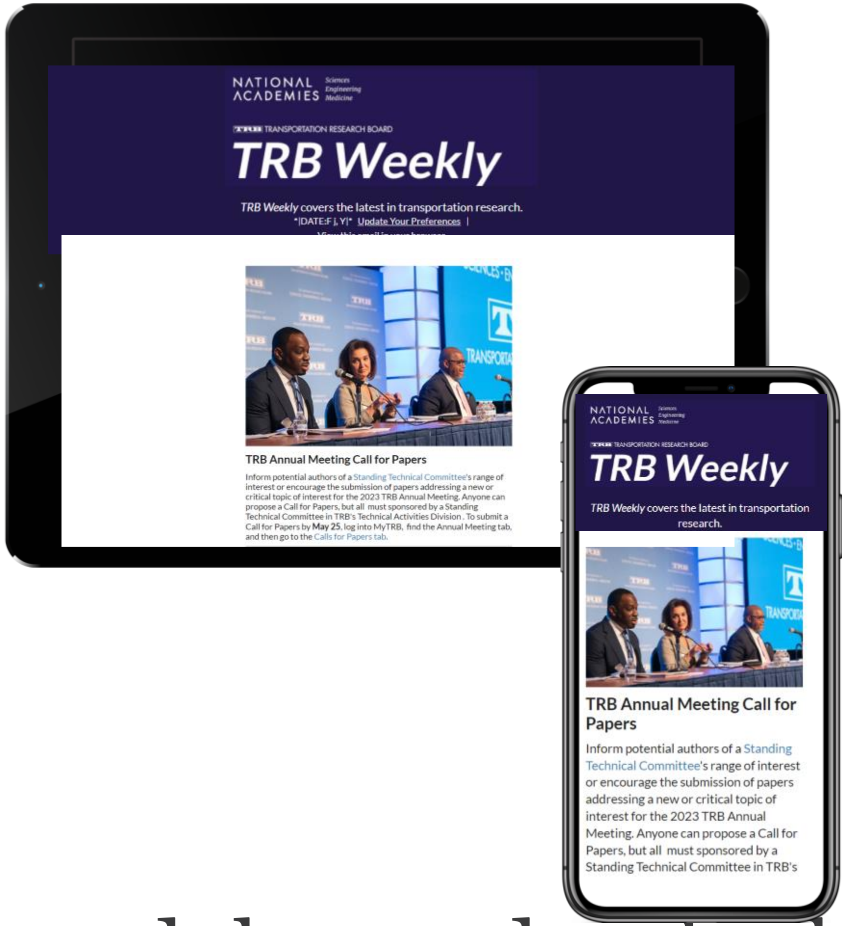

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