Use of Asphalt Reinforcement in Heavily Loaded Container Terminal Pavements

GEOANZ #1 ADVANCES IN GEOSYNTHETICS
7–9 JUNE 2022 | BRISBANE CONVENTION & EXHIBITION CENTRE

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GEOANZ #1 ADVANCES IN GEOSYNTHETICS

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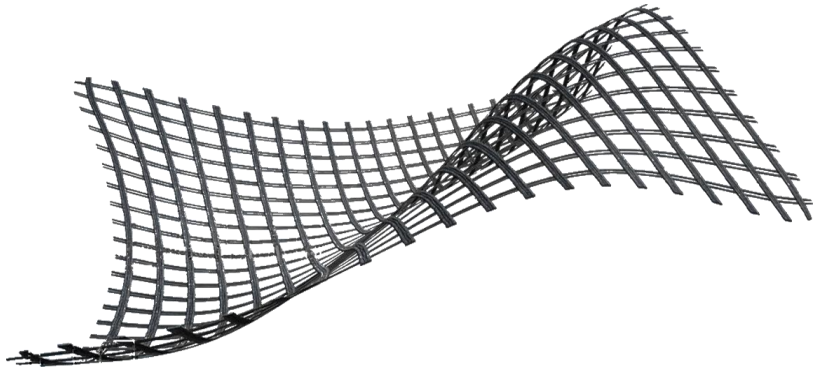
Agenda

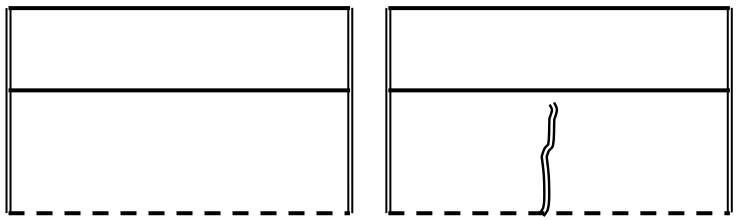
- Effective crack mitigation in Asphalt Pavements
- Heavy duty pavements: Typical pavement design
- Case Study:
  - Construction of a Brisbane container terminal pavement
  - Case Study: Adelaide Airport Taxiway Kilo reconstruction
- Scientific Performance Verification
- Typical Design Applications



Crack Formation in CTB & Propagation into Asphalt

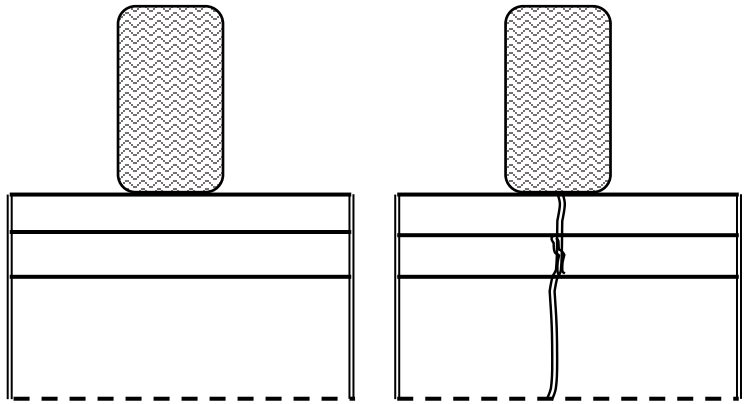
Crack Formation in CTB:

- Can develop soon after construction due to “shrinkage” in CTB
- Challenge in new pavement design/ construction



Crack Propagation into Asphalt:

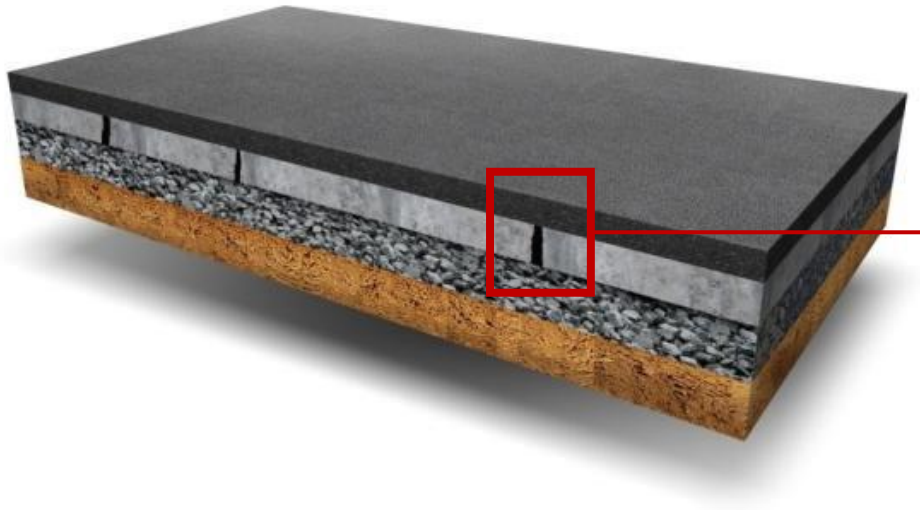
- Related to the crack growth
- Challenge in new pavement design/ construction
- Challenge in pavement rehabilitation

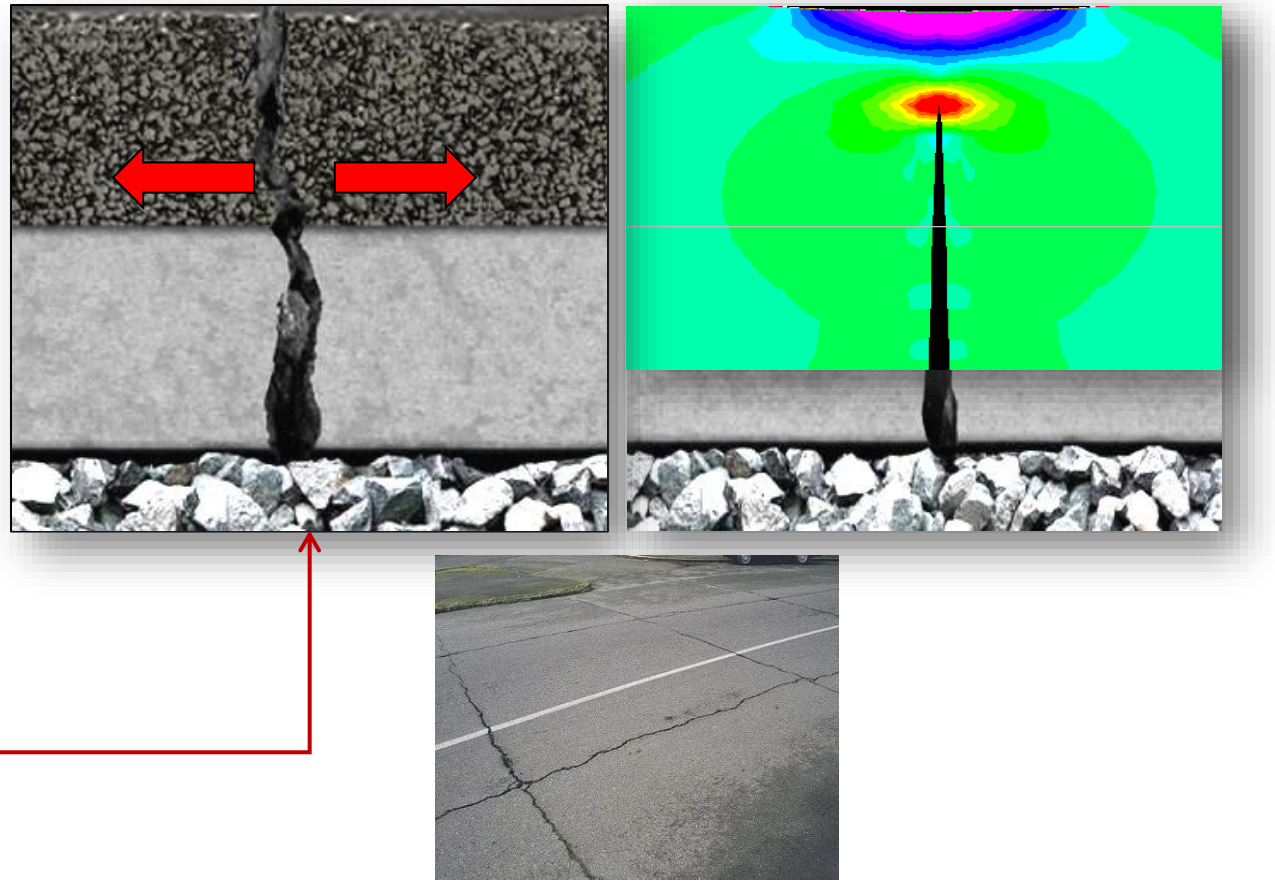


Shrinkage cracking in CTB & Reflective cracking in Asphalt

Reflective Cracking

- Crack growth into the new asphalt layer
- Due to high tensile stresses at crack tip





Source: Montestruque G. E., 2002, *Contribuição para a Ela-boração de Método de Projeto de Restauração de Pavimentos Asfálticos Utilizando Geossintéticos em Sistemas Anti-Reflexão de Trincas (Contribution to the preparation of a method of a project for rehabilitation of asphaltic pavements using geosynthetics on anti-reflective crack systems).* Doctor's Thesis, Technological Institute of Aeronautics, São José dos Campos, Brazil.

Traditional Design Method to Mitigate Reflective Cracking

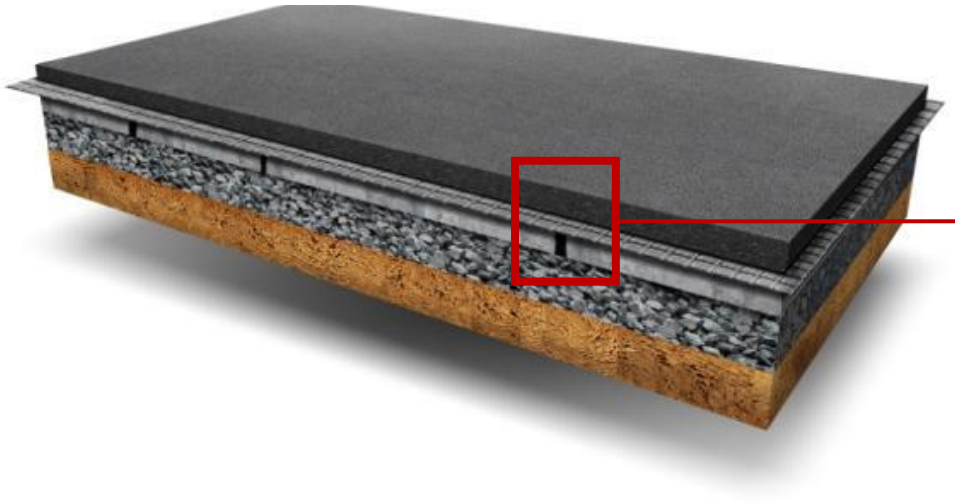
Sustainable ?

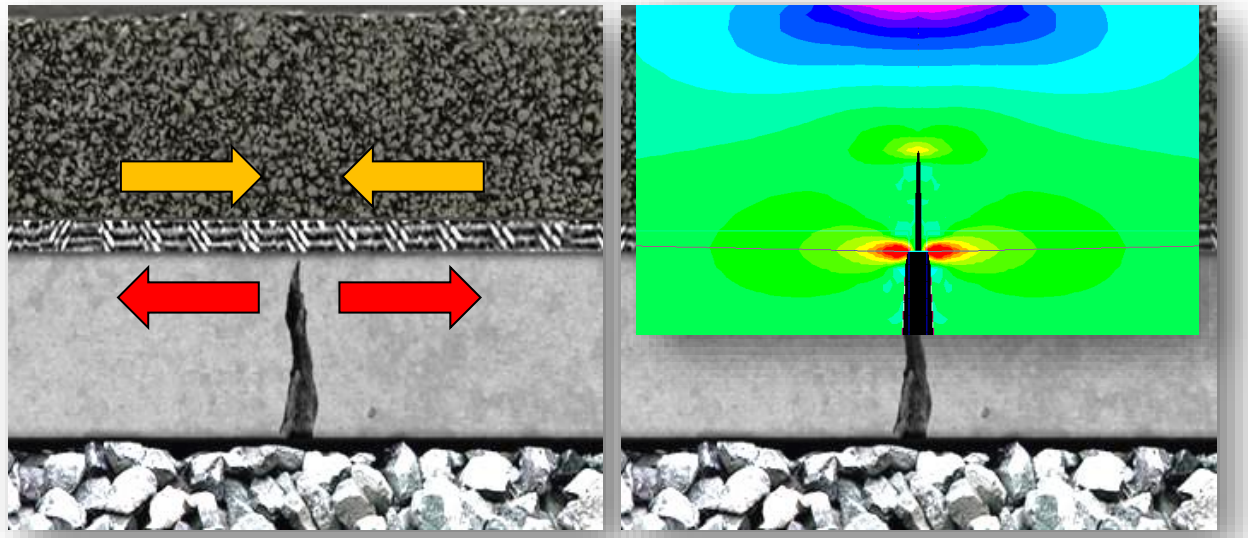
Engineering value ?

Solution for Reflective Cracking

Solution An Engineered Asphalt Reinforcement Geogrid

- Absorption and distribution of high tensile stresses
- Significantly reduced growth of reflective cracks





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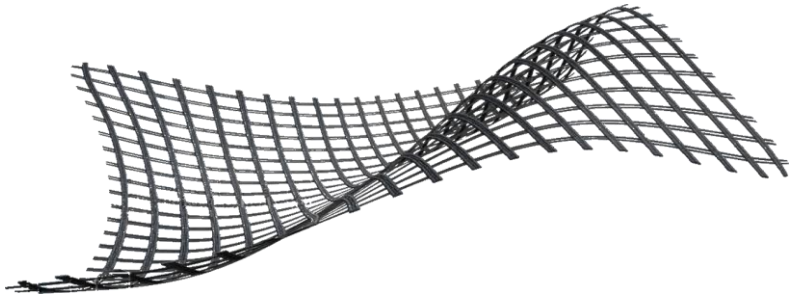
Case Studies



Construction of a Brand-new Pavement at a Brisbane Container Terminal
August, 2018

Brisbane Container Terminal

SITE CONSIDERATIONS

- Existing Conditions (reclaimed / marshy land)
- Pavement Strength for Container Storage
- Reflective Cracking from CTB Layer
- Dust Suppression (Council issues)

FOLLOWING CTB LAYER CONSTRUCTION

- CTB Pavement is uneven and not level
- Possible solution was fine milling to improve CTB shape prior to HaTelit C placement
- However, the CTB surface still needs to provide a good bond with HaTelit C and overlaying Asphalt

Brisbane Container Terminal

PAVEMENT SOLUTION

- Apply AMC-0 prime coat to CTB
- Install thin layer of bitumen-enriched asphalt corrector to –
  - Act as shape improvement
  - Improve surface properties for installation of the HaTelit C
  - Improve fatigue resistance properties
- Apply C170 bitumen tack coat to asphalt corrector
- Apply HaTelit C asphalt reinforcement
- Place 100mm nominal thickness EME2 asphalt, providing strength & water resilient properties

Brisbane Container Terminal

Figure 1. CTB Pavement – Prior to Works

Figure 2. CTB Pavement – AMC-0 Priming

Brisbane Container Terminal

Figure 3. Priming - Complete

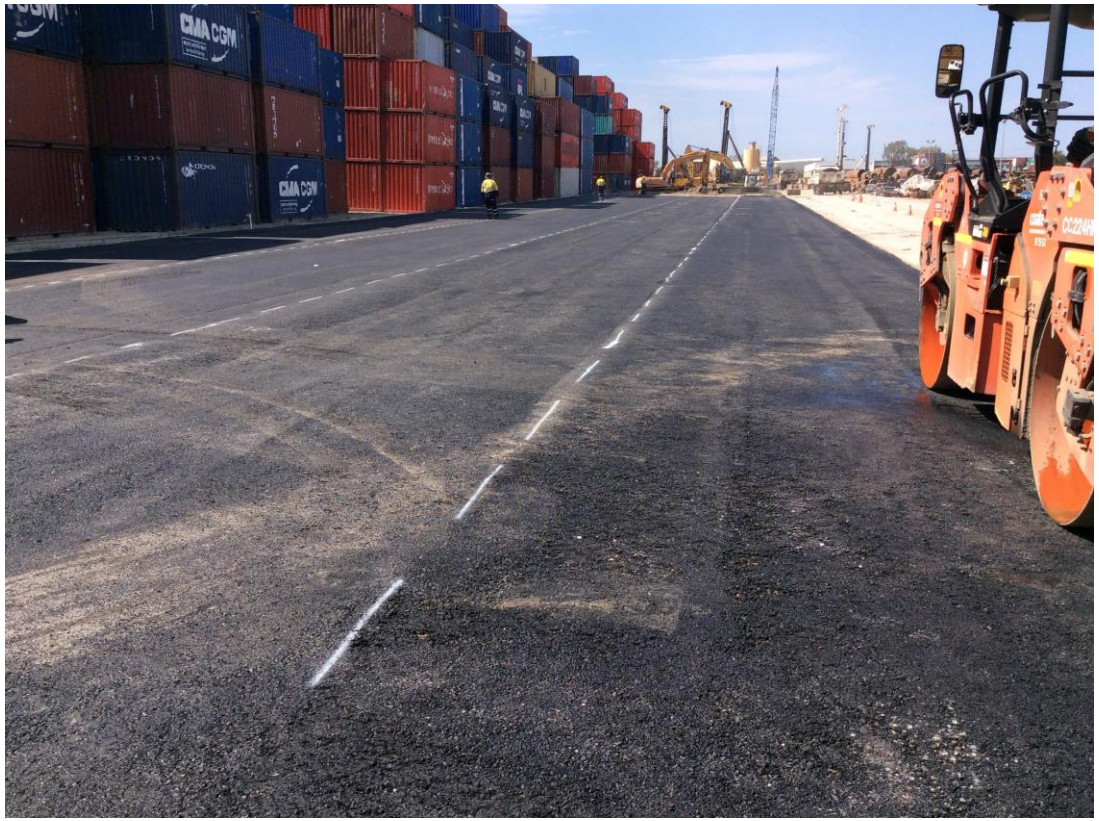


Figure 4. AC10 Corrector - Complete

Brisbane Container Terminal

Figure 5. Tack Coat and HaTelit C

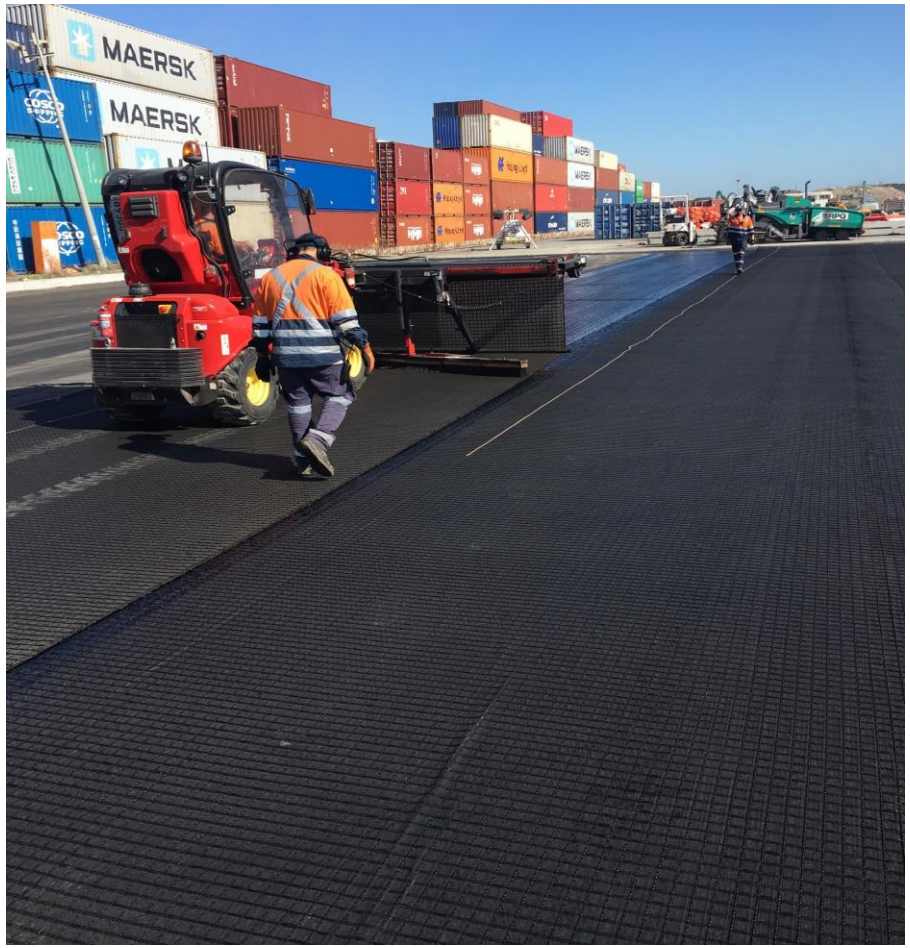


Figure 6. HaTelit C – Placement

Brisbane Container Terminal

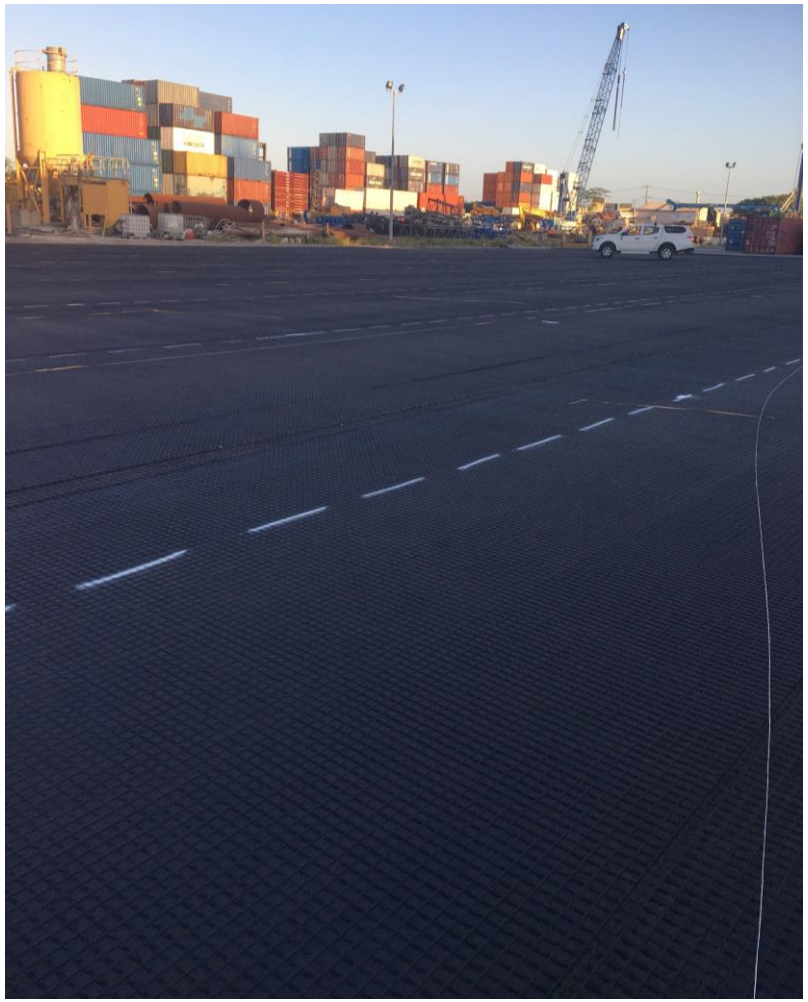
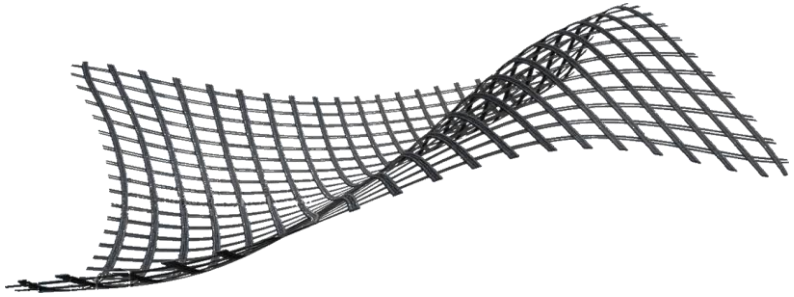


Figure 7. HaTelit C - Complete

Figure 8. EME2 - Under Construction

Case Studies



Adelaide Airport, Taxiway K Reconstruction
March 2016

Adelaide Airport – Taxiway K

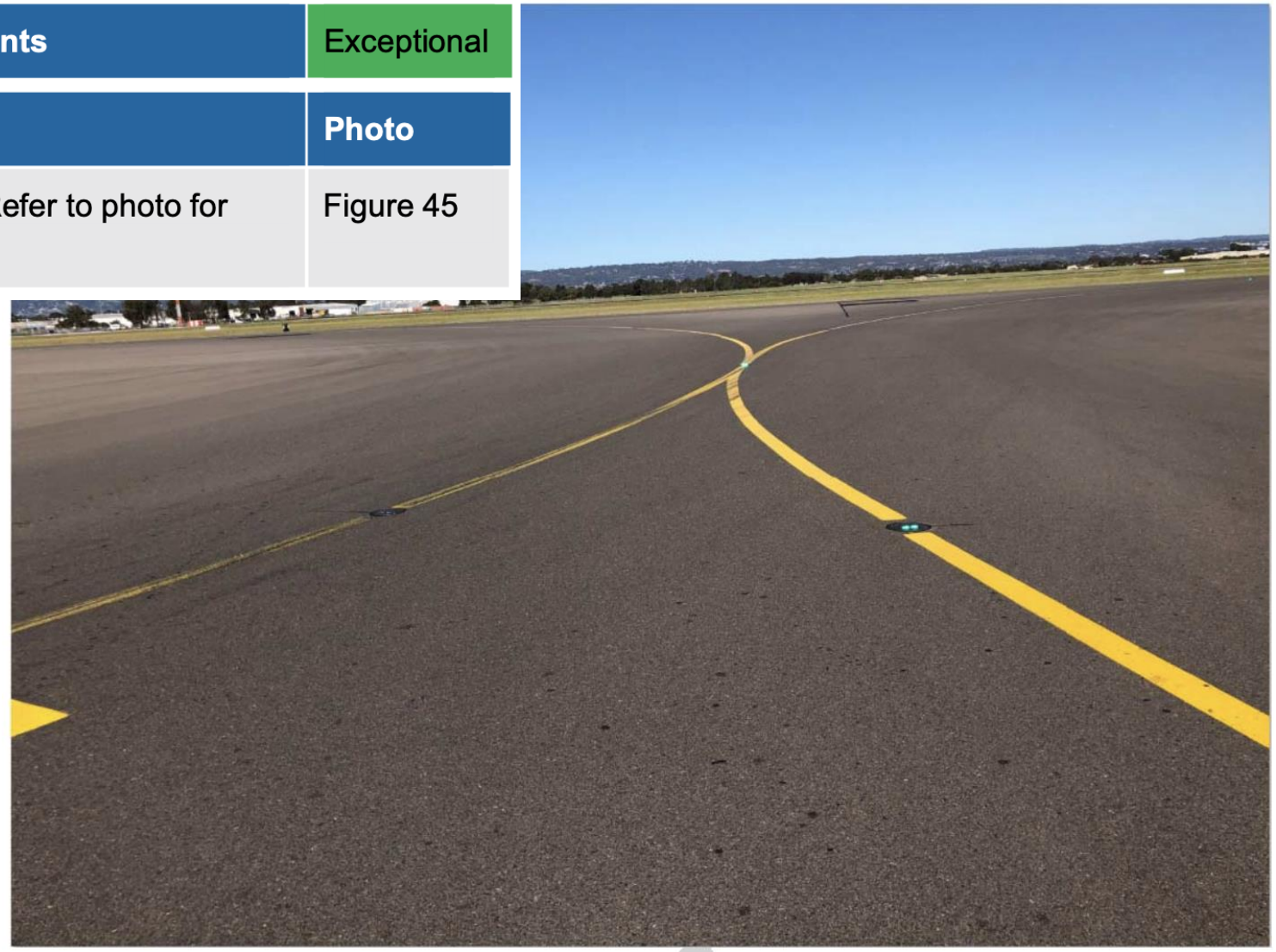
- Taxiway K constructed in 2004/05 as asphalt surfaced flexible pavement
- Extensive repeated failures in 2010 and 2013 led to reconstruction in 2016
- Pavement design solution was reconstruction of the pavement with HaTelit C incorporated into 100mm asphalt overlay over CTB (450mm thick).

***Source**: Adelaide Airport & Aurecon: Taxiway Kilo 2016 Reconstruction Pavement Detail*

Adelaide Airport – Taxiway K

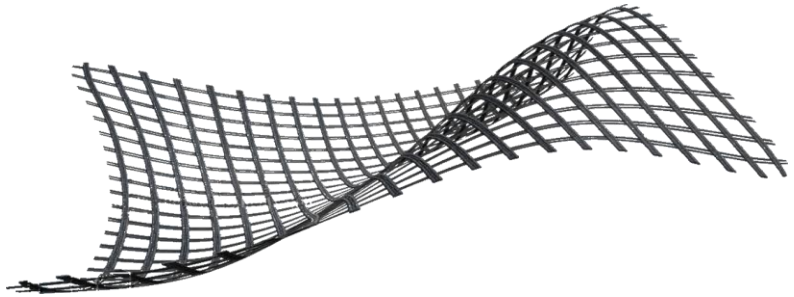
TWY K	General condition and general comments	Exceptional
Location	**Key Observations**	**Photo**
TWY K	No defects were evident on Taxiway K. Refer to photo for general view of Taxiway K	Figure 45

Source: Adelaide Airport
20/21 Pavement Inspection Report



Adelaide Airport – Taxiway K

Scientific Performance Verification



Effects of HaTelit reinforcement on
Extension of the Pavement Life-span

Scientific Performance Verification

1

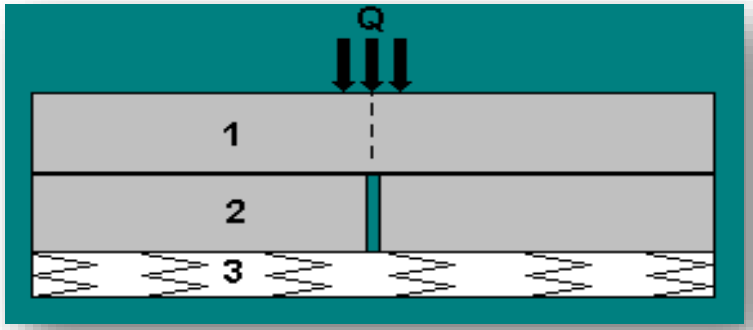
Doctoral Thesis, Technological Institute of Aeronautics, São José dos Campos, Brazil, 2002.

Dynamic Fatigue Tests to Determine the Effects of HaTelit® in Anti Reflective Cracking Applications in Asphalt Overlays

Scientific Performance Verification

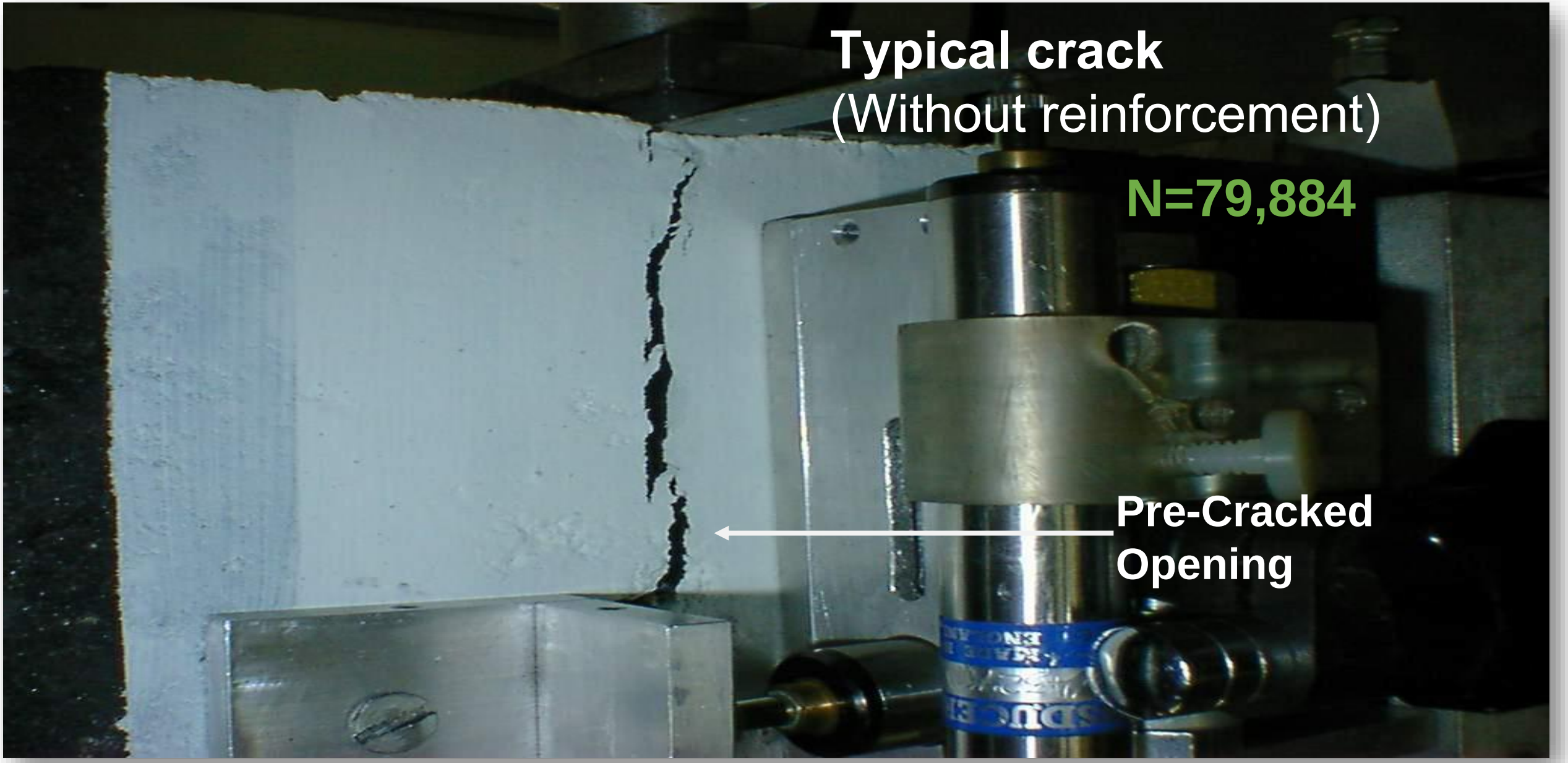
Set-up (2000)

Material	**HaTelit ® C**
Precrack	3mm, 6mm, 9mm
HaTelit ® Position	Directly above the crack tip
Load Position	Bending and Shear mode
Contact Pressure	560 kN/m^2 (max value)

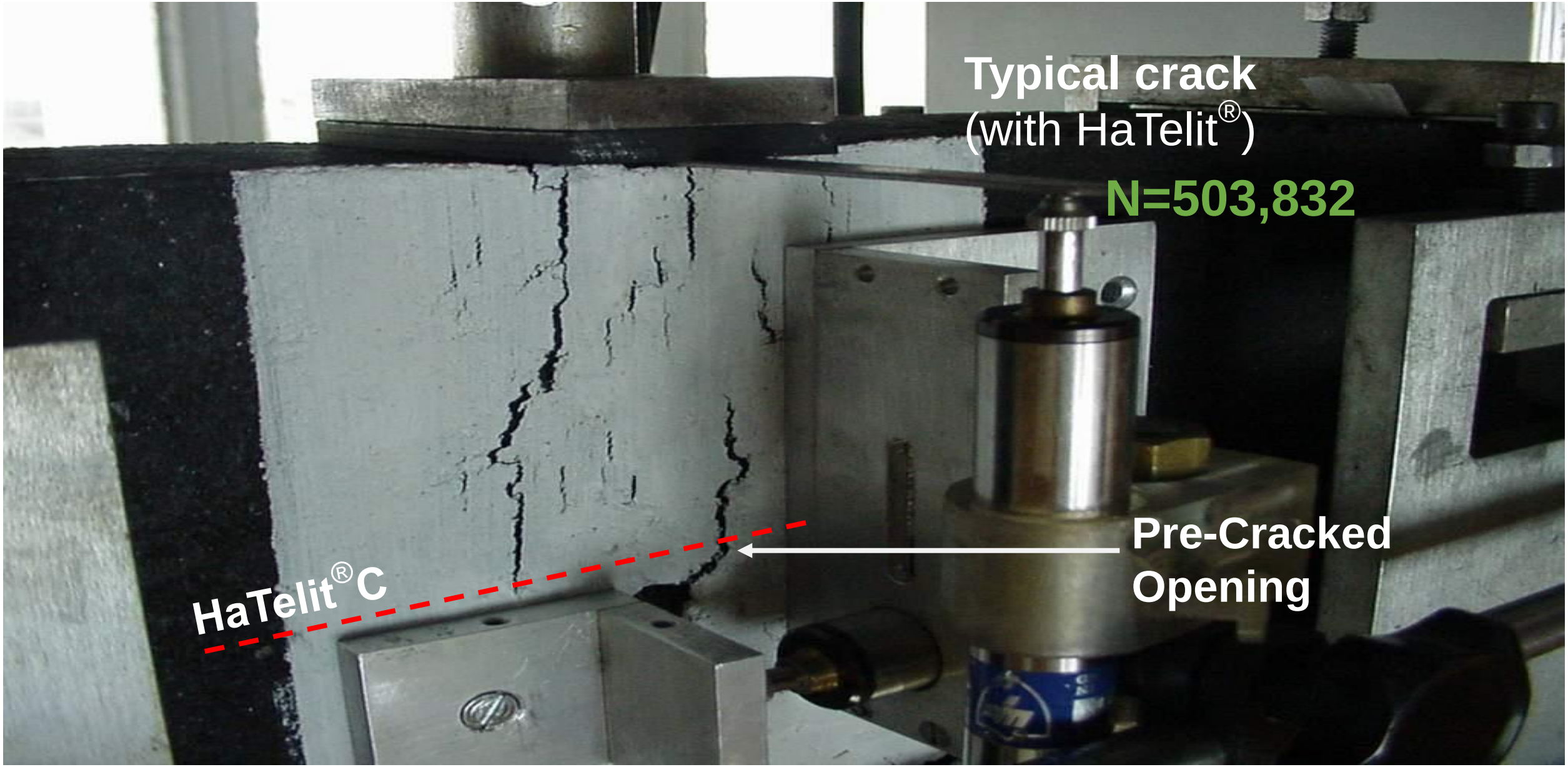


(1) Overlay
(2) Blocks with opening
(3) Elastic base (rubber)

Typical cracking without reinforcement



Typical cracking with HaTelit reinforcement



Scientific Performance Verification

Improvement factor

$$Vf = N_{f\ (with\ Hatelit\ ®)} / N_{f\ (without\ Hatelit\ ®)}$$

$$N_f = \frac{1}{c_{f1}}$$

$$c_{f1} = \frac{1}{N_{i}(B)} + \frac{2}{N_{i}(S)}$$

$$4.60 < Vf < 6.14$$

Impact of Material Choice & Construction Damage

2

Research into the Influence of Construction Damage on Asphalt Reinforcing Geosynthetics

Diploma Thesis, RWTH Aachen, Institute of Road and Traffic Engineering, Aachen, Germany, 2011

Impact of Material Choice & Construction Damage

Set-up (2011) Testing “Effective Tensile Strength“

- Simulating installation damage
  - Asphalt truck passes only
  - Asphalt compaction only (50mm AC overlay)
  - Combination of asphalt truck passes and compaction

- Comparing geogrids made of different raw materials:
  - PET asphalt reinforcement grid – Undamaged Tensile Strength 50kN/m
  - Glass fibre asphalt reinforcement grid – Undamaged Tensile Strength 74kN/m

Impact of Material Choice & Construction Damage

Construction Damage

- 35 passes with a 2 axle truck
- Corresponds to 7 semi trailers passes

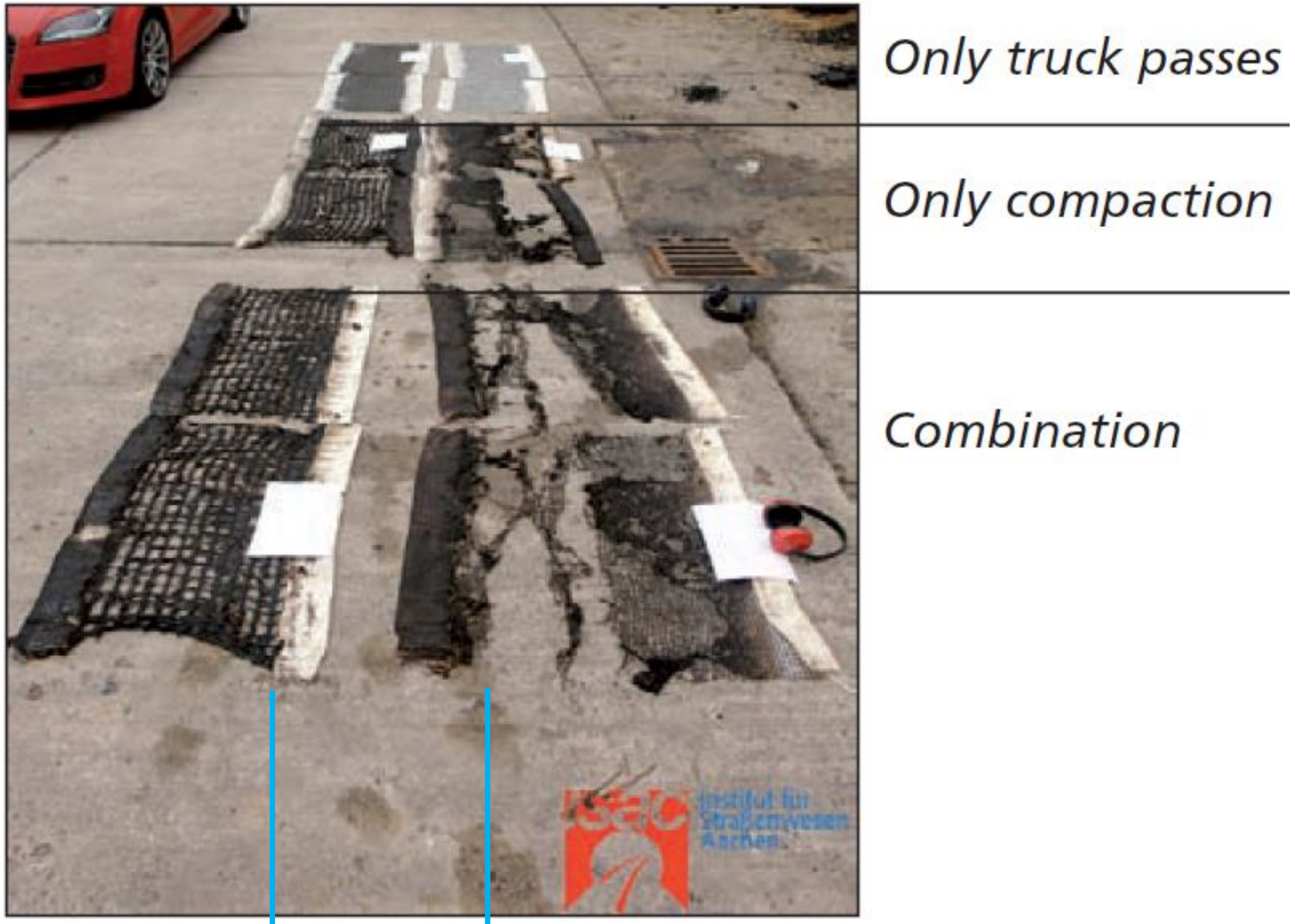
- 6 roller passes

Impact of Material Choice & Construction Damage

Results

- There is a considerable difference between the influence of trucks passes and asphalt compaction

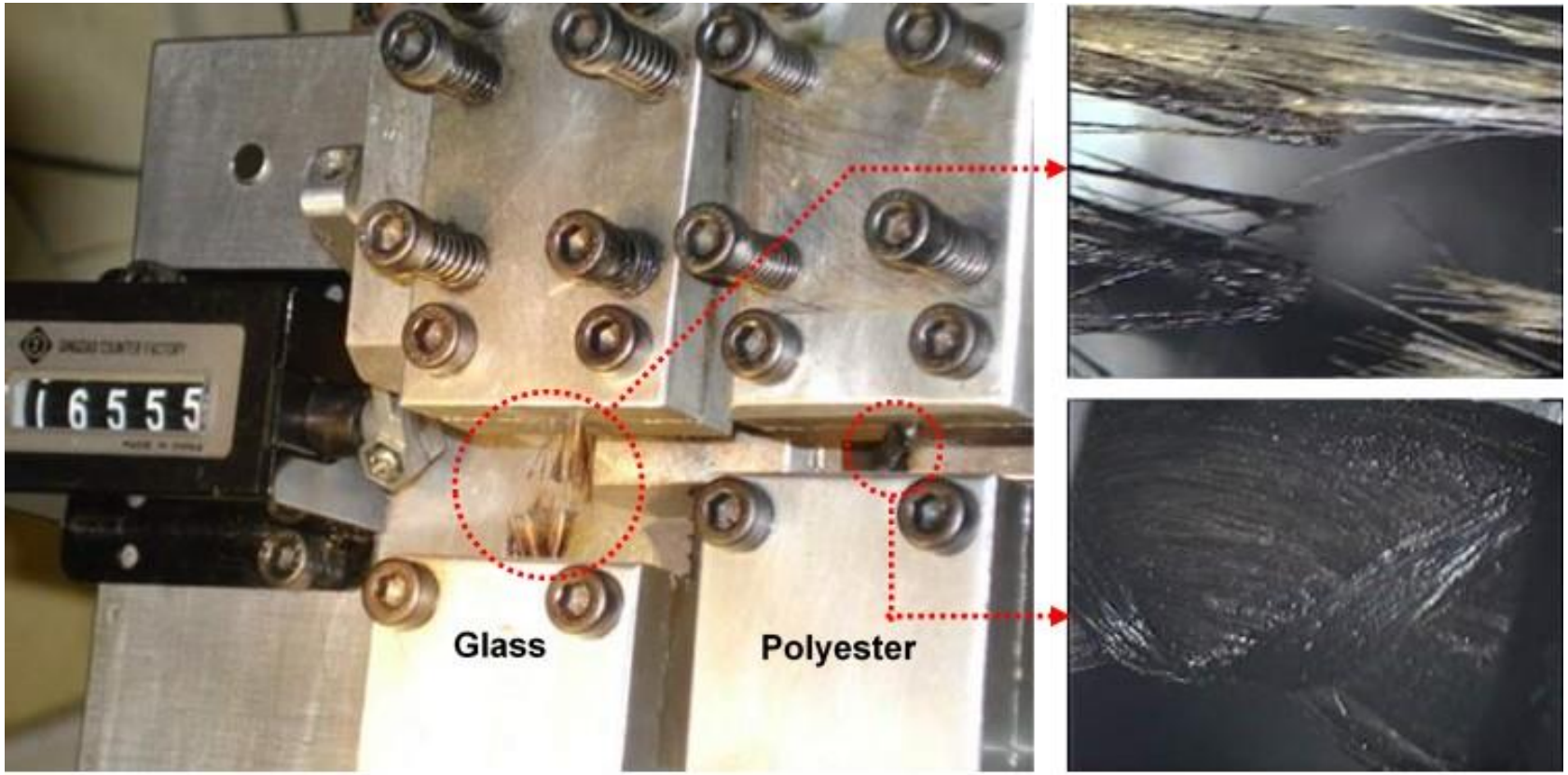
- Significant damage and loss of strength in the grid made from glass-fibres (Right), contrary to PET HaTelit C reinforcement (Left)



Impact of Material Choice & Construction Damage

Polyester vs. Glass fibres: Resistance to Shear stress

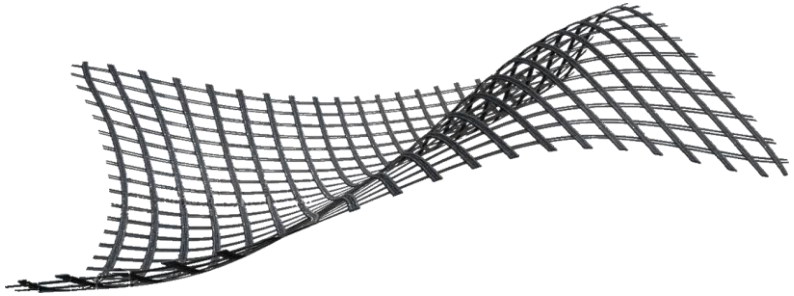
Montestruque et al. 2012



Glass-fibre strand broke between 16,000 and 21,000 cycles

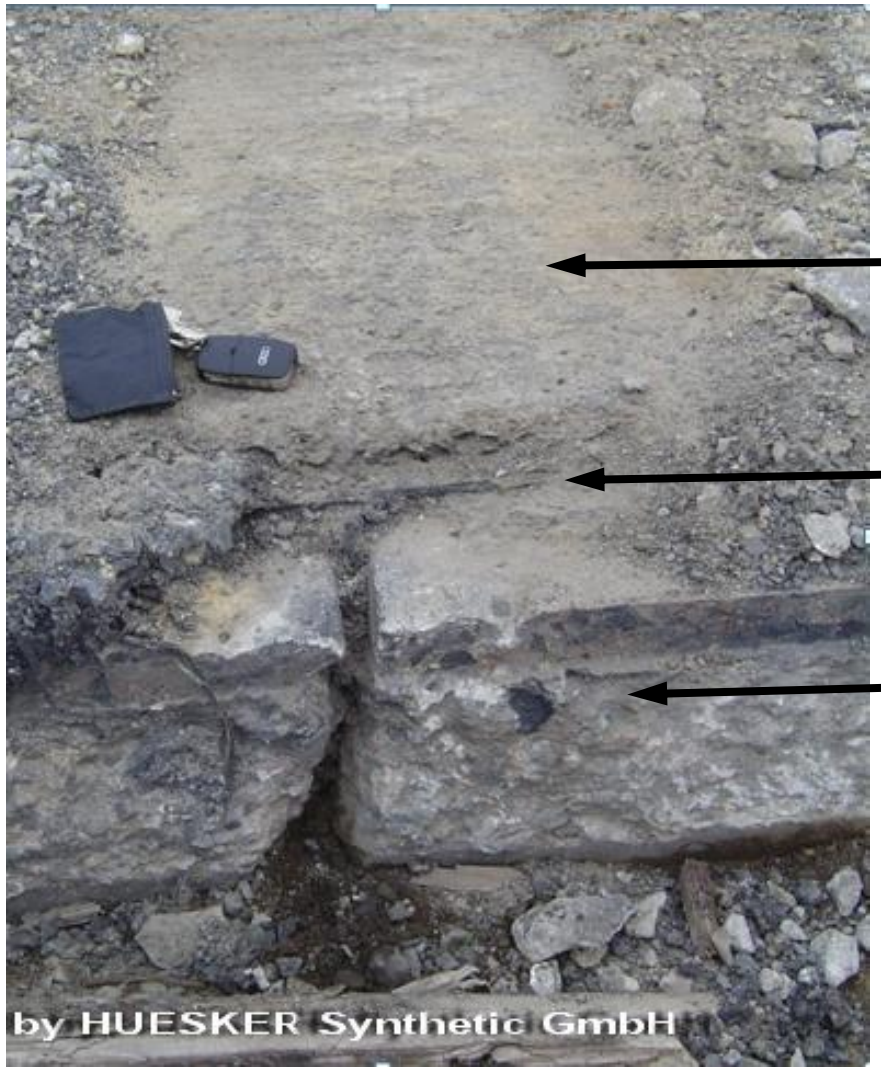
Polyester strand **did not break** and test was stopped at 160,000 cycles, demonstrating **significantly higher performance**

Field Verification



Long-term field performance

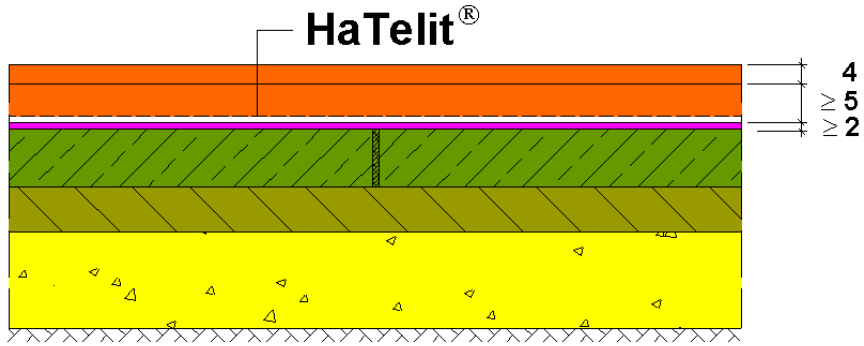
Optimum crack mitigation through effective reinforcement



- **15 years after rehabilitation**, in service with heavy traffic no further maintenance
- **No reflective cracking** in the AC from the underlying slab joints & cracks

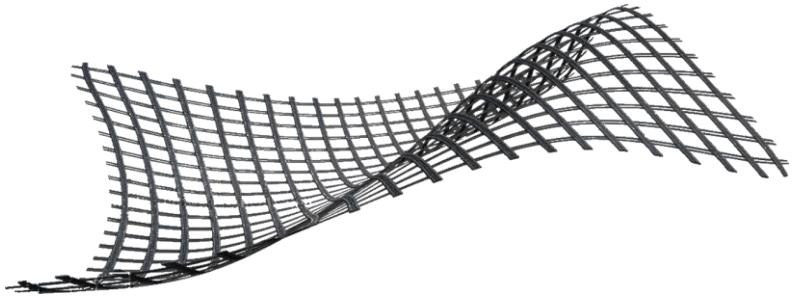
HaTelit® Asphalt reinforcement geogrid

Old concrete slabs



Source: Landesbetrieb für Straßenbau, Brandenburg, NL Autobahnen, 2005

Typical Design Applications



Typical Design Applications with HaTelit

To resist reflection of joints and cracks (e.g. ***fatigue cracks, differential cracks, shrinkage cracks***) into the new AC overlay, the HaTelit reinforcement technology has been used in

1. Asphalt Overlay Rehabilitation of existing rigid, composite, and flexible pavements:

- Existing and/or Cracked **concrete pavements**
- Cracked **composite pavements**
- Cracked **flexible (bound and unbound)** pavements
  - **Mill & fill**
  - **Retain & overlay** again cracked asphalt, with the new asphalt containing HaTelit

2. New Construction:

- Pavement **widening and extensions**
- Pavement tie-ins / **transition pavements**
- Newly constructed **Cement Stabilised Base** with asphalt surfacing
- New **Concrete pavements** (e.g. expedient) with asphalt surfacing

Heavy vehicle roads: New construction CTB & HaTelit C

HaTelit C between two 50mm AC layers, over new CTB

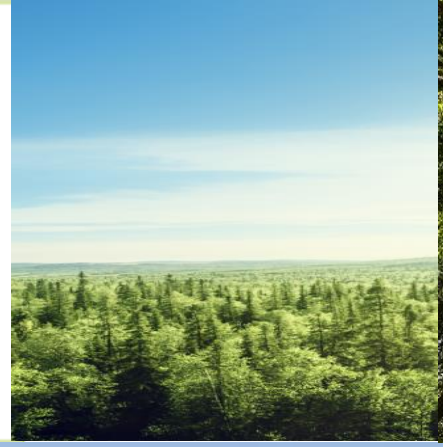
Highways: Rehab – Mill & fill over old CTB using HaTelit C

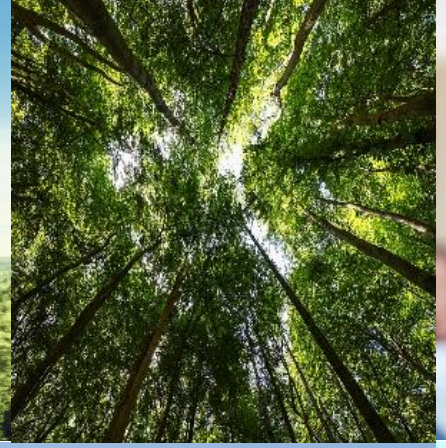
HaTelit C on “Sharp Curves” & Intersections

On ramp to M4

HaTelit® C

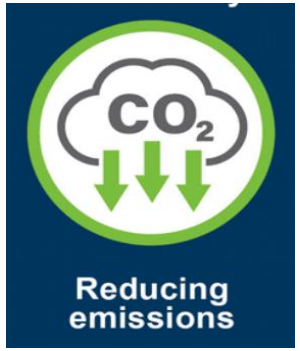
eco LINE

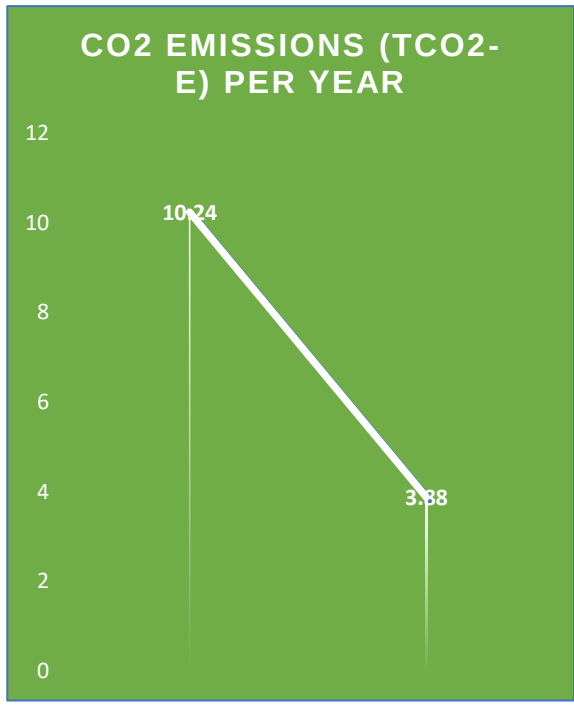




Designed to save resources

Sustainability: Asset durability + Circular Economy





Geogrids made from 100% recycled PET

Thank you