# Asphalt in Railways Tracks



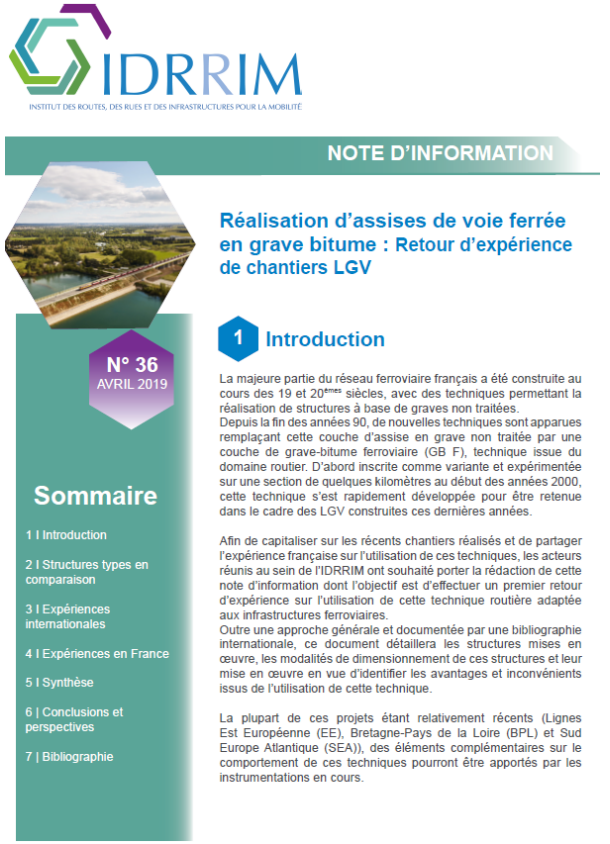
X Carbonneau

# Asphalt in Railways Tracks

- General overview
- Recent HSL projects in France

EIFFAGE COLAS EUROVIA VINCI

- Asphalt Mix advantages
- Conclusion



IDRRIM
INSTITUT DES ROUTES, DES RUES ET DES INFRASTRUCTURES POUR LA MOBILITÉ

NOTE D'INFORMATION

**Réalisation d'assises de voie ferrée en grave bitume : Retour d'expérience de chantiers LGV**

N° 36
AVRIL 2019

Sommaire



## 1 Introduction

La majeure partie du réseau ferroviaire français a été construite au cours des 19 et 20èmes siècles, avec des techniques permettant la réalisation de structures à base de graves non traitées.
Depuis la fin des années 90, de nouvelles techniques sont apparues remplaçant cette couche d'assise en grave non traitée par une couche de grave-bitume ferroviaire (GB F), technique issue du domaine routier. D'abord inscrite comme variante et expérimentée sur une section de quelques kilomètres au début des années 2000, cette technique s'est rapidement développée pour être retenue dans le cadre des LGV construites ces dernières années.

Afin de capitaliser sur les récents chantiers réalisés et de partager l'expérience française sur l'utilisation de ces techniques, les acteurs réunis au sein de l'IDRRIM ont souhaité porter la rédaction de cette note d'information dont l'objectif est d'effectuer un premier retour d'expérience sur l'utilisation de cette technique routière adaptée aux infrastructures ferroviaires.
Outre une approche générale et documentée par une bibliographie internationale, ce document détaillera les structures mises en œuvre, les modalités de dimensionnement de ces structures et leur mise en œuvre en vue d'identifier les avantages et inconvénients issus de l'utilisation de cette technique.

La plupart de ces projets étant relativement récents (Lignes Est Européenne (EE), Bretagne-Pays de la Loire (BPL) et Sud Europe Atlantique (SEA)), des éléments complémentaires sur le comportement de ces techniques pourront être apportés par les instrumentations en cours.

# General overview

› Road and Rail Tracks common ground :

- ✓ Infrastructures
- ✓ Transportation (People and Goods)
- ✓ Important network
- ✓ Cost (construction / maintenance)

› Not the same requirements

| Surface | Rail Tracks | Asphalt Wearing Course |
|---|---|---|
| Loading |   |   |
| Speed | 80 – 340km/h | 50 – 110km/h |
| Design Lifetime | 75 – 100 years | 20 – 30 years |

# Asphalt in Railways : An old story…

- Italy
  - Since 1907
  - More than 1200 km
- Germany)
  - Several solutions (ATD, Satro, GETRAC…)
- Japan
- USA (since 1980)

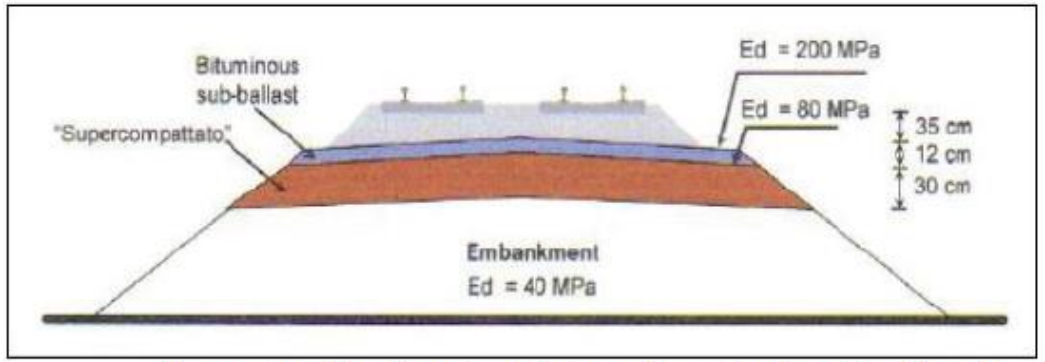



*Figure 1: Italian High-Seed Railway Cross-Sectional Profile [1.]*

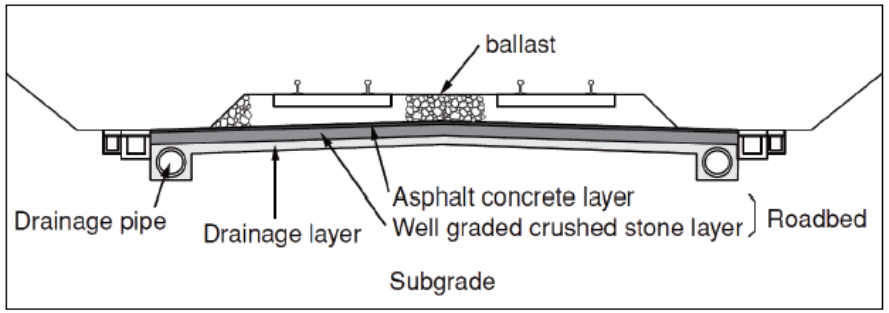



*Figure 11: Cross section of ballasted track and asphalt roadbed [10.]*

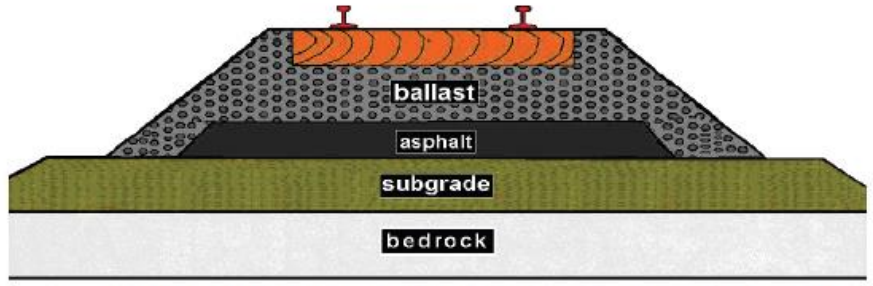


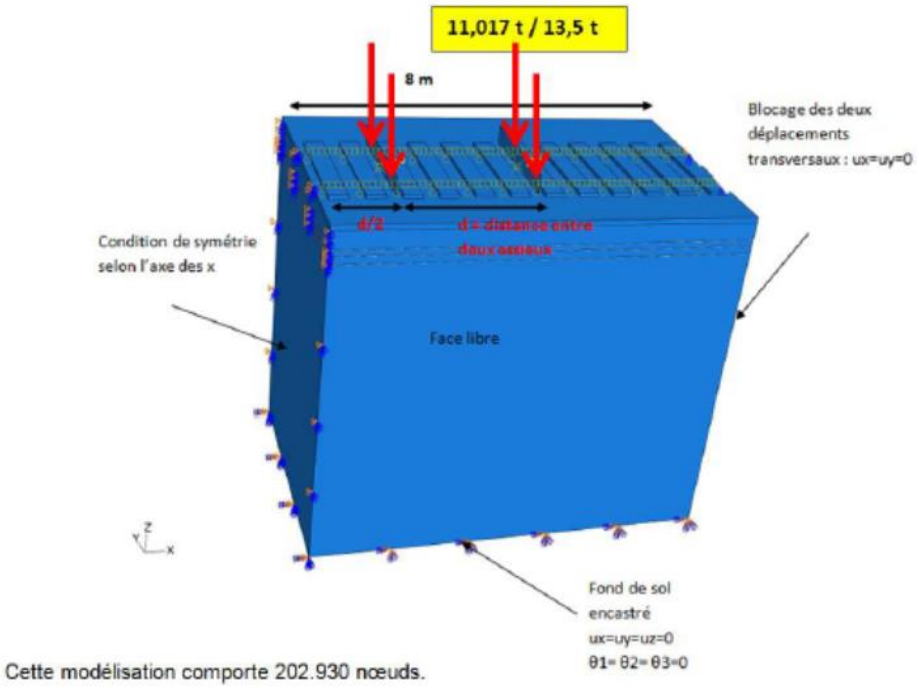

*Figure 12: "Asphalt Underlayment" trackbed without granular sub-ballast layer [9.]*

# Evolution of the structure

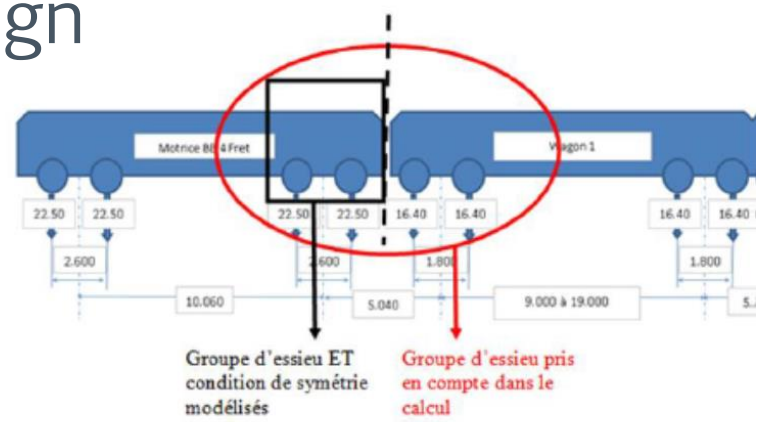
› To reduce  cost /  To take advantage of AC mixes

› French Experience on HSL

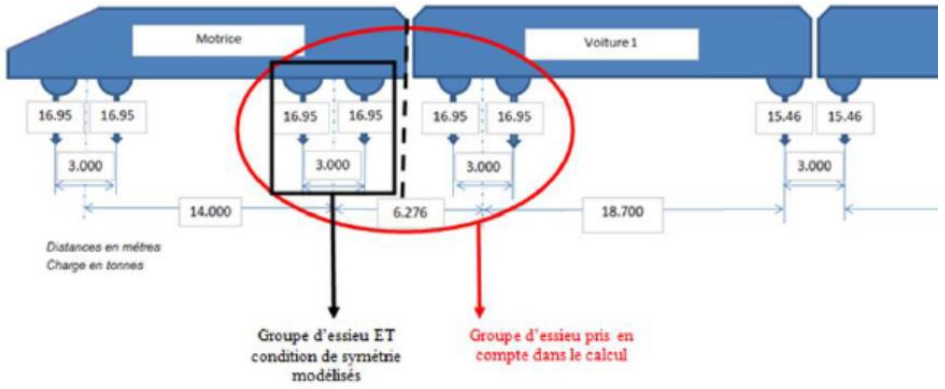
› Design : 3D modelling + Road Design




Cette modélisation comporte 202.930 nœuds.

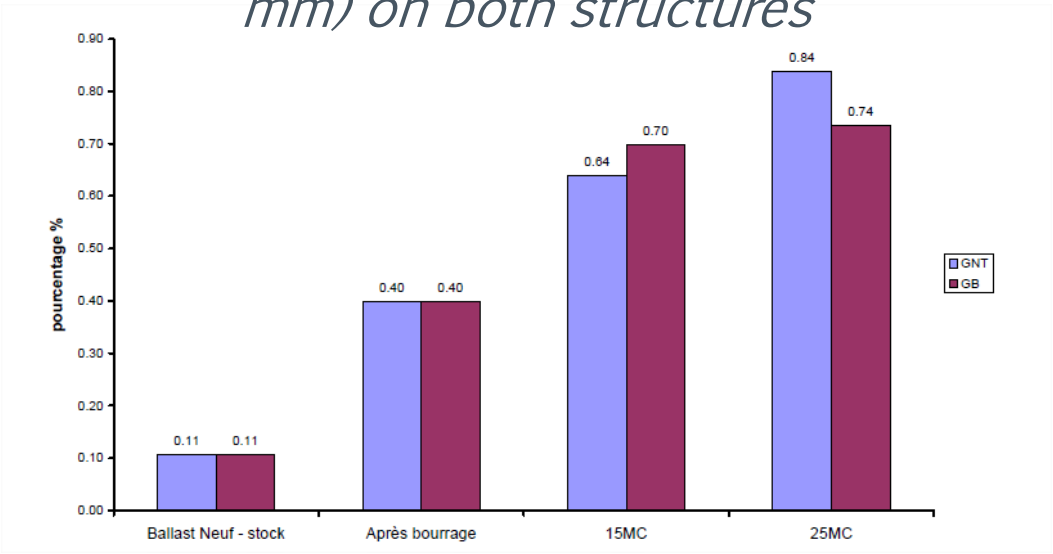



➢ TGV - *High Speed Train*



# Impact of the Asphalt layer on the durability of the ballast

*Fine aggregates distribution (< 0.5 mm) on both structures*




› SCALE ONE TRIALS: ATTRITION TESTS AT 25 MILLIONS CYCLES

NO CRUSHING EFFECT OF THE ASPHALT LAYER

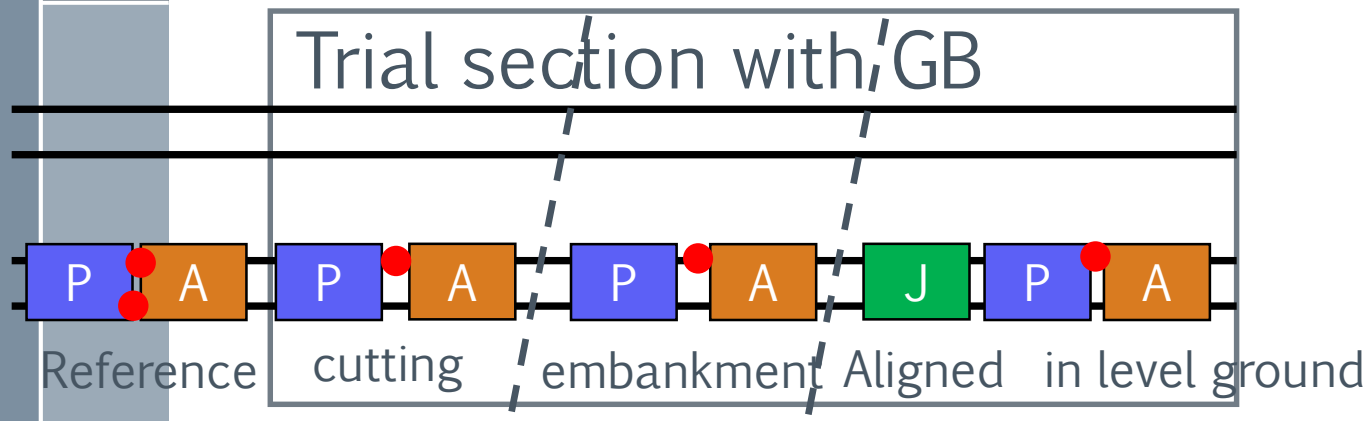
# Key advantages of asphalt layer

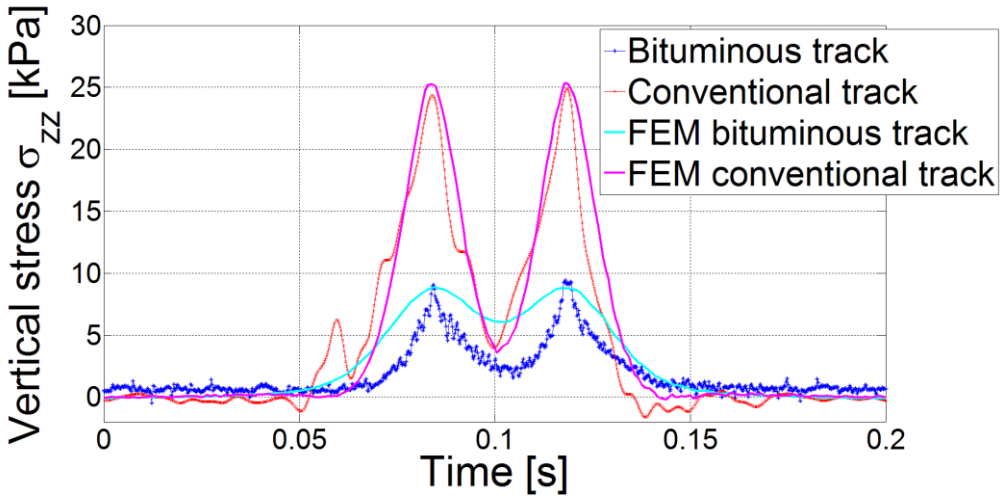
- Construction phase
  - Reduction of pavement layer thickness
  - Reduction of Ballast extra thickness on edges
  - Reduction of sensitivity to weather conditions (works schedule secured)
  - Improved traffic conditions before laying the track
  - Possible supply of a first layer of ballast
- Under operations
  - Improved homogeneity of the platform
  - Improved protection against water infiltrations
  - Increase stability of the asphalt layer
  - No need of phytosanitary products against vegetation

# First Trial on HSL: East-European HSL

- 3km experimental test section (2005-2007)
- Near Reims (slopes, structure, bridges, cut and fill)
- One section monitored


# First Trial on HSL: East-European HSL




A Accelerometer

P Pressure under traverse
stresses in GNT
strain measurements

J Strain gauges in GB

Temperature

Comparison between FEM and measurements

(from D Ramirez Cardona Thesis)

# Large recent projects in France

BPL

105 km

EIFFAGE

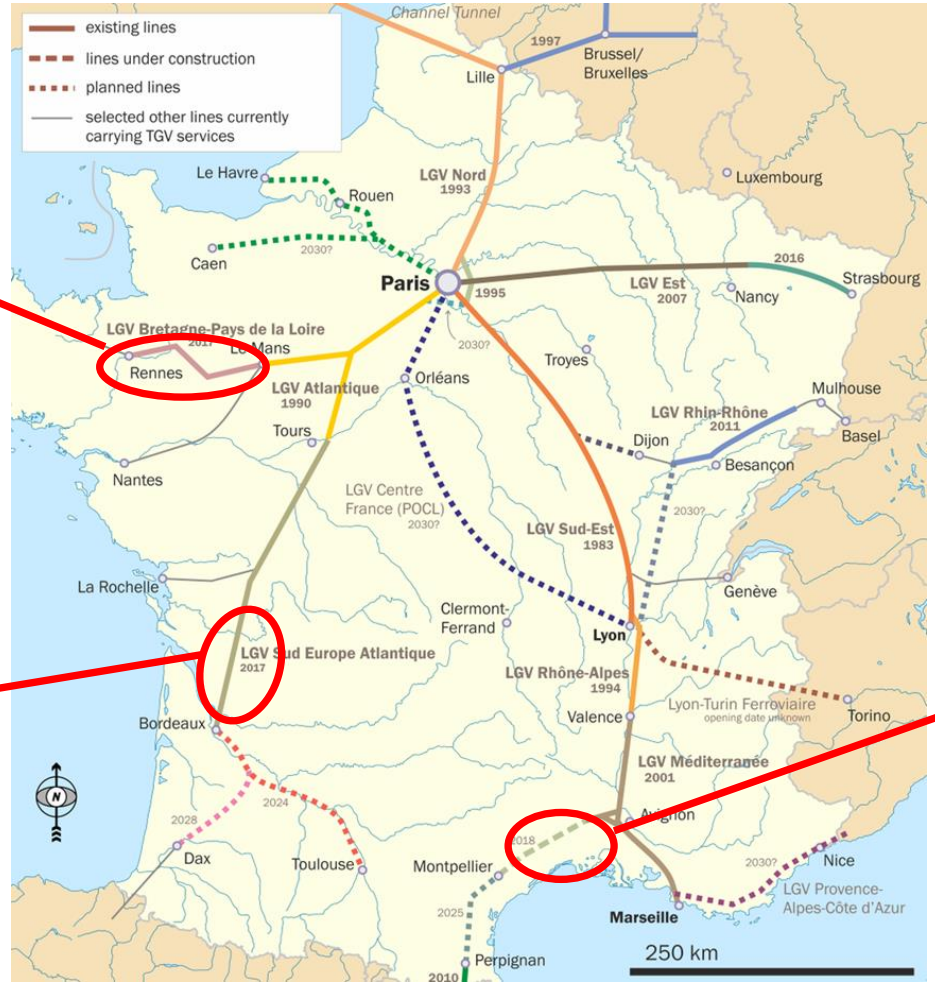
SEA

43km

Cosea

CONSTRUCTION SEA TOURS - BORDEAUX

EUROVIA VINCI



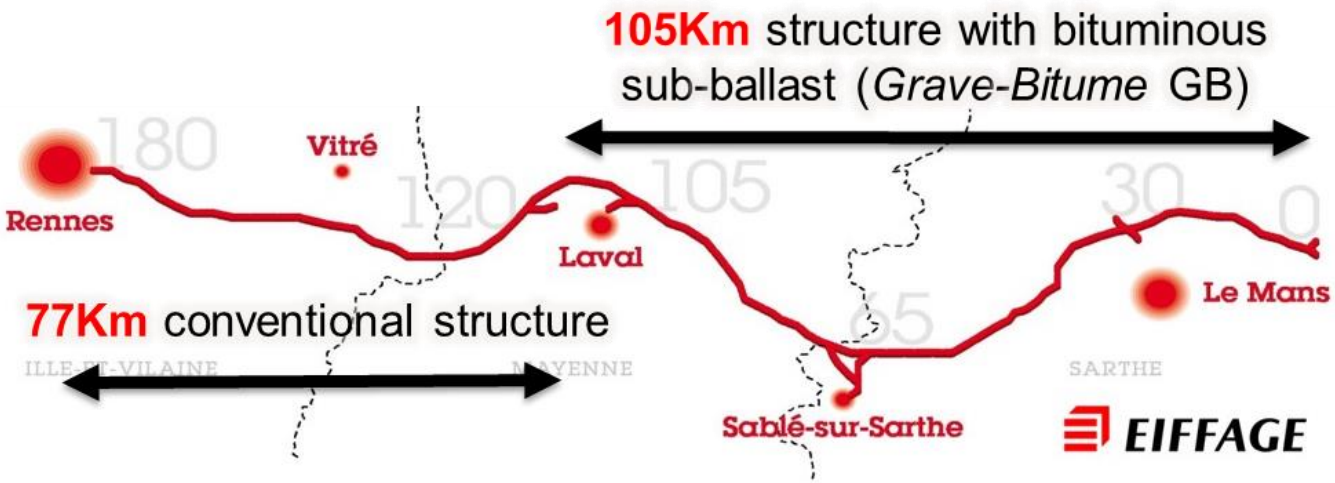

CNM

80 km

COLAS

WE OPEN THE WAY

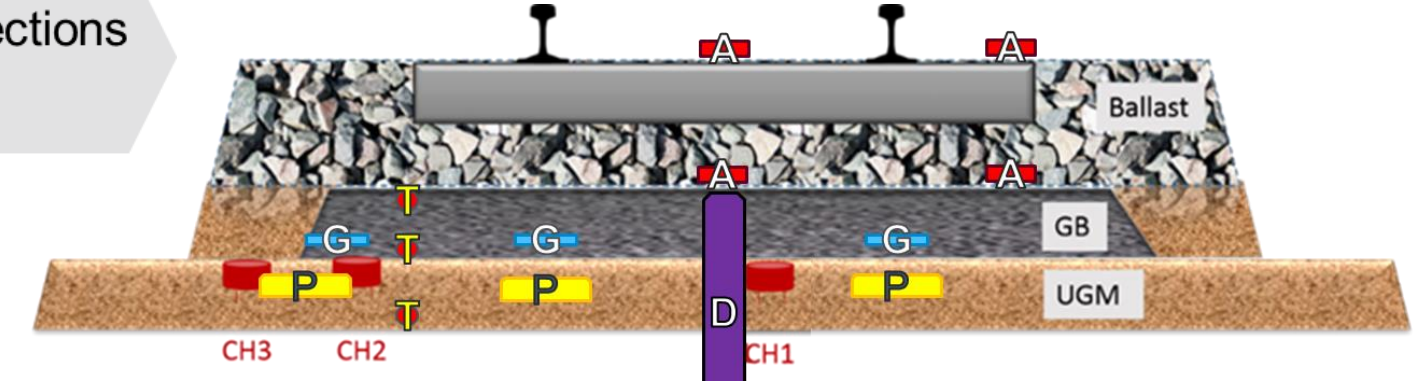
# BPL EIFFAGE



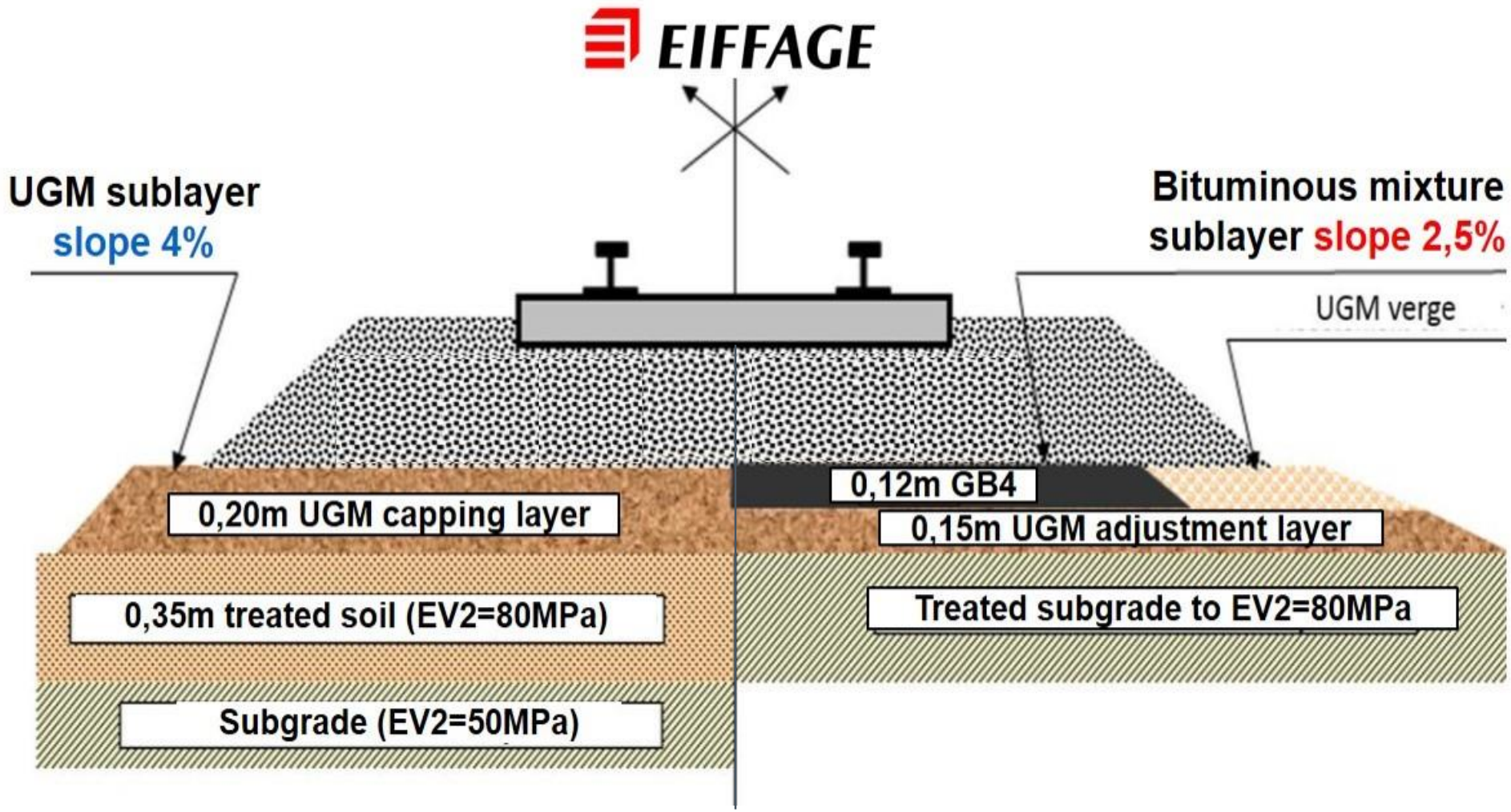

**4** Fully instrumented sections for track monitoring

**265k** Tons of GB4

**12** Months of work

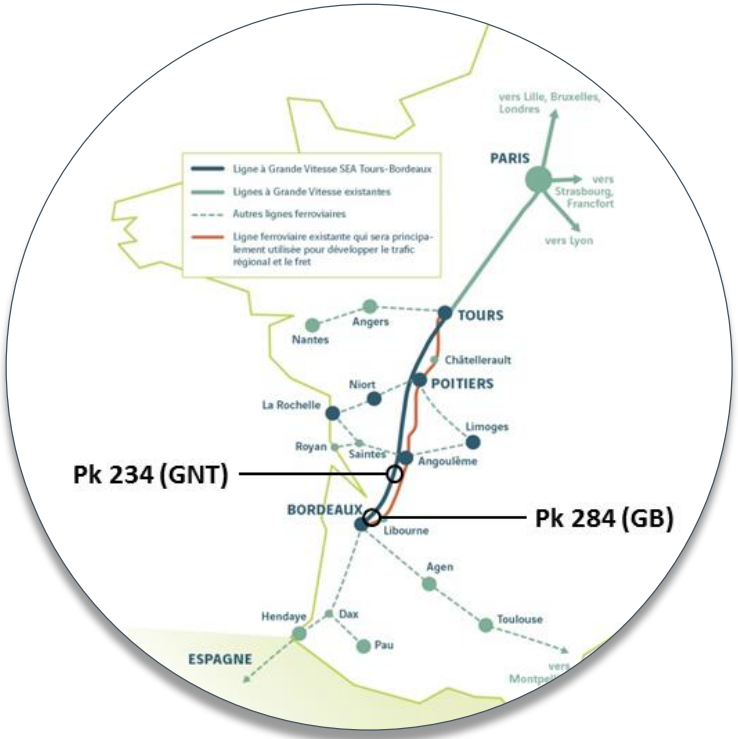


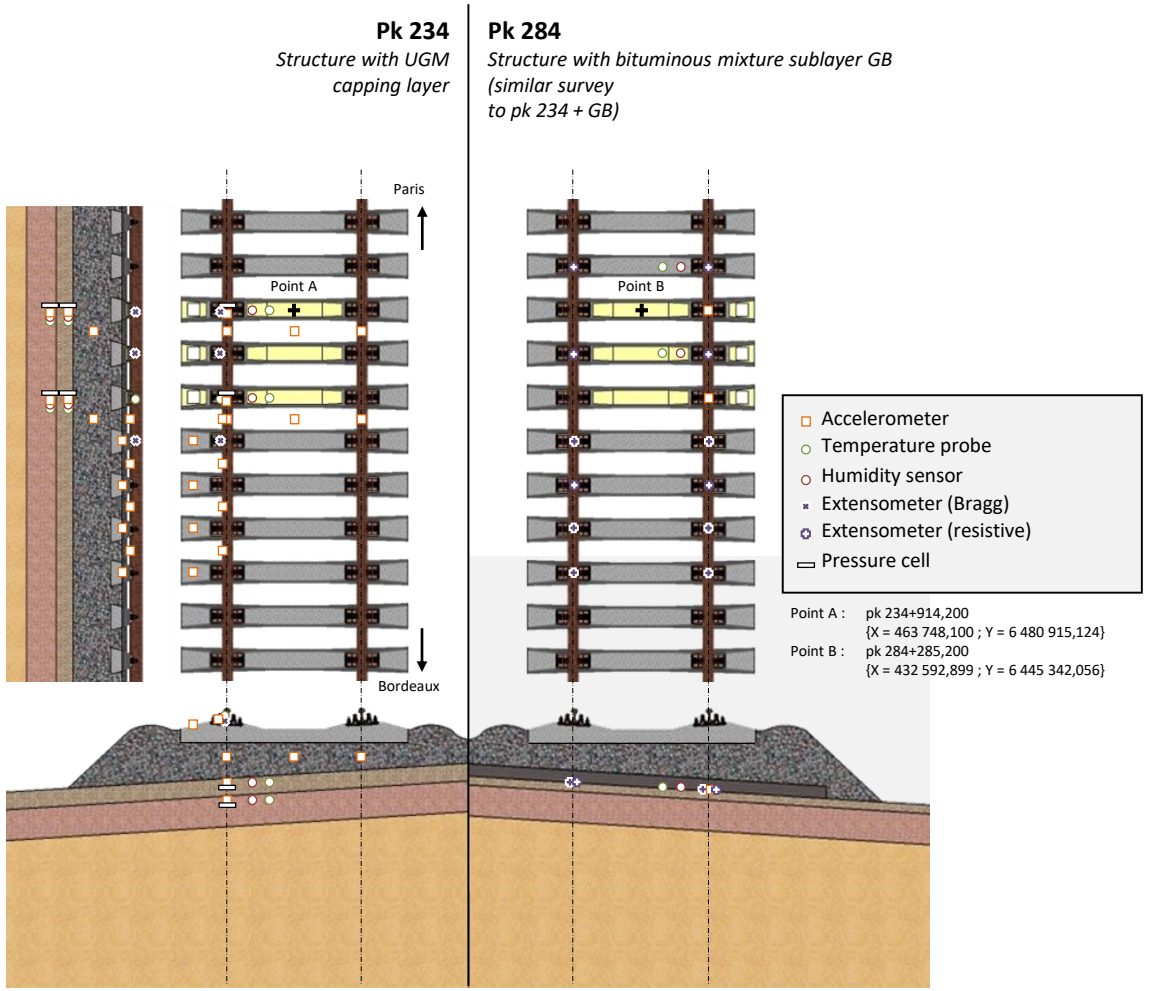
# BPL EIFFAGE


EIFFAGE
UGM sublayer
slope 4%
Bituminous mixture
sublayer slope 2,5%
UGM verge
0,20m UGM capping layer
0,12m GB4
0,15m UGM adjustment layer
0,35m treated soil (EV2=80MPa)
Treated subgrade to EV2=80MPa
Subgrade (EV2=50MPa)

# SEA

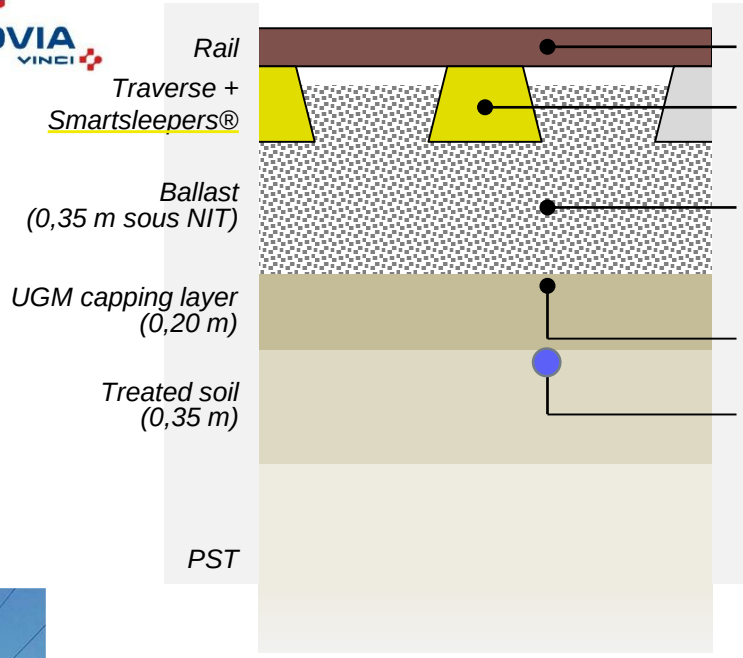
- 50 years concession
- 43 km (over 340 km) of “GB” (south of the line)
- Year of commissioning of the railway line: 2017



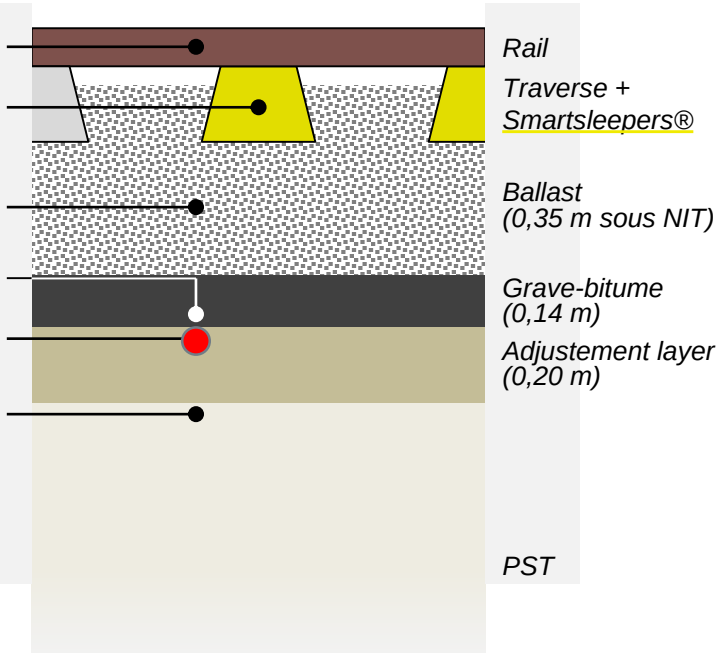



# SEA

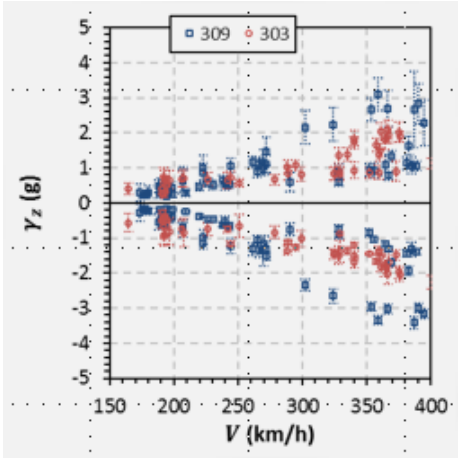
Pk 234 (structure avec GNT)



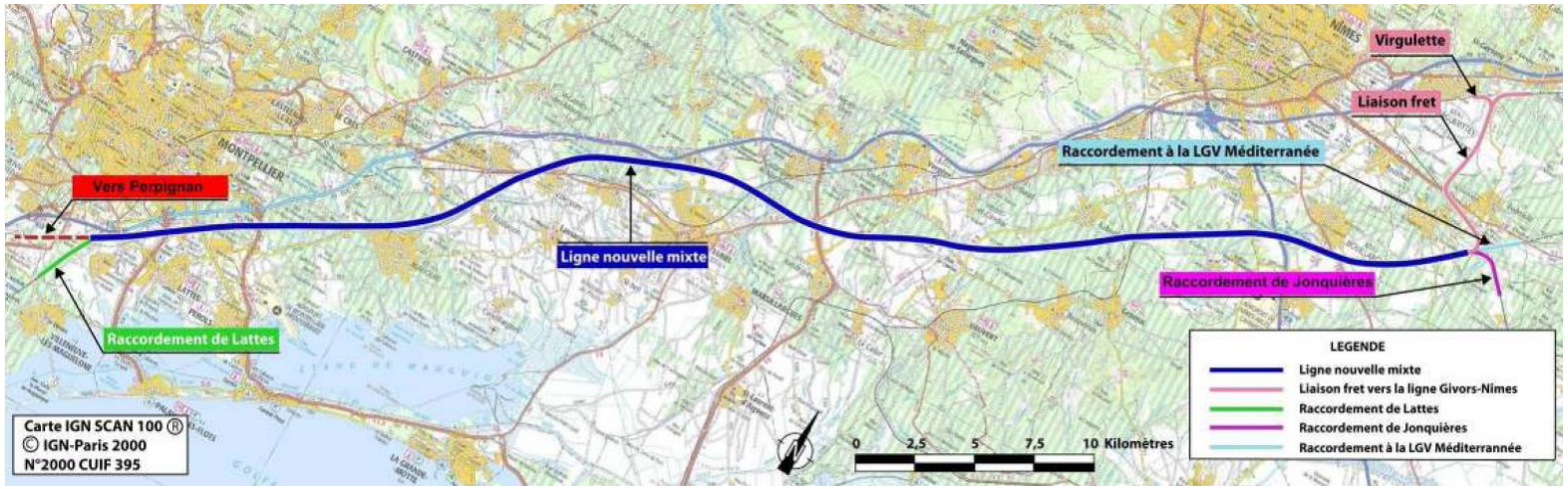

Pk 284 (structure avec GB)




- From a model approach *(Martin et al. 2017),* accelaration $\gamma_z$ for asphalt structure (15 cm;15 °C) and V = 342 km/h ~ $\gamma_z^{ref}$ is equivalent to and V = 270 km/h for a conventionnal structure .
- The trend is confirmed by onsite feedback.



CNM COLAS




*44 years Public Private Partnership*

*High speed track 61 km*
*+ 21 km connections*

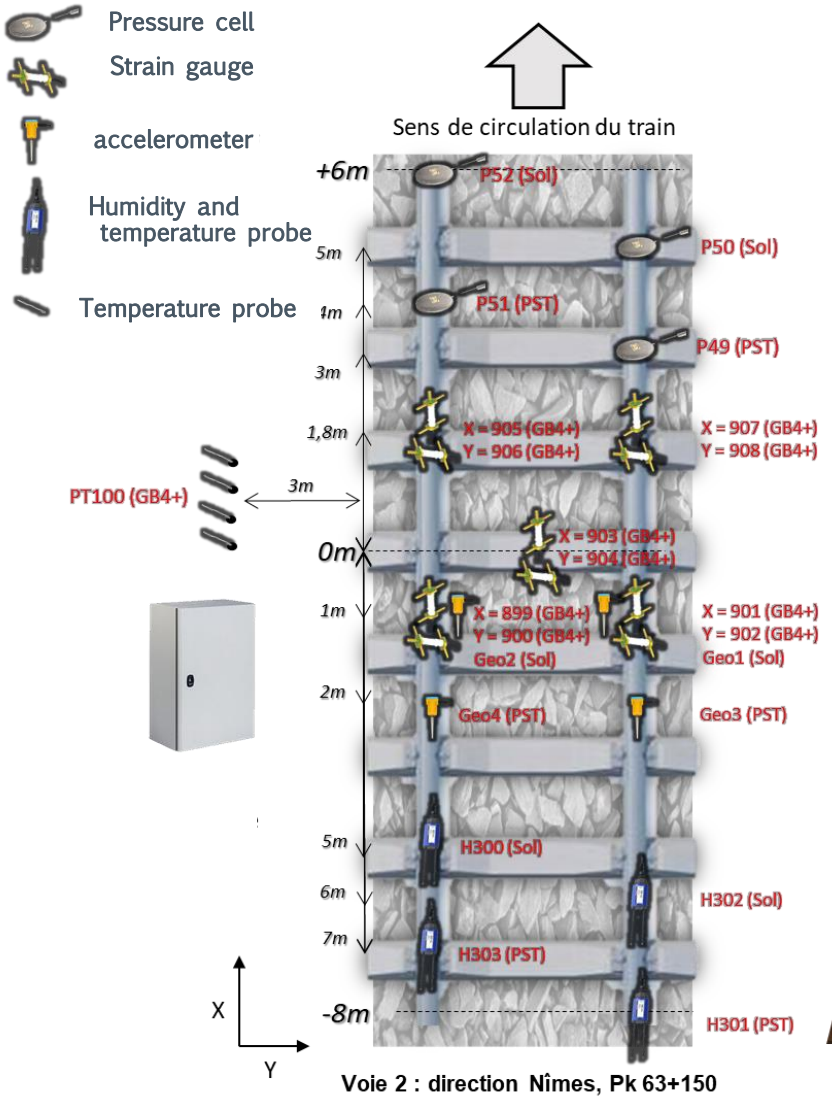
*Mixed traffic : HST + Freight*

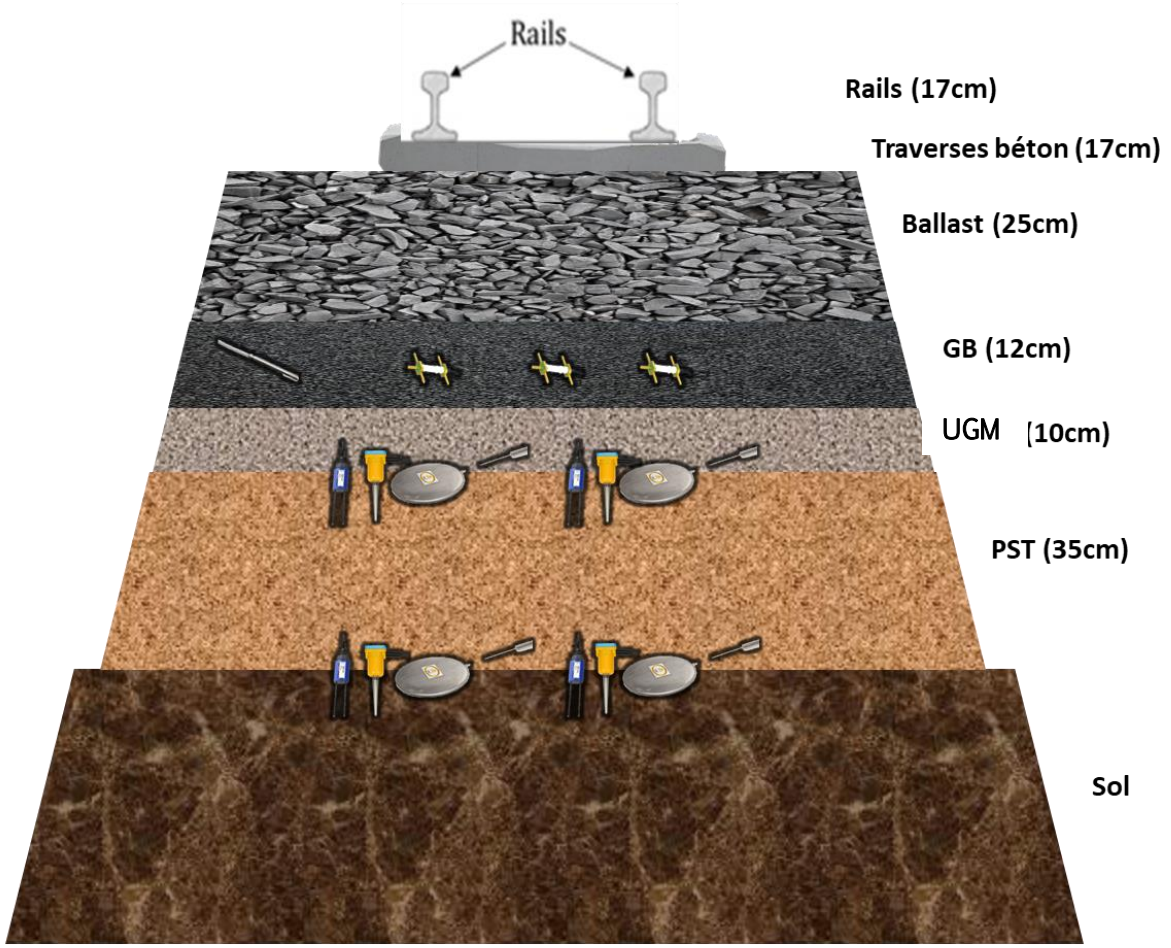
*239 000 t Base asphalt GB4+*

| | Requirements |
|---|---|
| Binder content | k > 2,9 |
| Voids | ≤ 4% |
| Modulus | ≥ 11000 MPa (3-6% voids) |
| Fatigue | ≥ 110 µdefs (3-6%voids) |

Base course covered by emulsion ECR 65% 800g/m² + gritting 4/6 6l/m²

# CNM

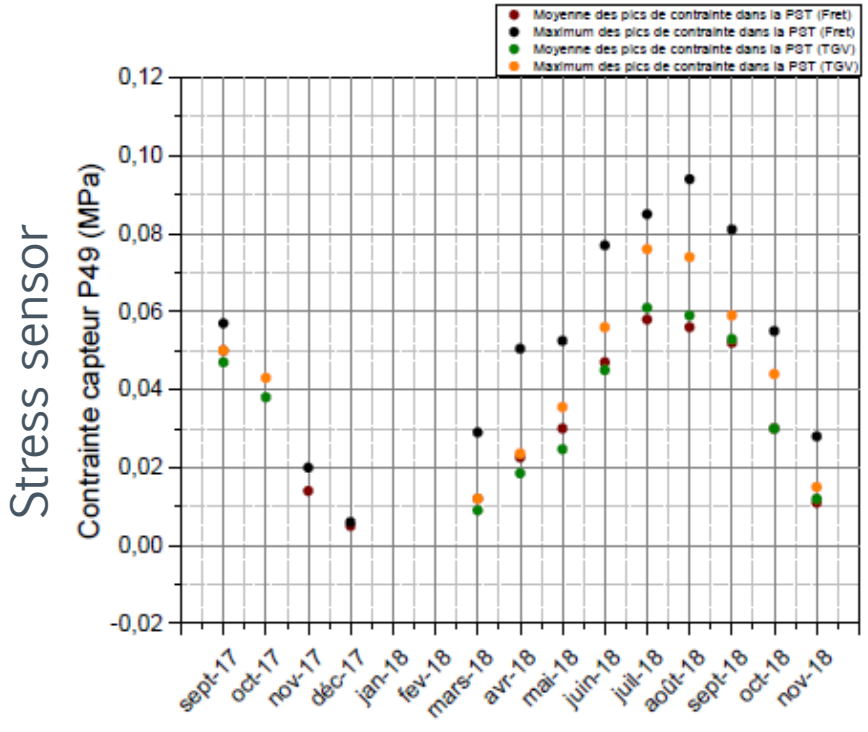

Pressure cell
Strain gauge
accelerometer
Humidity and temperature probe
Temperature probe
Sens de circulation du train
+6m
5m
1m
3m
1,8m
3m
0m
1m
2m
5m
6m
7m
-8m
P52 (Sol)
P50 (Sol)
P51 (PST)
P49 (PST)
X = 905 (GB4+)
Y = 906 (GB4+)
X = 907 (GB4+)
Y = 908 (GB4+)
PT100 (GB4+)
X = 903 (GB4+)
Y = 904 (GB4+)
X = 899 (GB4+)
Y = 900 (GB4+)
Geo2 (Sol)
X = 901 (GB4+)
Y = 902 (GB4+)
Geo1 (Sol)
Geo4 (PST)
Geo3 (PST)
H300 (Sol)
H302 (Sol)
H303 (PST)
H301 (PST)
X
Y
Voie 2 : direction Nîmes, Pk 63+150

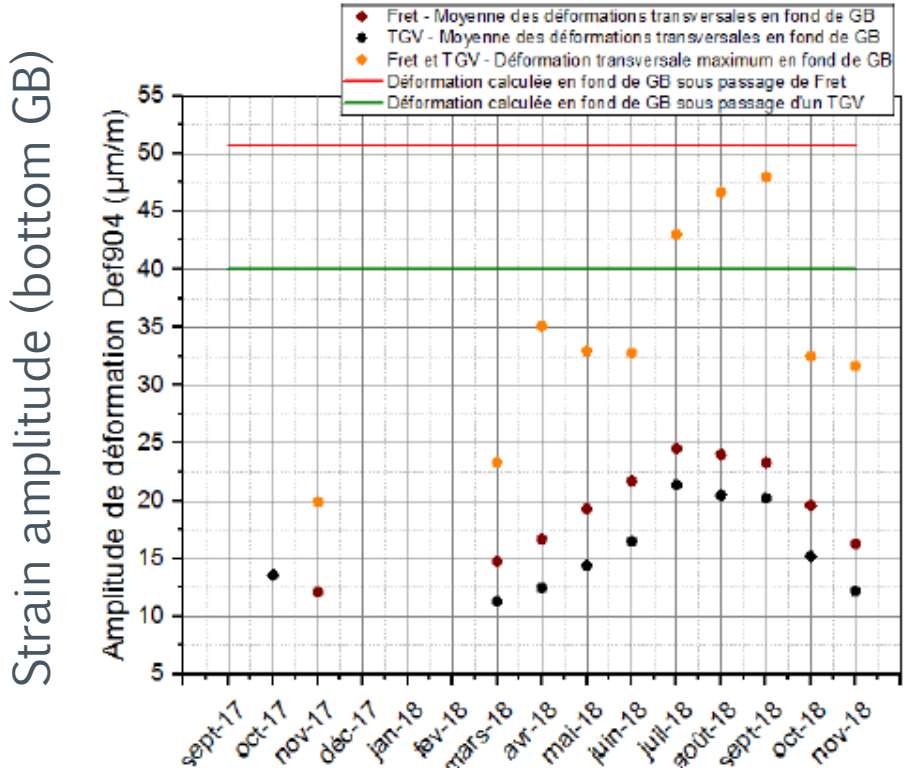

Rails
Rails (17cm)
Traverses béton (17cm)
Ballast (25cm)
GB (12cm)
UGM (10cm)
PST (35cm)
Sol

# Feedback from Projects & Monitored sections

› Validation of assumptions used for design

› Measures lower than maximum values

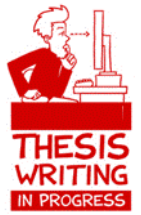



Ex. measures from CNM HSL

# Feedback from Projects & Monitored sections

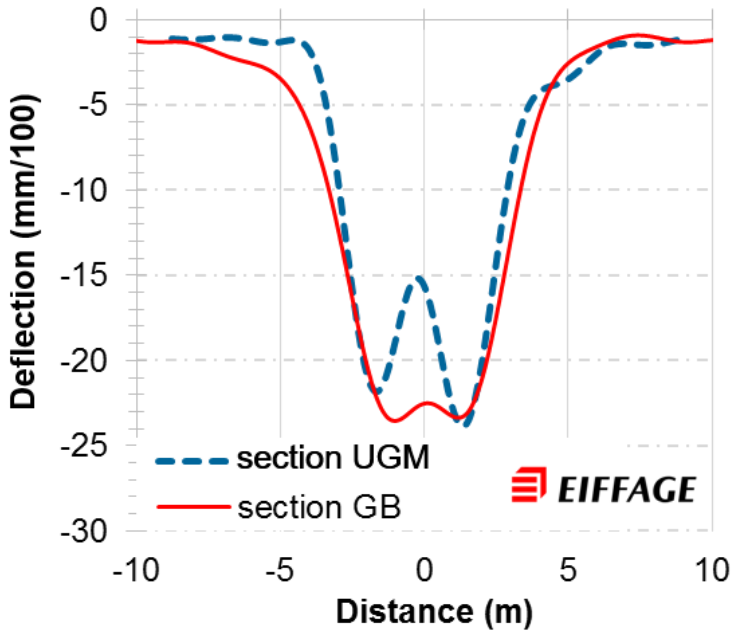
› Positive effect on vertical acceleration



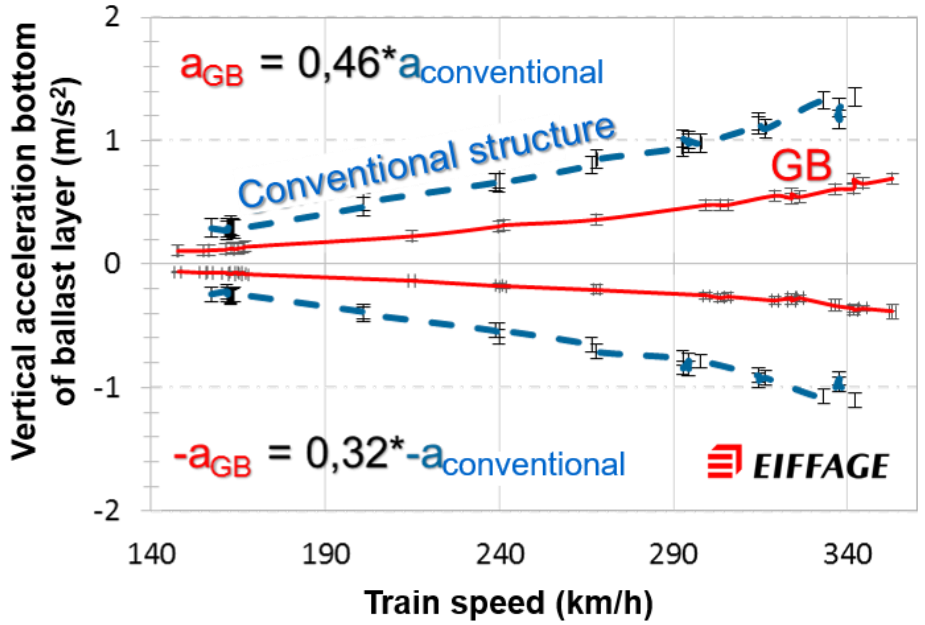

Khairallah et al. 2018

PhD thesis in progress (due for 10/19)

– **Deflexion**: Similar magnitude but traction return attenuated



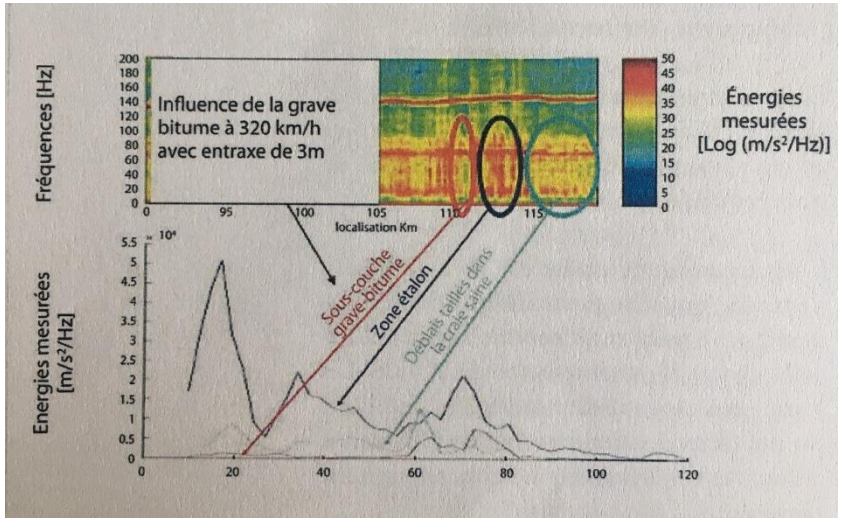

– **Vertical acceleration**: 40% less at the ballast bottom and 50% less on the sleeper (320km/h train speed)




Ex. measures from BPL HSL

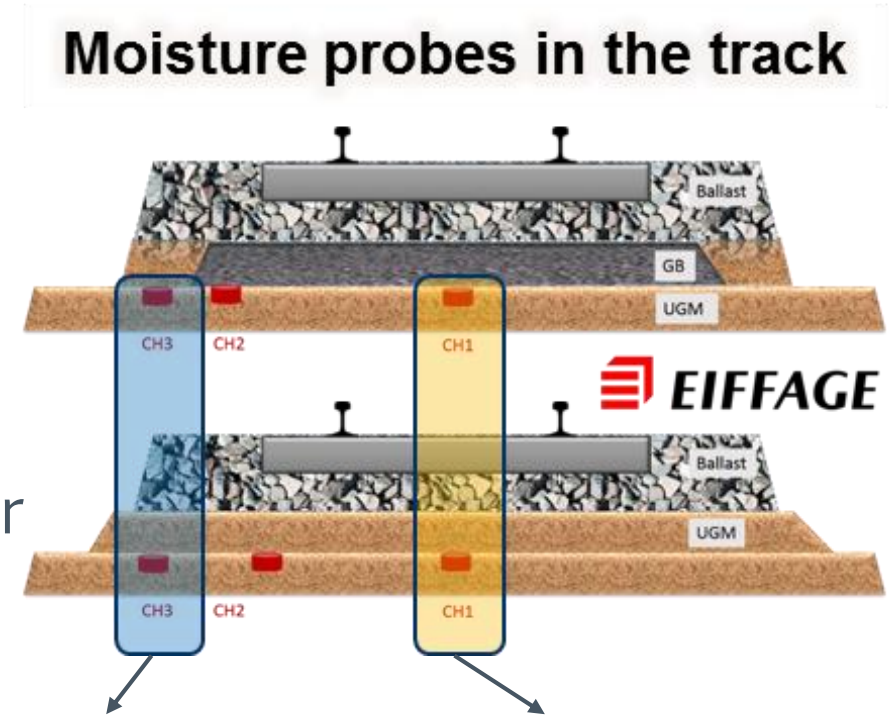
# Feedback from Projects & Monitored sections

- Benefit for longitudinal levelling
  - Reduction of maintenance cost due to lesser need for tamping
- Good solution for a speed of 320km/h
  - Monobloc concrete sleepers + pads to reduce attrition
  - Asphalt sub-ballast trackbed

# Feedback from Projects & Monitored sections

- Platform protection from water infiltration
  - Stable moisture content of the soil layers
  - Increased durability of the platform
  - Enhanced evacuation of run-off water




| Structure type | Rain time | Rainfall | Subgrade water content variation | |
|---|---|---|---|---|
| | | | Ballast limit | Track axle |
| All UGM | 12h | 23mm | **26%** | **9%** |
| GB4 sub-ballast | 14h | 23mm | **13%** | **0%** |

Ex. measures from BPL HSL

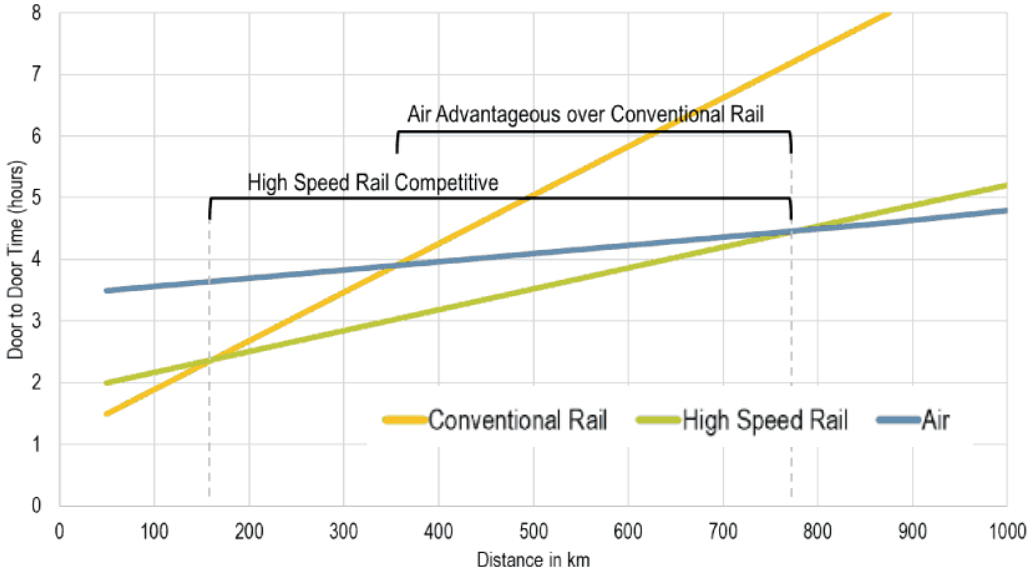
# Feedback from Projects & Monitored sections

Summary:

- Good behaviour of GB
- Positive effect on deflection and acceleration under Ballast
- Good solution for High speed ( 320 km/h)
- As a result : Savings in maintenance
- Prevent damage due to water (durability).
- Care with drainage and design for remediation.

# ASPHALT IN RAILWAYS

## OPPORTUNITIES FOR THE FUTURE?




*Source : Commission for Integrated Transport, London (2004) High-speed rails: international comparisons, Steer Davies Gleave.*