



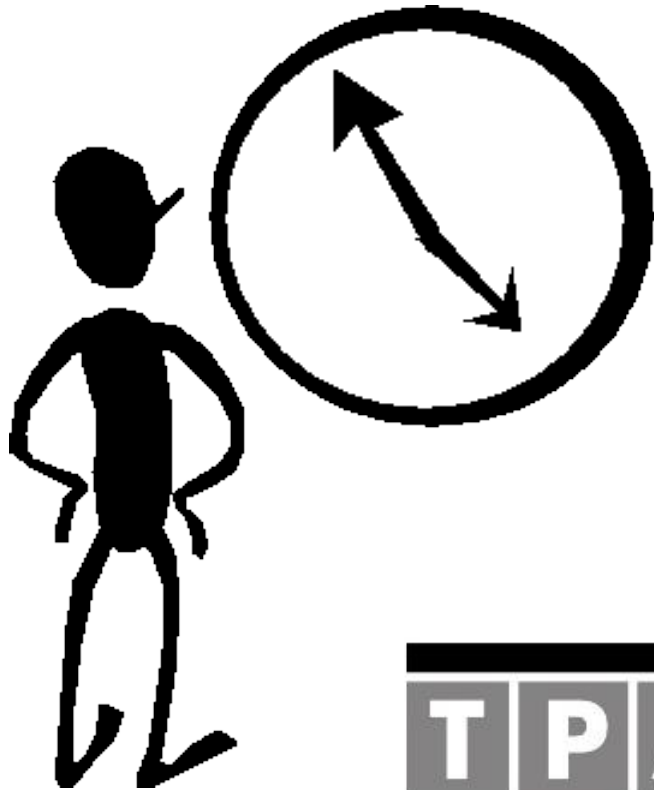
**STRABAG**  
TEAMS WORK.

IGOR RUTTMAR



# 20 YEARS OF ROAD CONSTRUCTION DEVELOPMENT IN POLAND.

HOW THE INNOVATIONS ARE BORN.



16<sup>th</sup> Romanian National Congress  
of Roads and Bridges, September 21-24, 2022



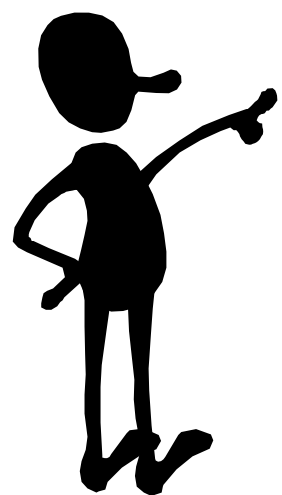
**STRABAG**  
TEAMS WORK.





## DISCLAIMER

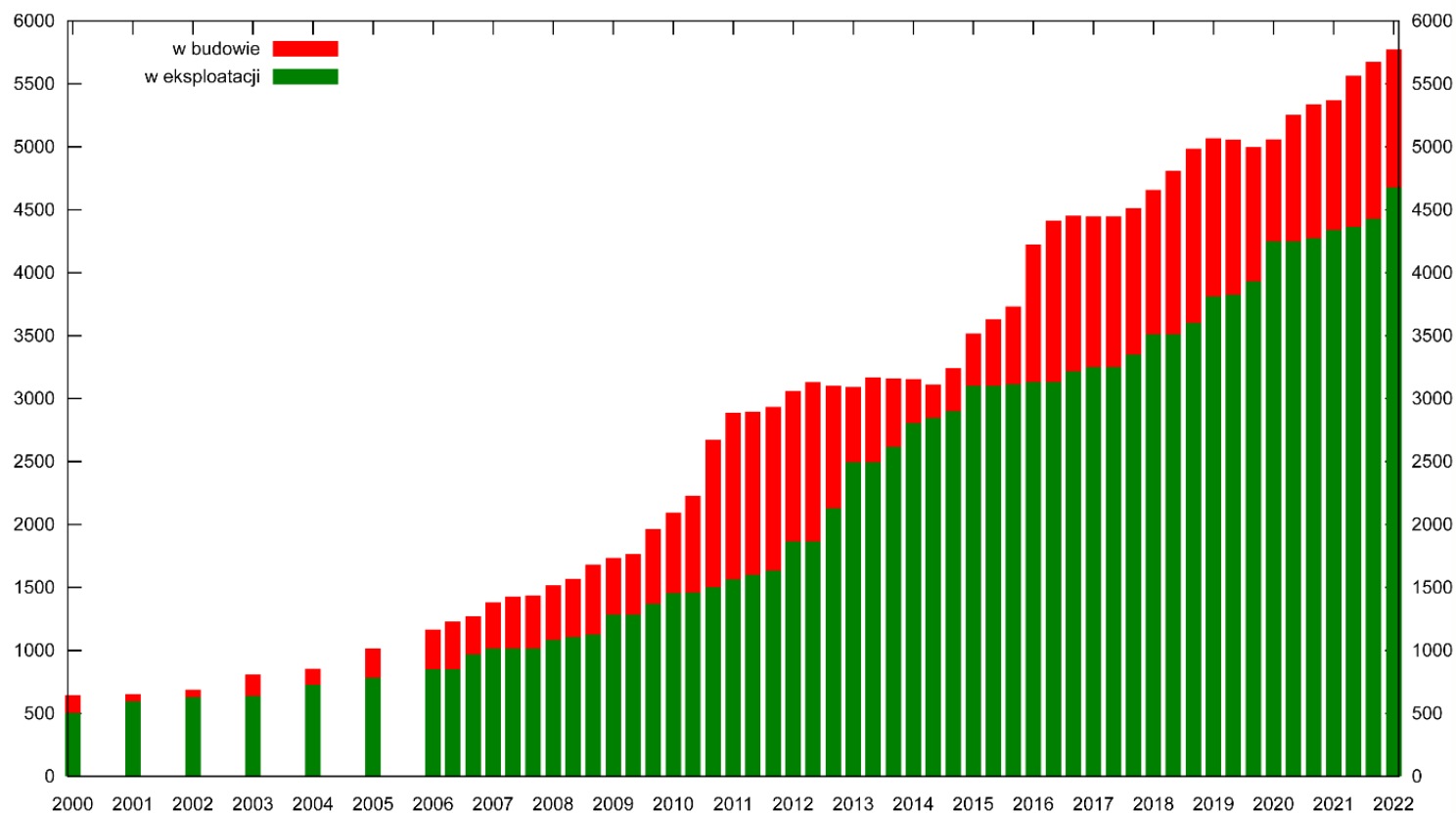
WE DO NOT  
WANT TO  
RE-INVENT THE  
WHEEL!





# PAST AND PRESENT ASPHALT ROADS IN POLAND

# NATIONAL MOTORWAY AND EXPRESSWAYS CONSTRUCTION PROGRAM IN POLAND 2000-2022



RUTTING ISSUE

**1998**



A2 Motorway  
Konin - Wrześńia

Let's use wheel  
tracking test!



A4 Motorway  
Wrocław-Nogowczyce

**1998**



# WHEEL TRACKING TEST (EN 12697-22) INTRO



SMALL DEVICE



LARGE DEVICE

11.5 13.0

t/axle t/axle



**2000**

**TRADITIONAL  
ASPHALT  
PAVEMENT**



2000

8 cm

AC 0/20 D50

4 cm

SMA 0/11 D50

17 cm

AC 0/25 D50

**15 mln**

115 kN  
ESALs



”

Do or do not.  
There is  
no try.

Yoda, *The Empire Strikes Back*



**2004**

**„EME”  
HIGH STIFFNESS  
MODULUS AC  
>14.000 MPa**





2004

9 cm

AC 20

PMB

4 cm

SMA 11

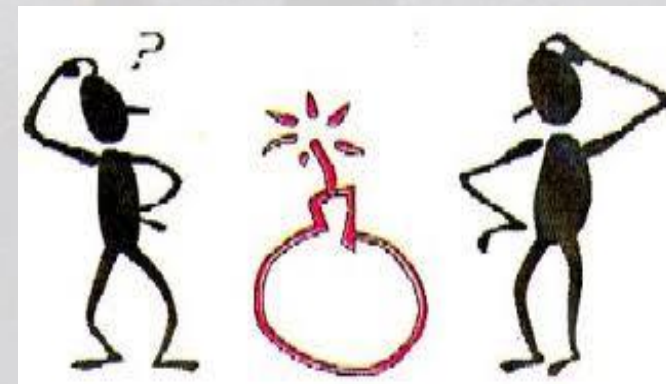
13 cm

AC „EME” 20

20/30

**17 mln**

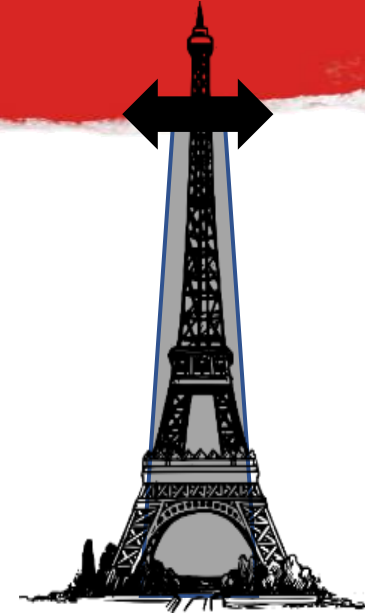
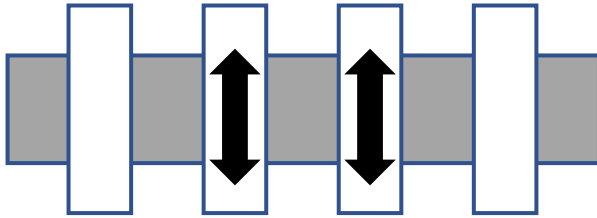
115 kN  
ESALs



# PERFORMANCE TESTS FOR EME MIXES

4PB-PR VS 2PB-TR

2004



**STIFFNESS**

$T = 10^{\circ}\text{C}$  |  $f = 10\text{ Hz}$

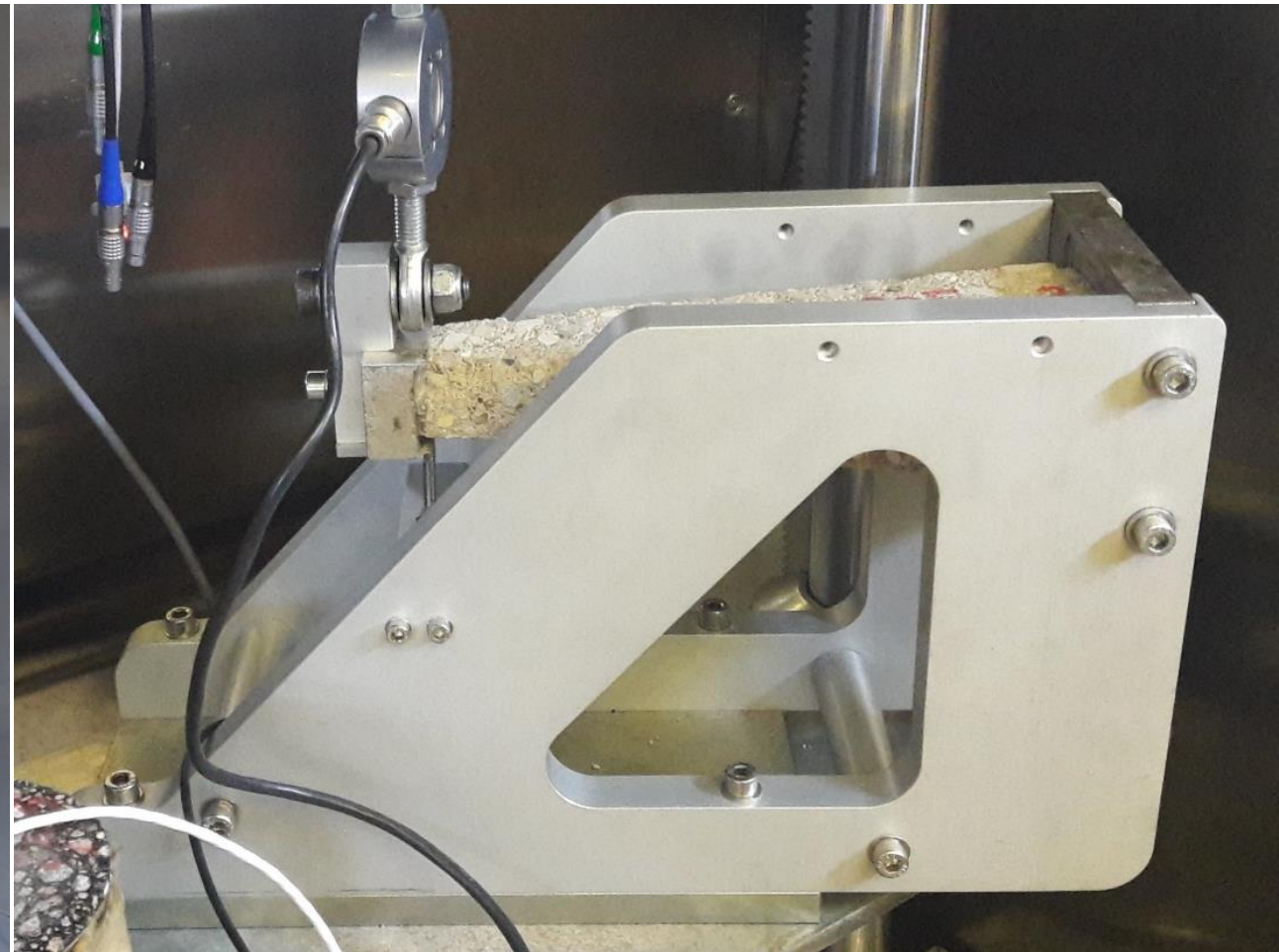
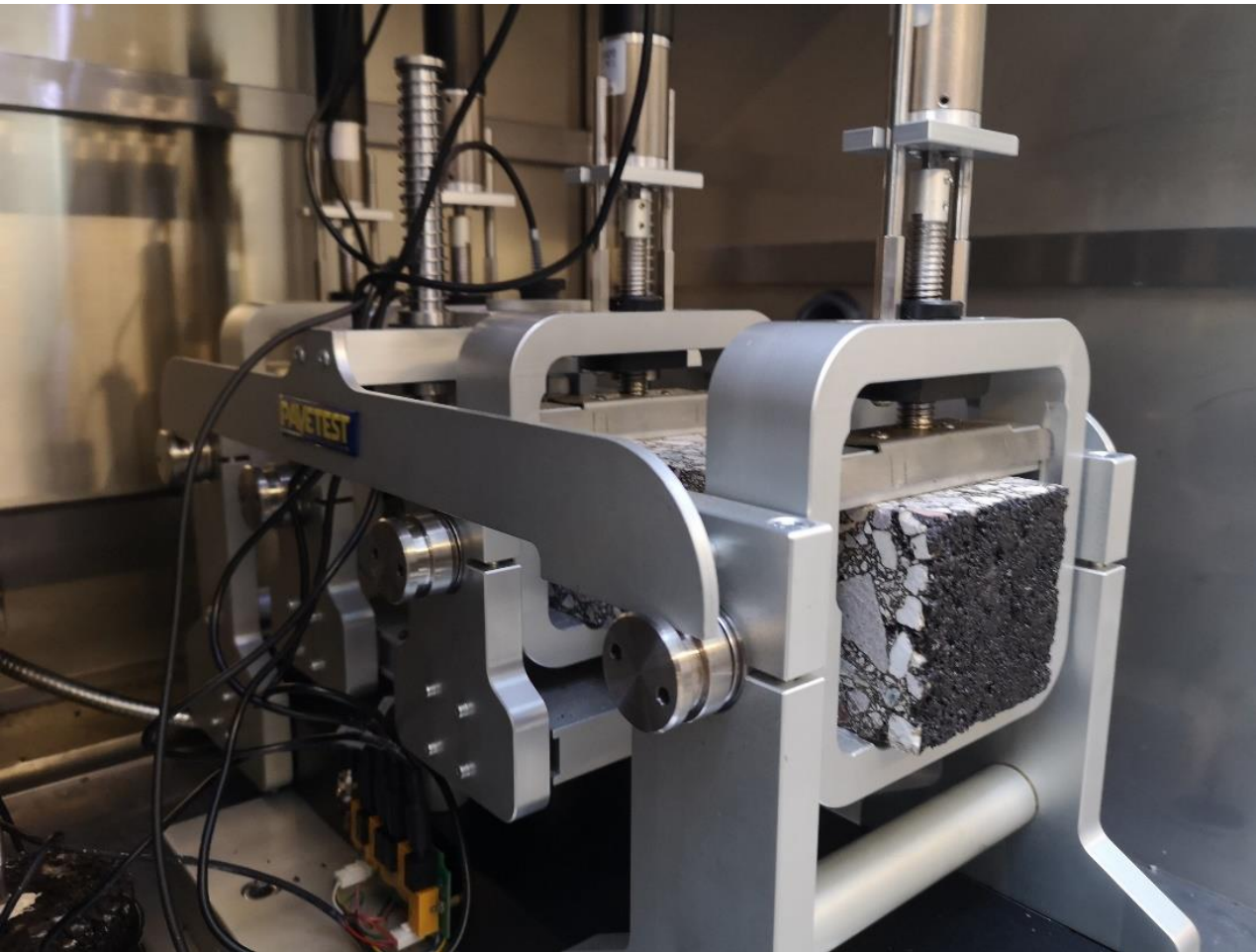
$T = 15^{\circ}\text{C}$  |  $f = 10\text{ Hz}$

**FATIGUE**

$T = 10^{\circ}\text{C}$  |  $f = 10\text{ Hz}$

$T = 10^{\circ}\text{C}$  |  $f = 25\text{ Hz}$

# INTRODUCTION OF STIFFNESS AND FATIGUE I SPECS FOR EME



4PB-PR instead 2PB-TR



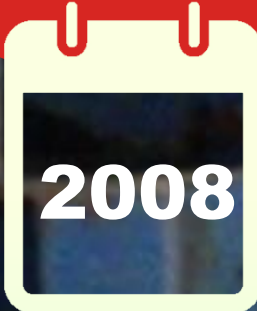
**BACK TO THE REALITY**

**HEAVY VEHICLE SIMULATOR**

**FOR TESTING EME**



**HVS**  
(Heavy Vehicle Simulator)  
**PRUSZKOW**



**2008**

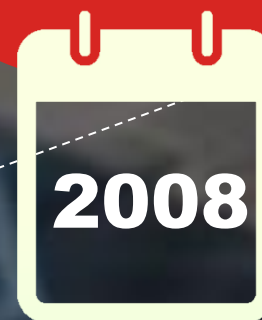


**HVS**  
(Heavy Vehicle Simulator)  
**PRUSZKOW**

2008



**HVS**  
(Heavy Vehicle Simulator)  
**PRUSZKOW**



A

B

D

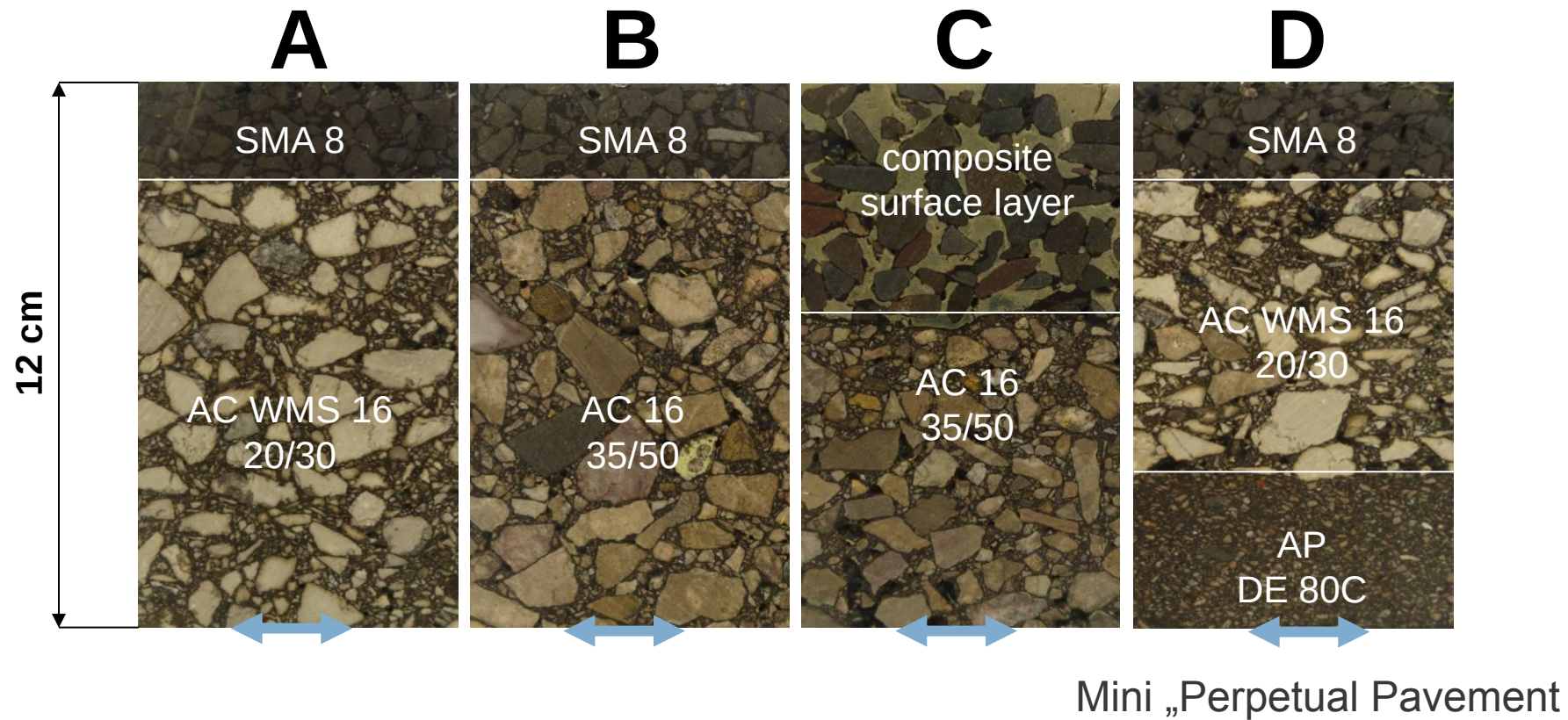
C





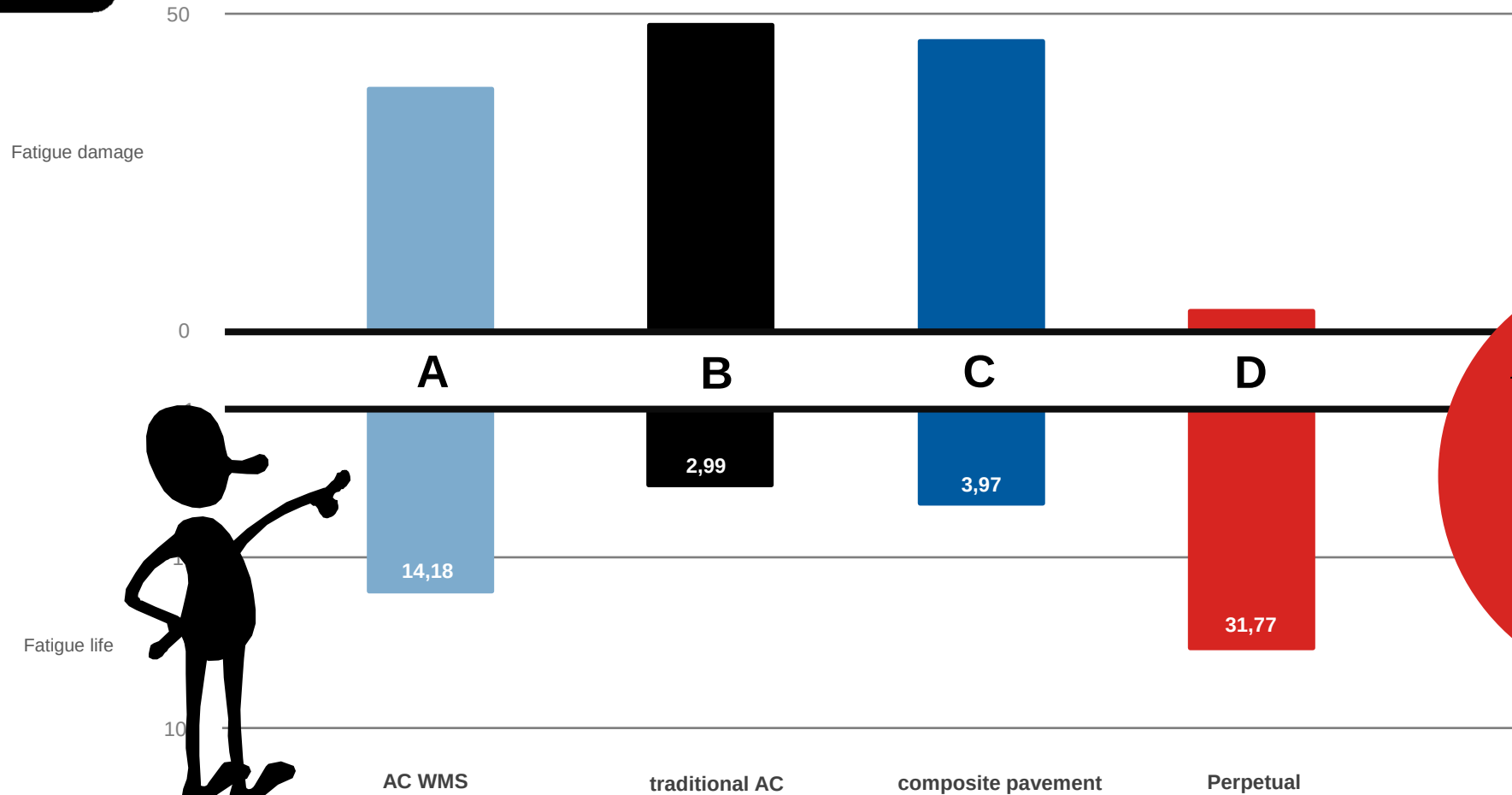
# SPENS RESEARCH PROGRAM

## TESTED PAVEMENT TYPES





# FATIGUE DAMAGE / LIFE



**2011**

**WIDE USE  
HIGH STIFFNESS  
MODULUS AC  
(AC WMS  
= EME)**



**EURO2012**  
POLAND-UKRAINE



**2011**

8 cm

AC WMS 16

PMB 25/55-60

4 cm

SMA 11

PMB 45/80-55

17 cm

AC WMS 16

20/30

**54 mln**

115 kN

ESALs



BRACE YOURSELF  
**WINTER IS  
COMING**





Winter came!



TOO  
STIFF!



**LOW  
TEMPERATURE  
CRACKING**



”

The error of  
the past is  
the wisdom of  
the future”



Dale E. Tuner

# ANOTHER PERFORMANCE TESTS

LOW TEMPERATURE CRACKING TEST (EN 12697-46)



**TSRST**  
(Tensile  
Strength  
Restrained  
Specimen  
Test)

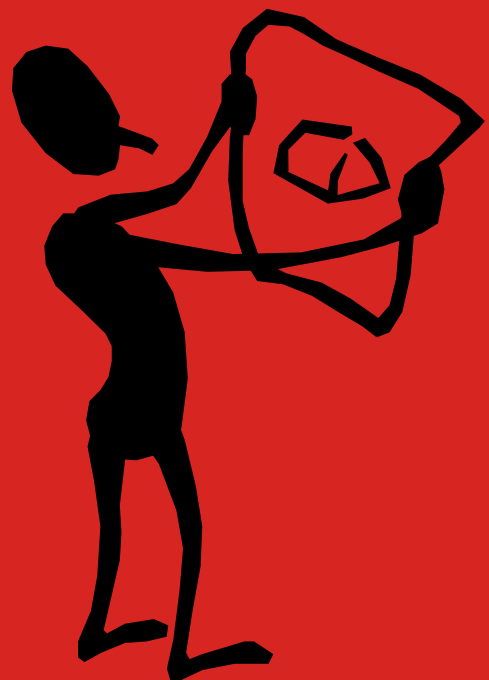


The image is a horizontal collage. The top half shows a blurred laboratory or workshop setting with various pieces of equipment and a person in the background. A white, torn-paper-like banner runs across the middle. Below the banner, the background continues with a blurred image of a person in a white lab coat working on a large black tire mounted on a red machine. In the bottom right corner, there is a cartoon illustration of Yoda, the green alien from Star Wars, wearing a white robe and looking grumpy.

„GET BACK TO THE LAB!”



**STRABAG** ГРА LAB, PRUSZKÓW 2012



# STIFFNESS VS. FATIGUE

# STIFFNESS MODULUS AND FATIGUE RESISTANCE

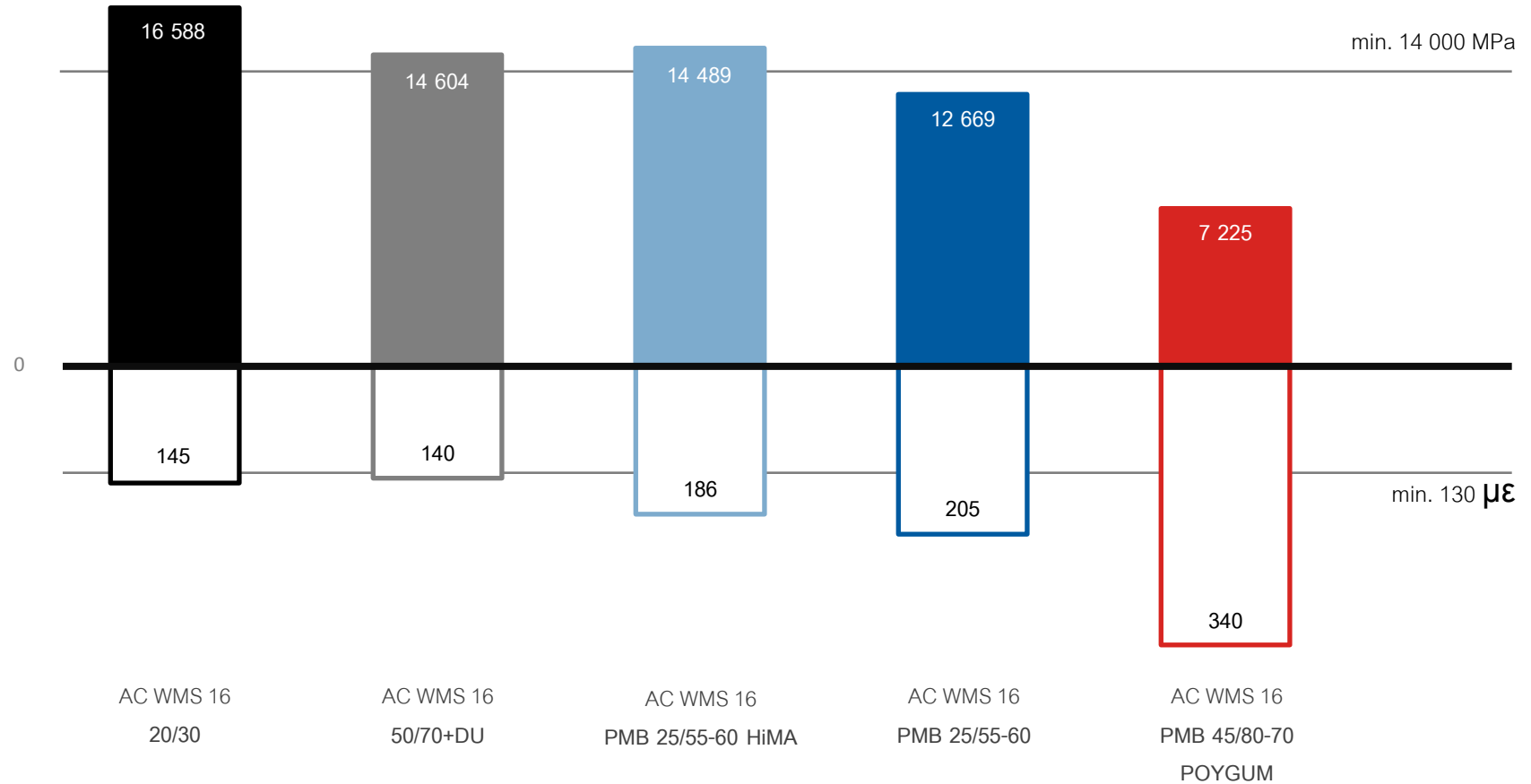


4PB-PR  
10°C, 10 Hz

min. 14 000 MPa

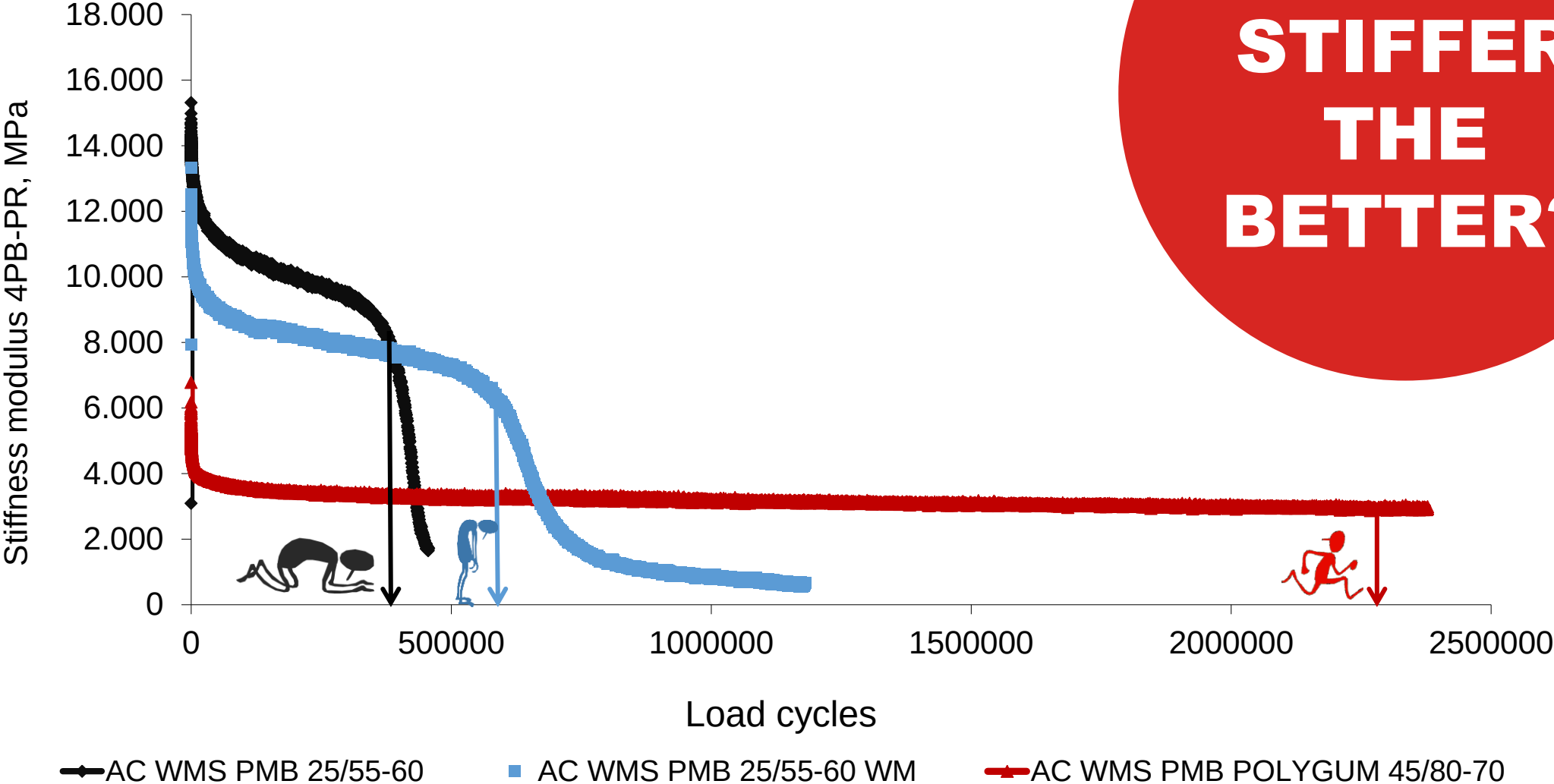
Stiffness modulus  $S$   
[MPa]

Fatigue resistance  $\epsilon_6$  [ $\mu\text{mm/mm}$ ]



FATIGUE TESTS ON AC WMS 16 (EME)

**THE  
STIFFER  
THE  
BETTER?**



”

Mind what you  
have learned.  
Save you it can.

*Yoda, The Empire Strikes Back*





# DESIGN & BUILD CONTRACTS



# DESIGN & BUILD

10 YEARS  
GUARANTEE!

2013

**STRABAG**  
TEAMS WORK.

Opacz  
2000 m

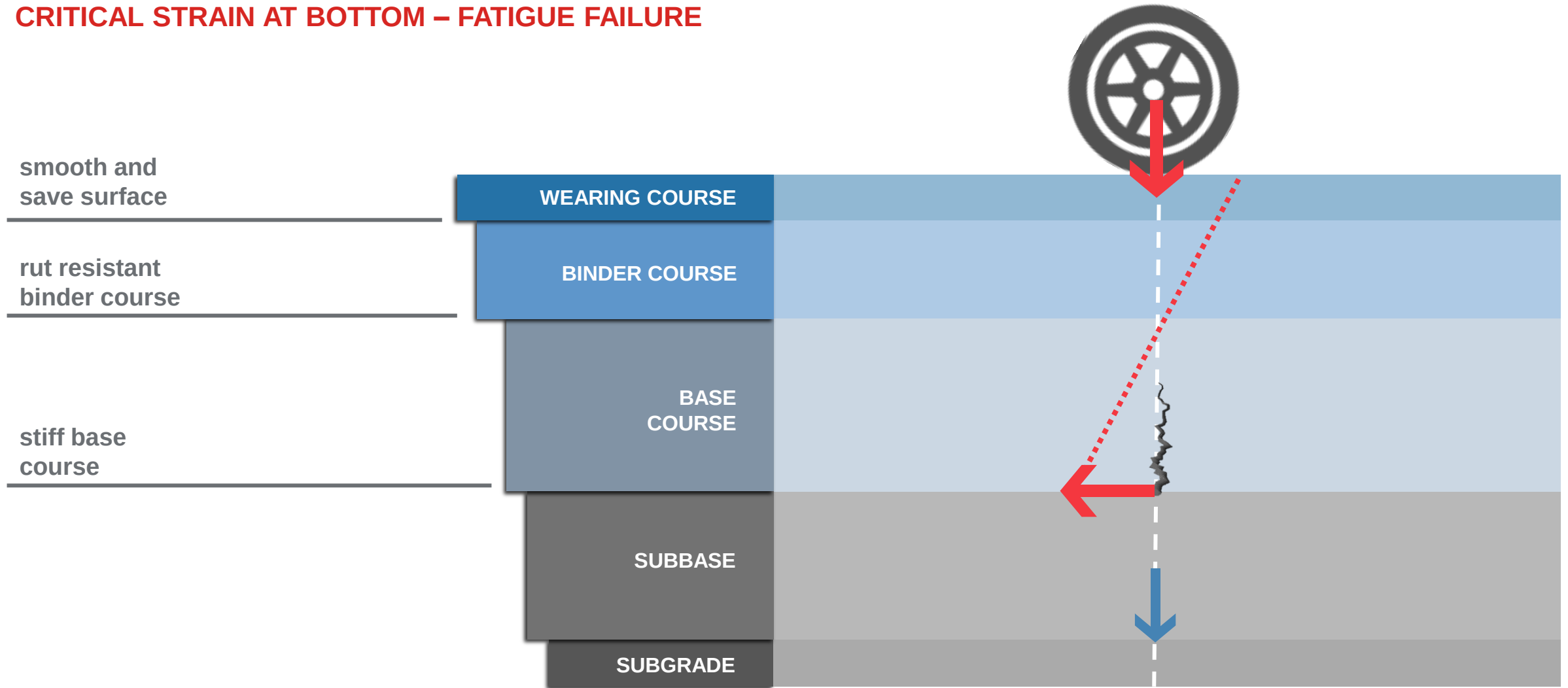
S7 E77  
Warszawa  
Gdańsk  
S8 E67  
Warszawa  
Budzisko PL LT



**Perpetual  
pavement** is „an  
asphalt pavement designed  
and built to last longer than  
50 years without requiring  
major structural rehabilitation  
or reconstruction, and  
needing only periodic surface  
renewal (...)”

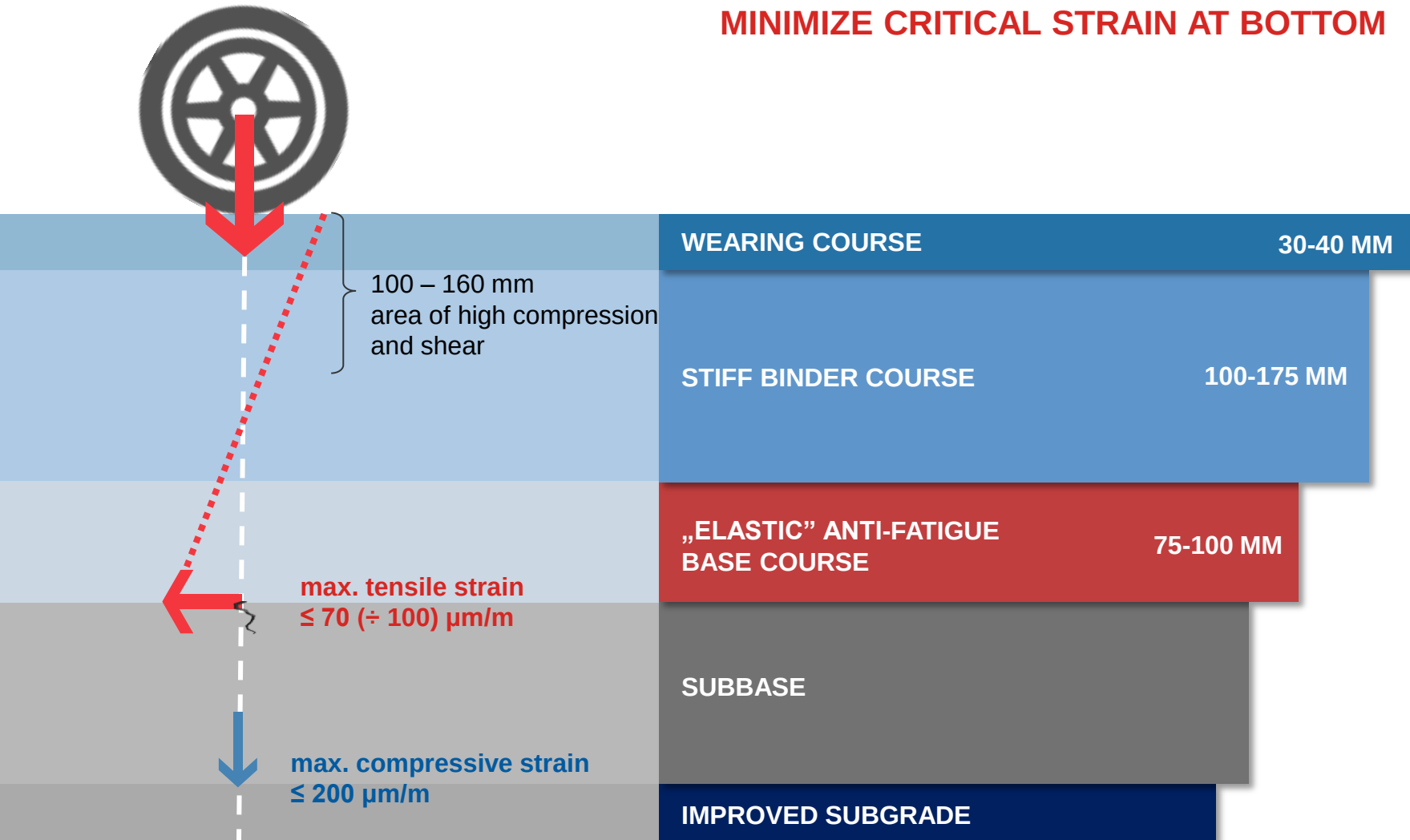
# TRADITIONAL ASPHALT PAVEMENT

## CRITICAL STRAIN AT BOTTOM – FATIGUE FAILURE



# PERPETUAL ASPHALT PAVEMENT

## MINIMIZE CRITICAL STRAIN AT BOTTOM



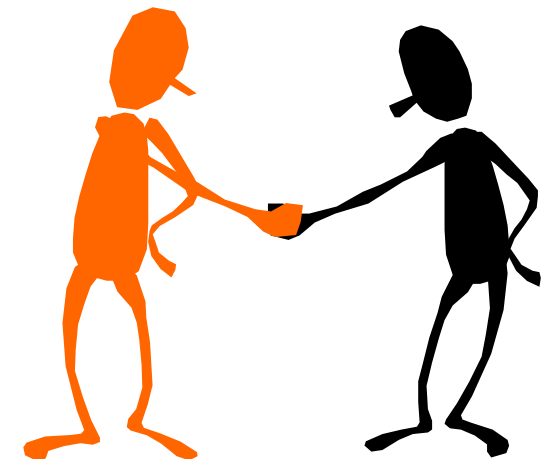
**durable, renewable**  
(e.g. SMA)



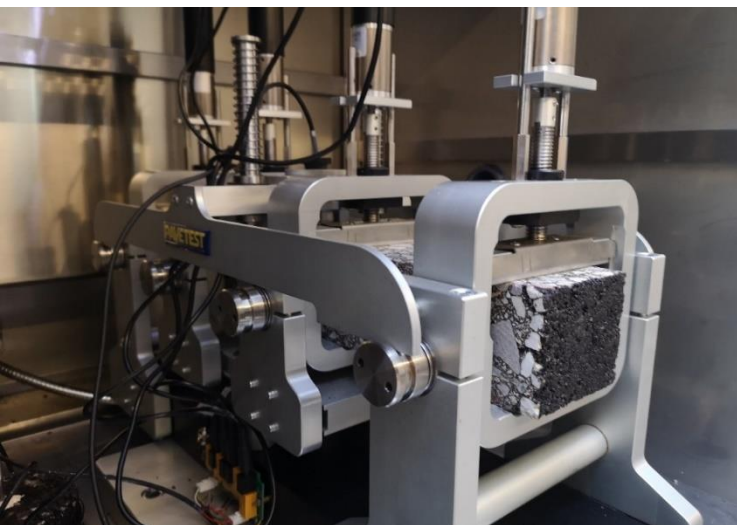
**stiff, rut resistant**  
(e.g. EME)



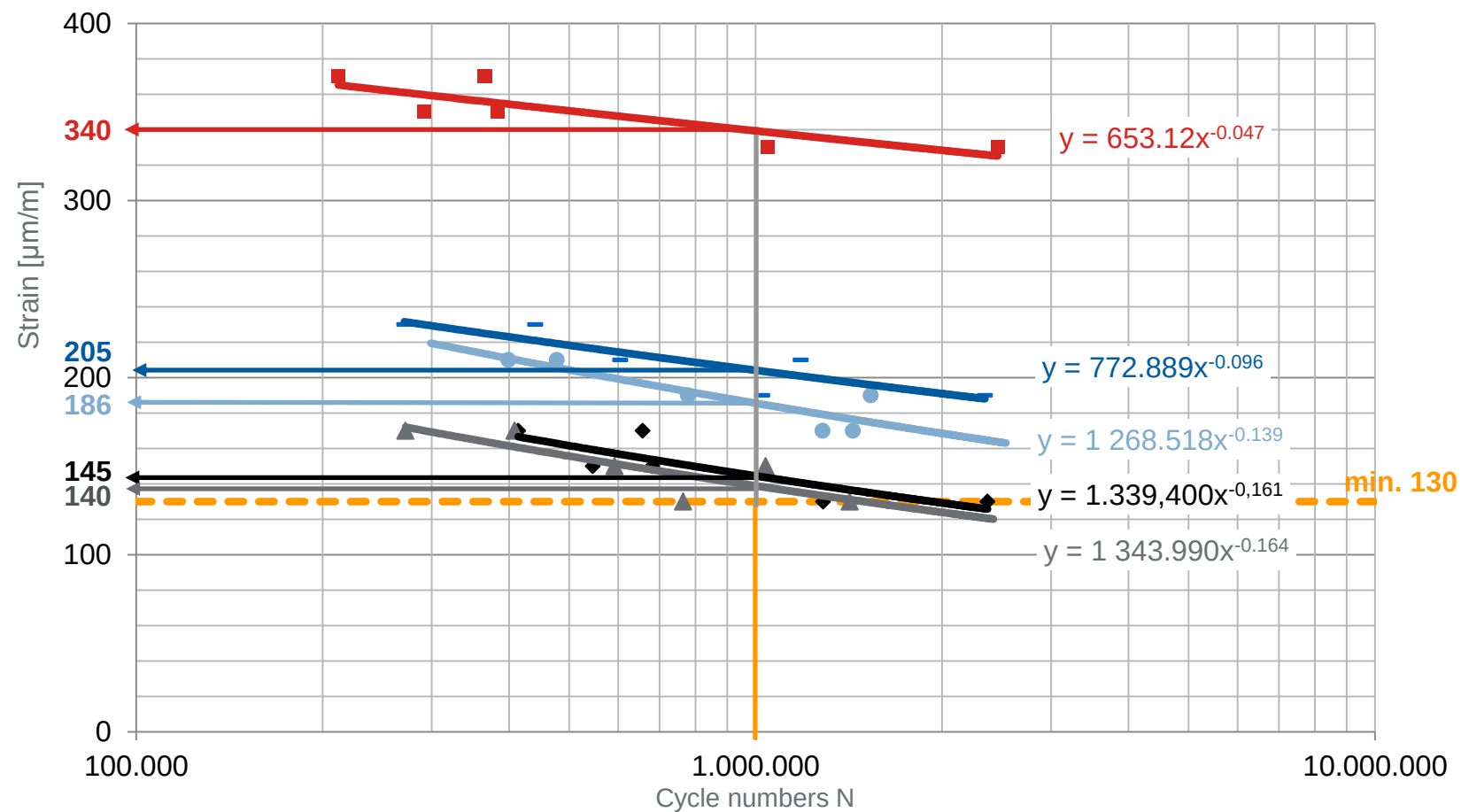
**„anti-fatigue“ layer**



# ANTI-FATIGUE MIX



## 4PB-PR (10°C, 10 HZ) – PN-EN 12697-24



● AC WMS 16 PMB 25/55-60  
■ AC MWS 16 PMB 45/80-80 SM

◆ AC WMS 16 20/30  
▲ AC WMS 16 50/70+DU

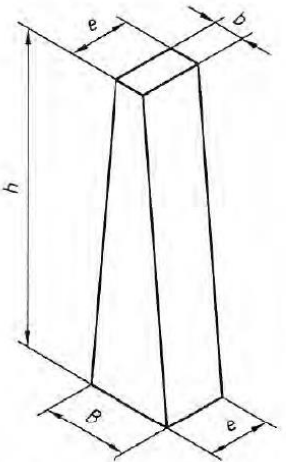
— AC WMS 16 PMB 25/55-60 WM

# FRENCH DESIGN METHOD

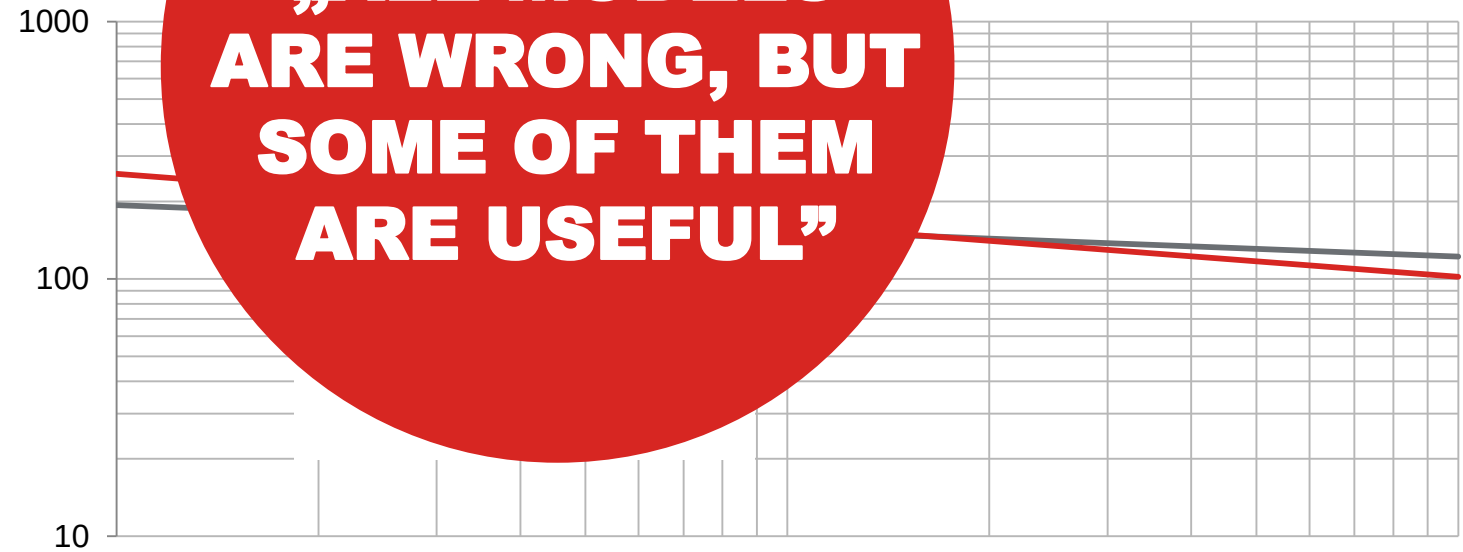
## FATIGUE CRITERION

$$NE = \left( \frac{\epsilon_{rad}}{\left[ \frac{\epsilon}{\sigma(C)} \right]^{0,5} \cdot k_r \cdot k_c \cdot k_s} \right)^{\frac{1}{b}} \cdot 10^6$$

2PB-TR (15°C, 10 Hz)



strain [ $\mu\text{m/m}$ ]



**„ALL MODELS  
ARE WRONG, BUT  
SOME OF THEM  
ARE USEFUL”**



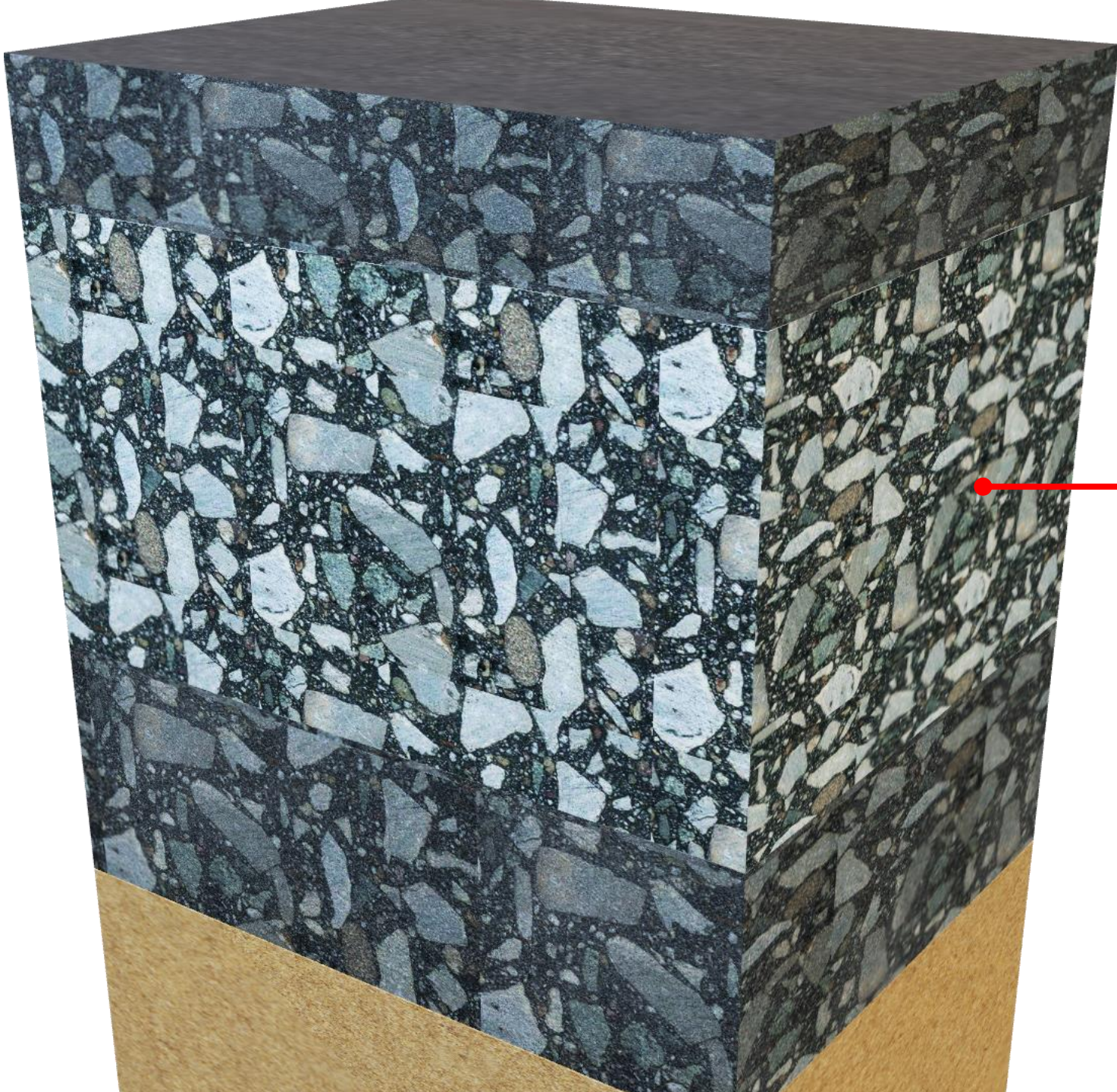
4 cm

SMA 11 S

PMB 45/80-55



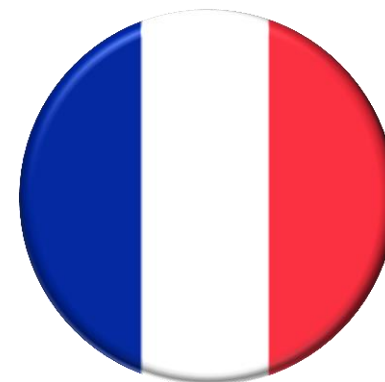
**STRABAG**  
TEAMS WORK.



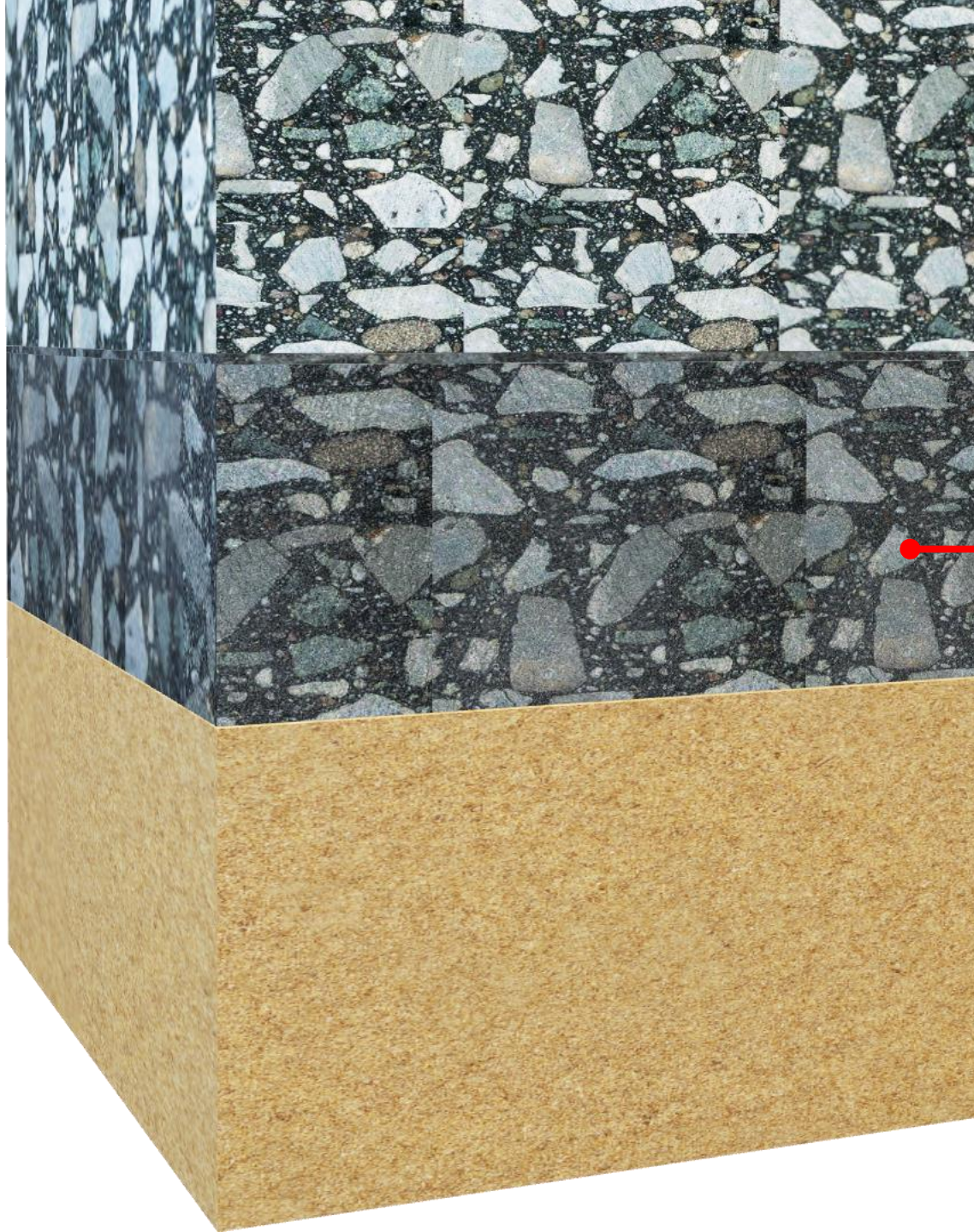
14 cm

AC WMS 16 W

PMB 25/55-60



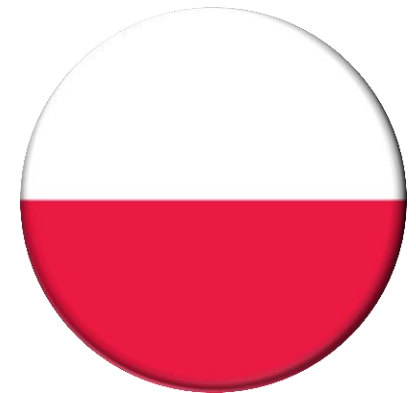
**STRABAG**  
TEAMS WORK.



8 cm

AC 16 P „ANTI-FATIGUE”

PMB 45/80-70



**STRABAG**  
TEAMS WORK.

S 8

perpetual  
pavement



S 8



TRIAL SECTION  
**ANTI-FATIGUE  
LAYER**

(150 m)

2014

A photograph of a road construction site. In the foreground, a thick layer of dark, freshly laid asphalt is being compacted by a yellow roller. To the right of the asphalt, there is a pile of loose, light-colored gravel. In the background, another yellow roller is visible, and the road stretches into the distance under a cloudy sky. The image is overlaid with a red banner on the left and a red circle on the right.

**S 8**

TRIAL SECTION  
**ANTI-FATIGUE  
LAYER**

(150 m)

**2014**

# NEWS OF THE DAY

2014



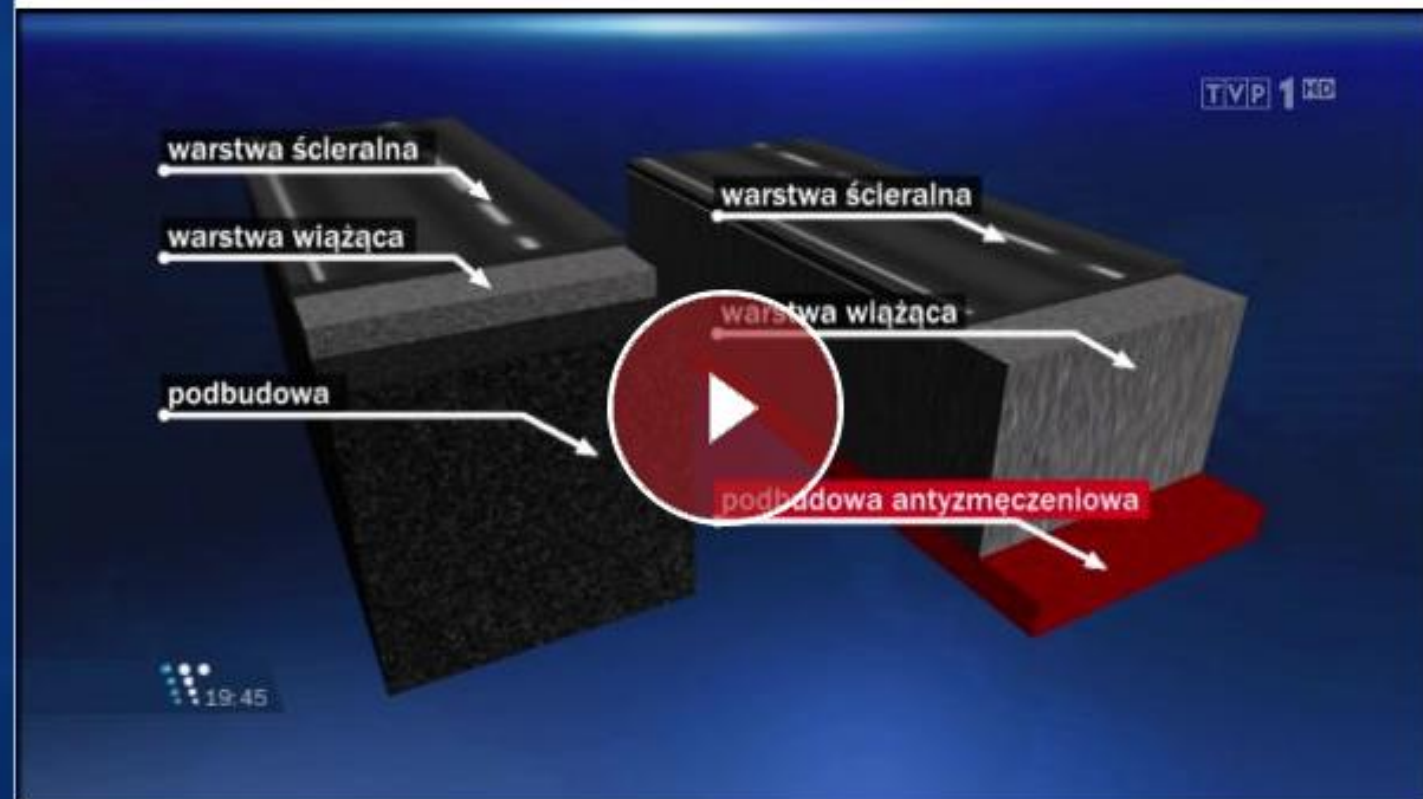
| Źródło: Fakty TVN

## 13.09.2014 | Superasfalt prosto z Polski – 18 lat gwarancji, 50 lat bez remontu

Drogowa rewolucja to nie żarty. Testowe 150 metrów superasfaltu leży już na S8. Żadnych dziur, kolein i nierówności – to będzie nowa polska specjalność. Drogowcy sprawdzają, czy asfalt się nie męczy, a zmęczeni kierowcy pewnie ... [rozwin](#)

### DŁUGOWIECZNA DROGA

Publikacja: 13 września 2014, 19:53



[Lubię to!](#) 0

Dobrych dróg w Polsce przybywa, ale dziury i koleiny, są wciąż zimą wielu z nas. Kierowcy płaczą i płacą. Drogowcy zazwyczaj tłumaczą się klimatem, że albo mamy upał albo siarczasty mróz. Ale uwaga, nadchodzi rewolucja - pod Warszawą jest właśnie testowany

### TWARZE



### TOP 10

1. — Anna Przybylska 1978-2014
2. — Pożegnanie
3. — (Nie)trzeźwy poranek
4. — Groźny zabójca
5. — Wojny stadionowe
6. — Putin jak Herkules
7. — System obrony
8. — W spirali długu
9. — Tragedia pod ziemią
10. — Wirus strachu

# NEWS OF THE DAY

2014



9:05  
WSTAJESZ  
I WIESZ

MEC. P. SCHRAMM,  
KANCELARIA  
GESSEL



21:47  
ŚWIAT

Polska  
i Świat

PREMIER DONALD TUSK ZŁOŻYŁ DYMISJĘ NA RĘCE PREZYDENTA  
NDERSKIEJ KOMISJI: MALEZYJSKI BOEING 777 ZOSTAŁ STRĄCONY



# HIGHLY MODIFIED ASPHALT BINDER

---

HiMA (7,5 % of SBS)

# S7 PERPETUAL HiMA

2017

Asfalt

Polimer  
SBS

Asfalt

Polimer  
SBS

Asfalt

S7

3 cm

SMA 8 ARB

17 cm

AC WMS 16

PMB 25/55-60

6 cm

AC AF (anti-fatigue) 16

PMB 45/55-80 HiMA



**STRABAG**  
TEAMS WORK.



# S6 PERPTUAL HiMA

2018

Asfalt

Asfalt  
drogowy  
zwykły

Polimer  
SBS

Asfalt

Asfalt  
modyfikowany

Polimer  
SBS

Asfalt

Asfalt  
wysokomodyfikowany  
(akugowiczny)

S6

3 cm

SMA 8 ARB

12 cm

AC WMS 16 W

PMB 25/55-60

7 cm

AC AF (anti-fatigue) 16

PMB 45/80-80 HiMA

2018



**STRABAG**  
TEAMS WORK.



AND THE STORY  
GOES ON...



**EFRA**  
EFEKTYWNA RAFINACJA

**GDANSK  
RAFINERY**

**2018**



A large industrial facility, possibly a refinery or chemical plant, with a massive horizontal pipe being moved by a heavy-duty truck. The pipe is dark grey and has a large circular opening at one end. It is being transported on a red MAMMOET heavy-duty truck. The truck is moving along a dirt road. In the background, there are blue steel structures, scaffolding, and other industrial equipment. The ground is covered in snow. Several workers in red safety suits and hard hats are visible in the foreground.

**HEAVY  
DUTY  
PAVEMENT**

**LOW SPEED  
HEAVY TRUCKS  
SMALL RADIUS**



**SMA 16** PMB 45/80-80

5 CM

**SMA 22** PMB 25/55-80

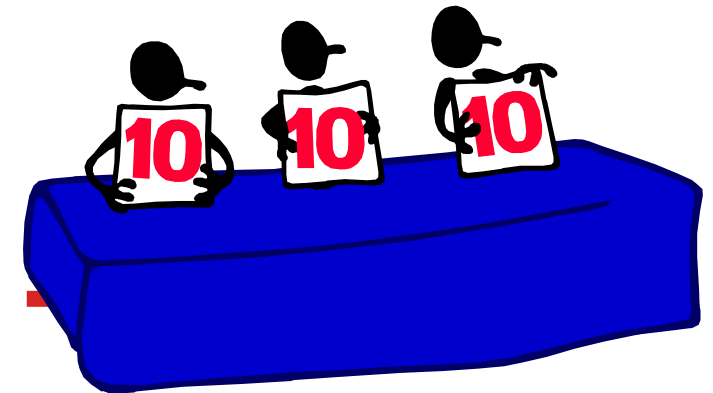
9 CM

**SMA 16** PMB 45/80-80

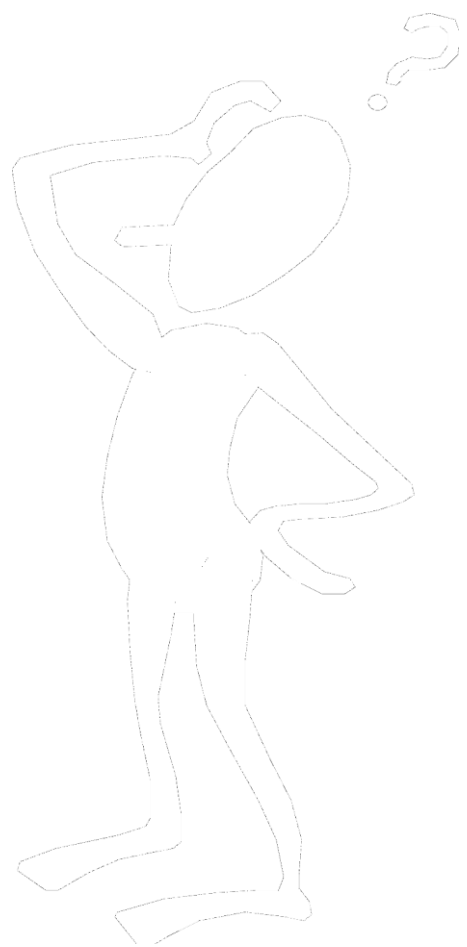
6 CM

**NEW!**  
**TRIPLE SMA**

**2018**



**STRABAG**  
TEAMS WORK.



WHAT NEXT....?

# FOR HOW LONG YET ?

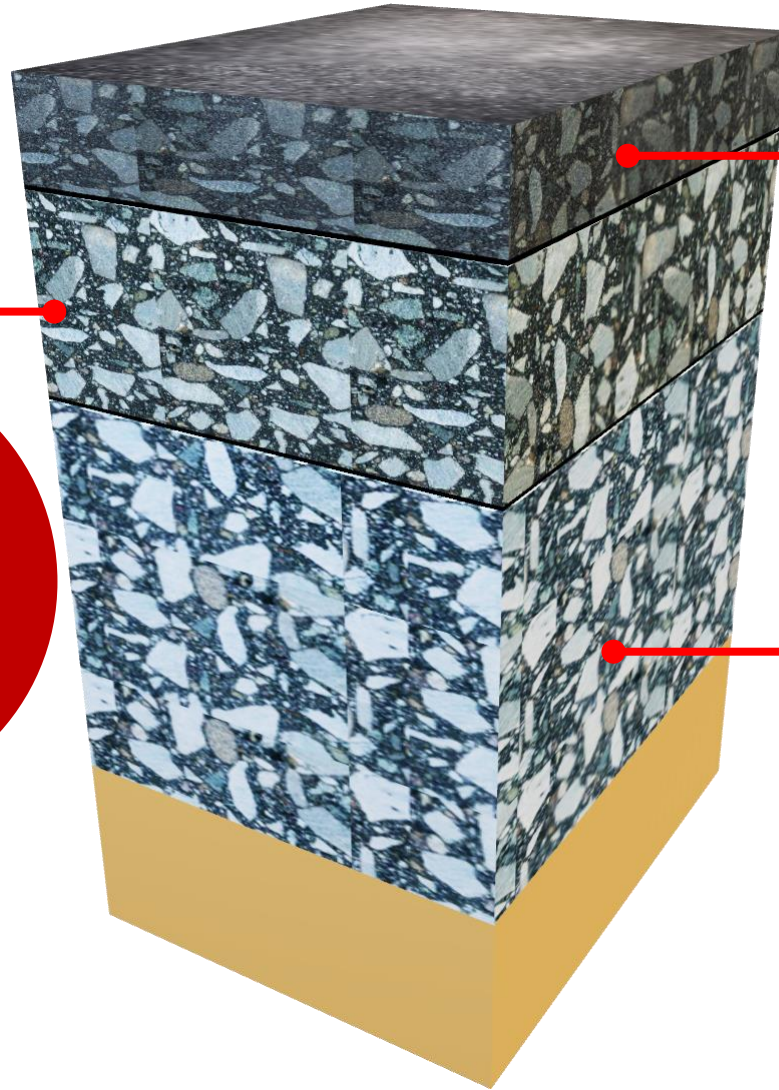
AC 16, 35/50 or PMB

SMA 8 or 11 PMB

**30 CM**

**?**

AC 22, 35/50





# RUBBER MODIFIED ASPHALT BINDER



UNIA EUROPEJSKA  
EUROPEJSKI FUNDUSZ  
ROZWOJU REGIONALNEGO



POLITECHNIKA WARSZAWSKA

**STRABAG**

# WE CARE ABOUT SUSTAINABILITY

Asphalt-rubber Pavements  
Durable, Safe and Environmentally friendly



# PRICELESS TIRE COMPONENTS



**NATURAL  
RUBBER**



**POLY-BUTADIEN**



**SULFUR**



**SYNTETIC  
RUBBER**



# PRICELESS TIRE COMPONENTS



KAUCZUK NATURALNY



SIARKA



POLIBUTADIEN



KAUCZUK SYNTETYCZNY



AKTYWATOR



PRZYSPIESZACZ



PRZECIWUTLENIACZ



SADZA



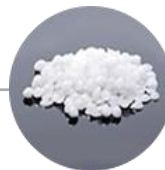
KWAS STEARYNOWY



KRZEMIONKA



TLENEK CYNKU



WOSK



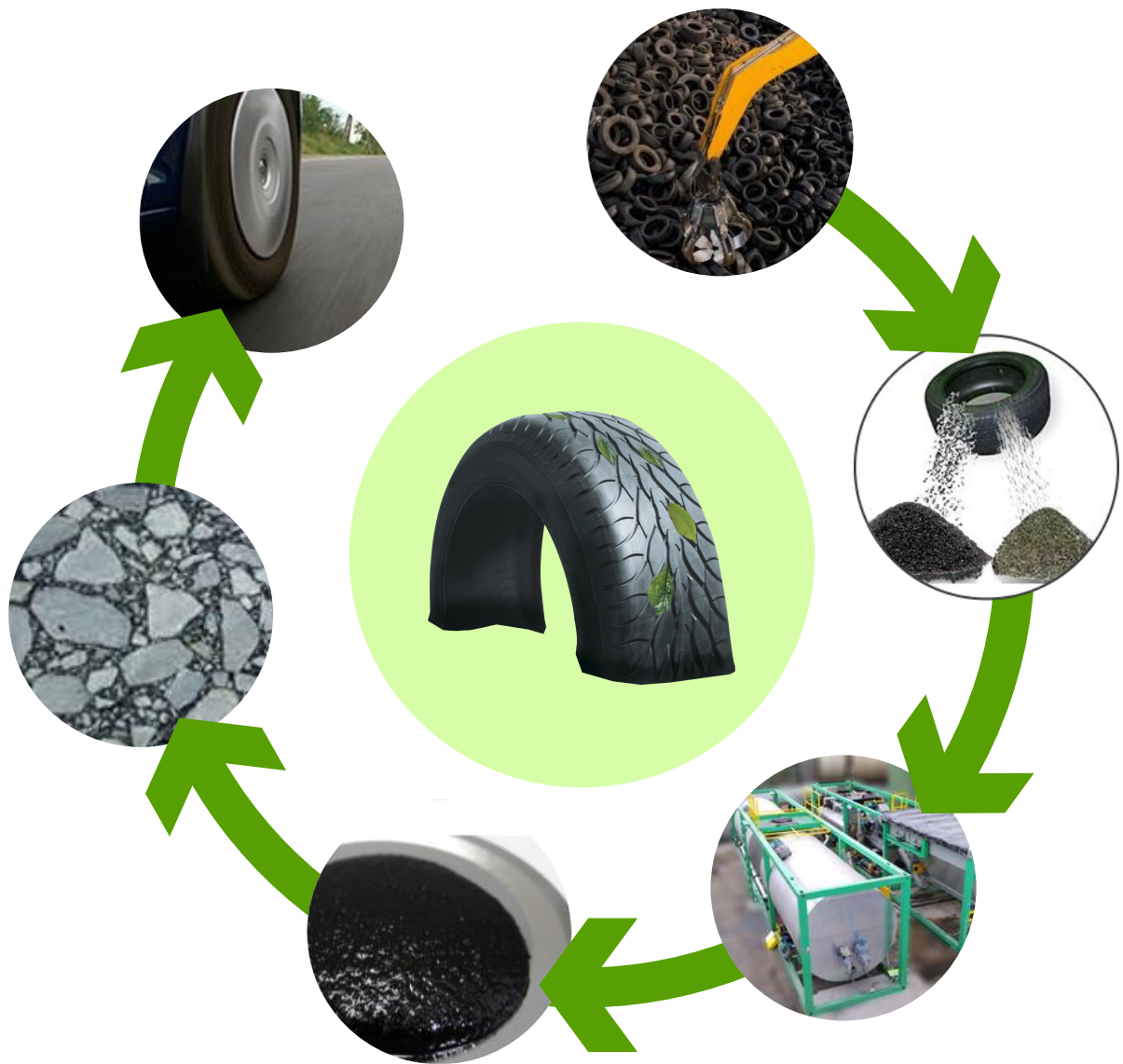
OLEJ MINERALNY



OLEJ RZEPAKOWY



# TIRE'S SECOND LIFE – CIRCULAR ECONOMY



# TWO METHODS



## DRY METHOD

Adding the **granulated rubber** directly into the mixer as a  
replacement of the aggregate part

(max 3% related to mixture)



## WET METHOD

Mixing of **rubber powder** under  
heating with hot bitumen

(reaction time min 45 min)

m. „Field Blend”

(min 15 % related to binder)

m. „Terminal Blending”

(about 4÷10 % related to binder)



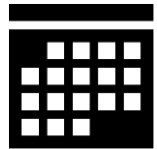
# DRY METHOD



## DRY METHOD

Adding the **granulated rubber** directly into the mixer as a  
replacement of the aggregate part

(max 3% related to mixture)



2003

DK 12  
JARACZEWO



”

Much to  
learn  
you still  
have.

*Yoda, Attack of the Clones*



# WET METHOD



## WET METHOD

Mixing of rubber powder under  
heating with hot bitumen  
(reaction time min 45 min)

### m. „Field Blend”

(min 15 % related to binder)

### m. „Terminal Blending”

(about 4÷10 % related to binder)



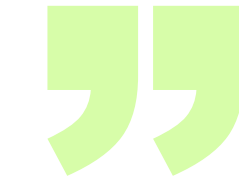
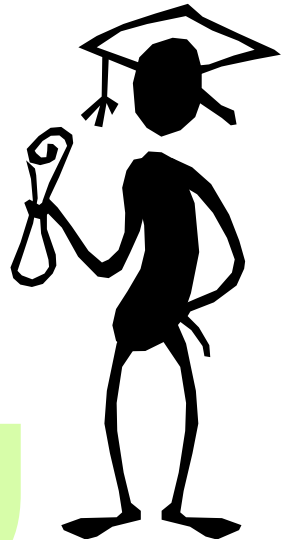
## ASPHALT-RUBBER BINDER (ARB)

minimum 15% of rubber in relation to the total binder ...

rubber particles have to swell...

**ALTERNATIVE  
TO  
PMB**

*Definicja wg ASTM D8*

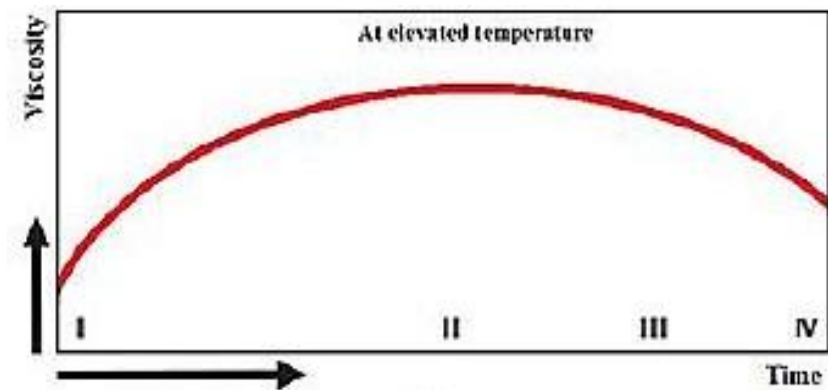
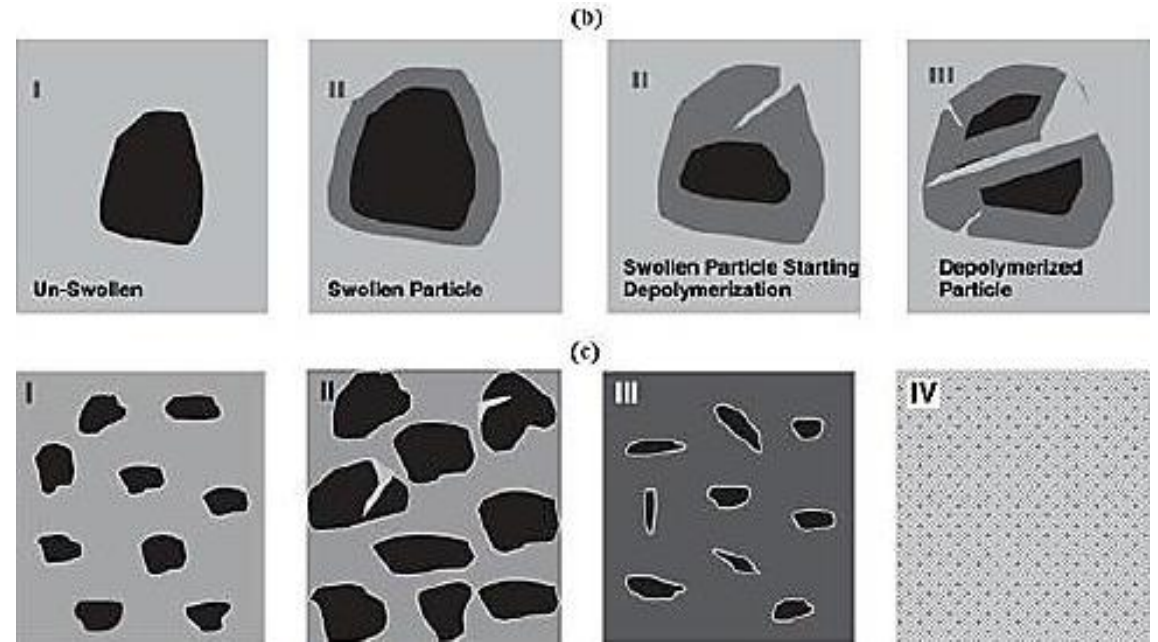


**STRABAG**  
TEAMS WORK.

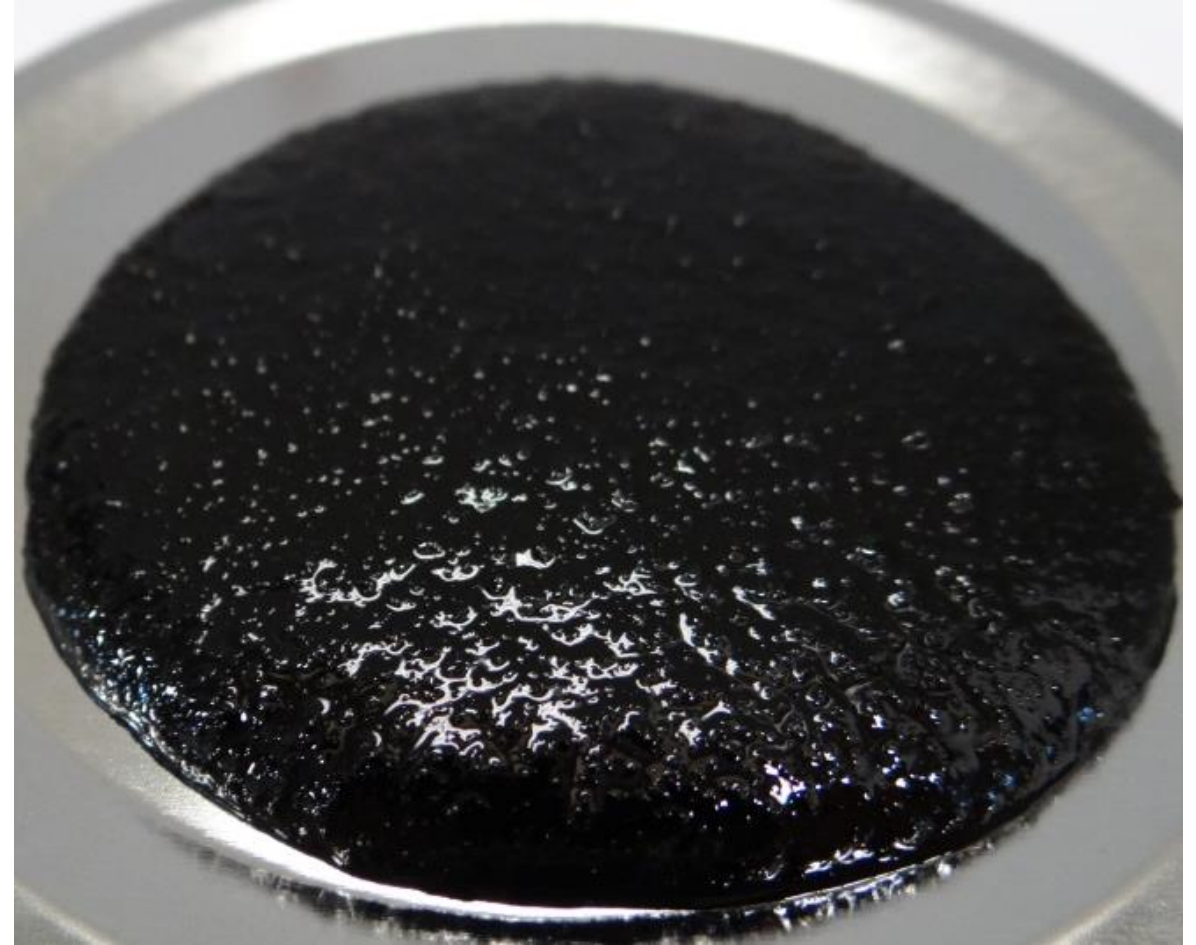
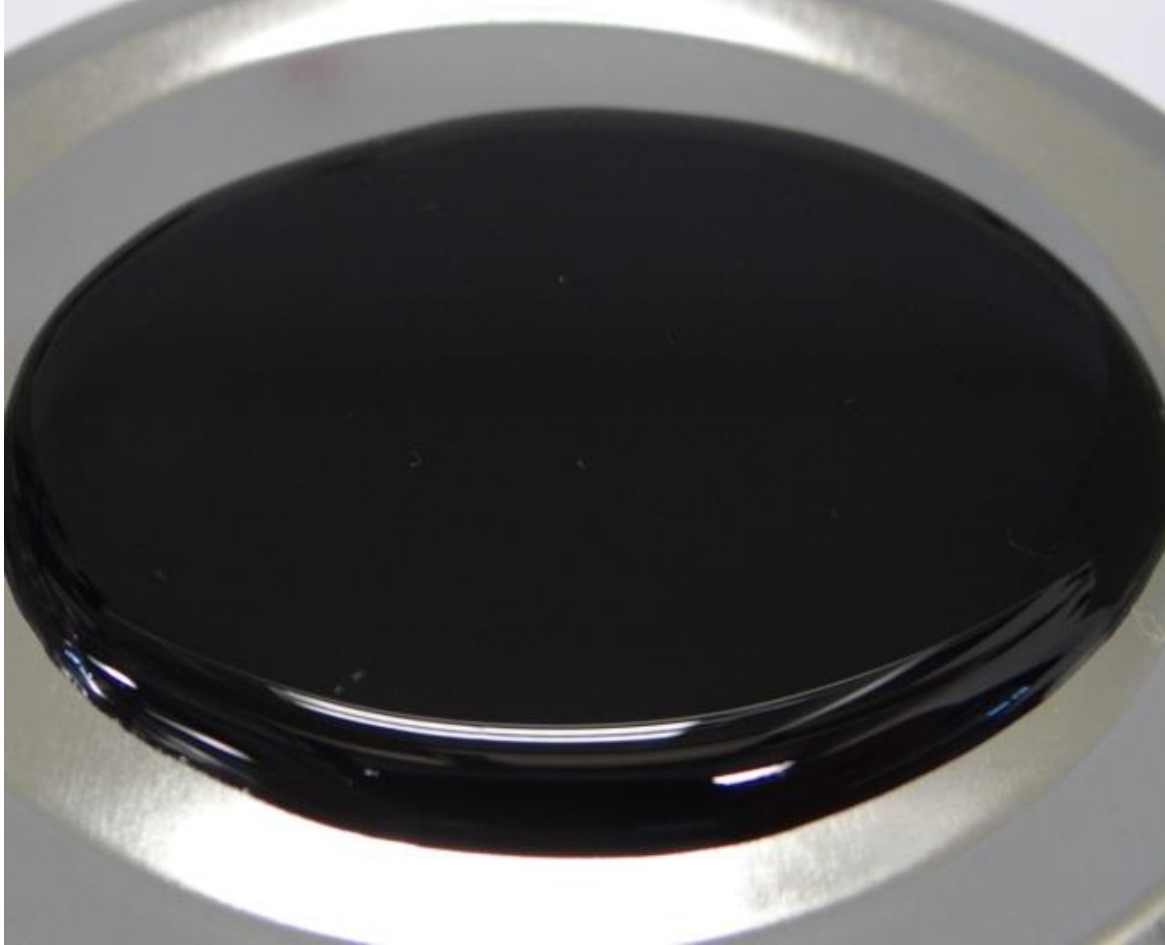
# MODIFICATION BY „WET” PROCESS



„AL DENTE”



# PMB VS ASPHALT-RUBBER



The image shows a large industrial facility for asphalt-rubber production. In the foreground, a large horizontal cylindrical tank is mounted on a green metal frame. To its right is a large rectangular processing unit, also on a green frame, with a black tarp covering its top. A worker in a black jacket and orange cap is walking near the rectangular unit. In the background, there are conveyor belts, a yellow generator labeled 'STRABAG', and large rolls of material. The entire scene is set in an outdoor industrial area with a green corrugated metal building in the background.

**ASPHALT  
-RUBBER  
PRODUCTION  
AT THE PLANT  
„WET”**



2013

6 asphalt-rubber mixes:

SMA 11, BBTM 8A, AC 5 AF,  
AC 16 TD, AC 16 W, SAMI



**2022**

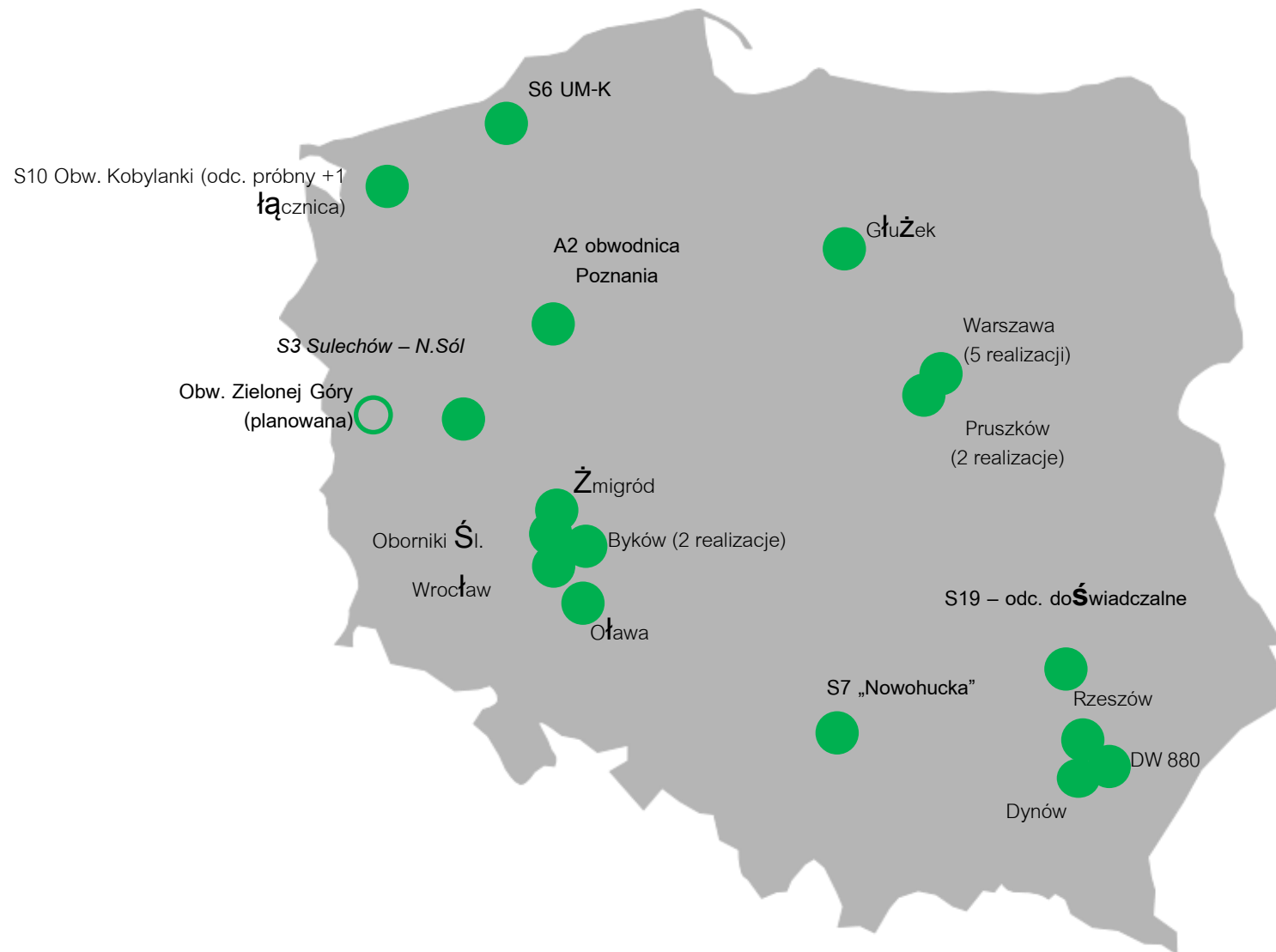
Two structures, 3 mix types:

SMA 11 S AMG KR 3-7

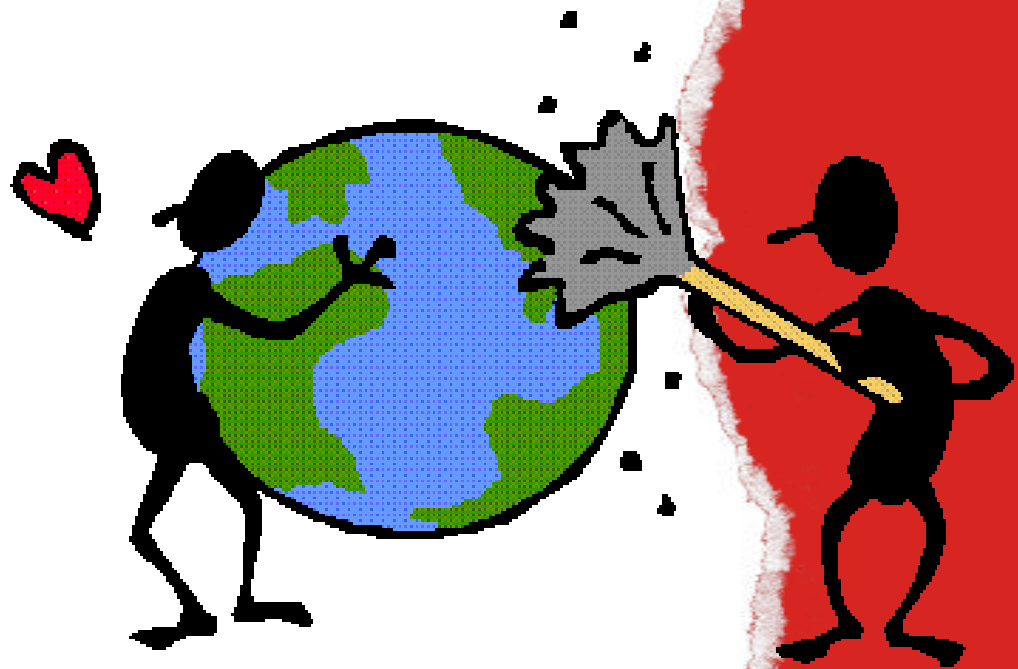
AC 16 W AMG KR 3-7

AC AF 11 P AMG KR 3-7

# RUBBERBIT® 2013-2021 – 26 SITES



More than  
**250 000**  
tons



# ASPHALT RECYKLING



**PEOPLE SAY  
THAT CAT HAVE  
9 LIVES...  
...BUT FOR ASPHALT  
IT'S ALREADY  
PROVEN!**





**WASTE?**

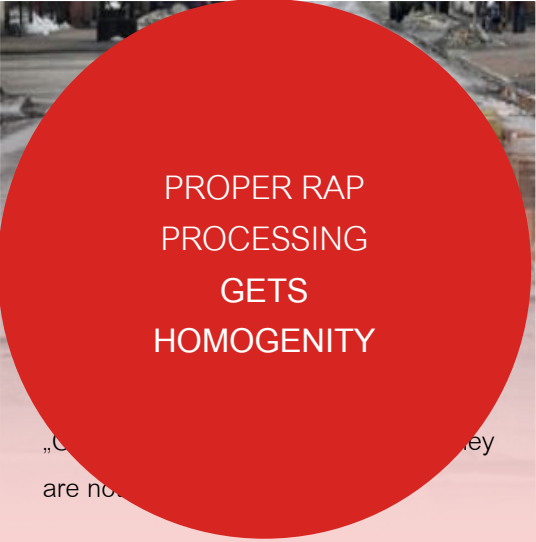


# **RECLAIMED ASPHALT**

(MINERAL AGGREGATE AND  
BINDER)



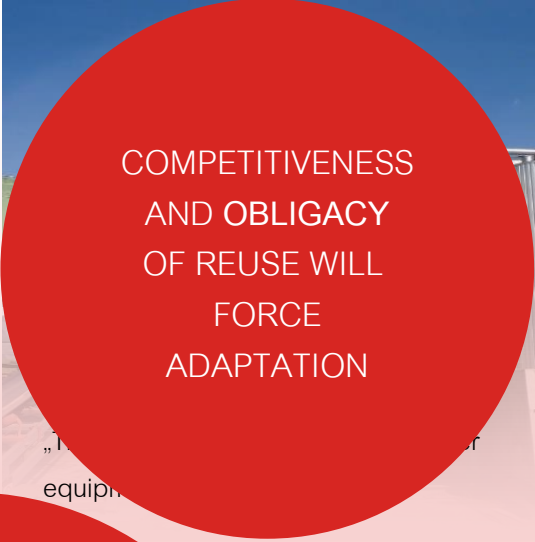
# DOUBTS AND QUESTIONS



PROPER RAP  
PROCESSING  
GETS  
HOMOGENITY



RAP  
CONTAINS  
ASPHALT BINDER  
AND MINERAL  
AGGREGATES



COMPETITIVENESS  
AND OBLIGACY  
OF REUSE WILL  
FORCE  
ADAPTATION



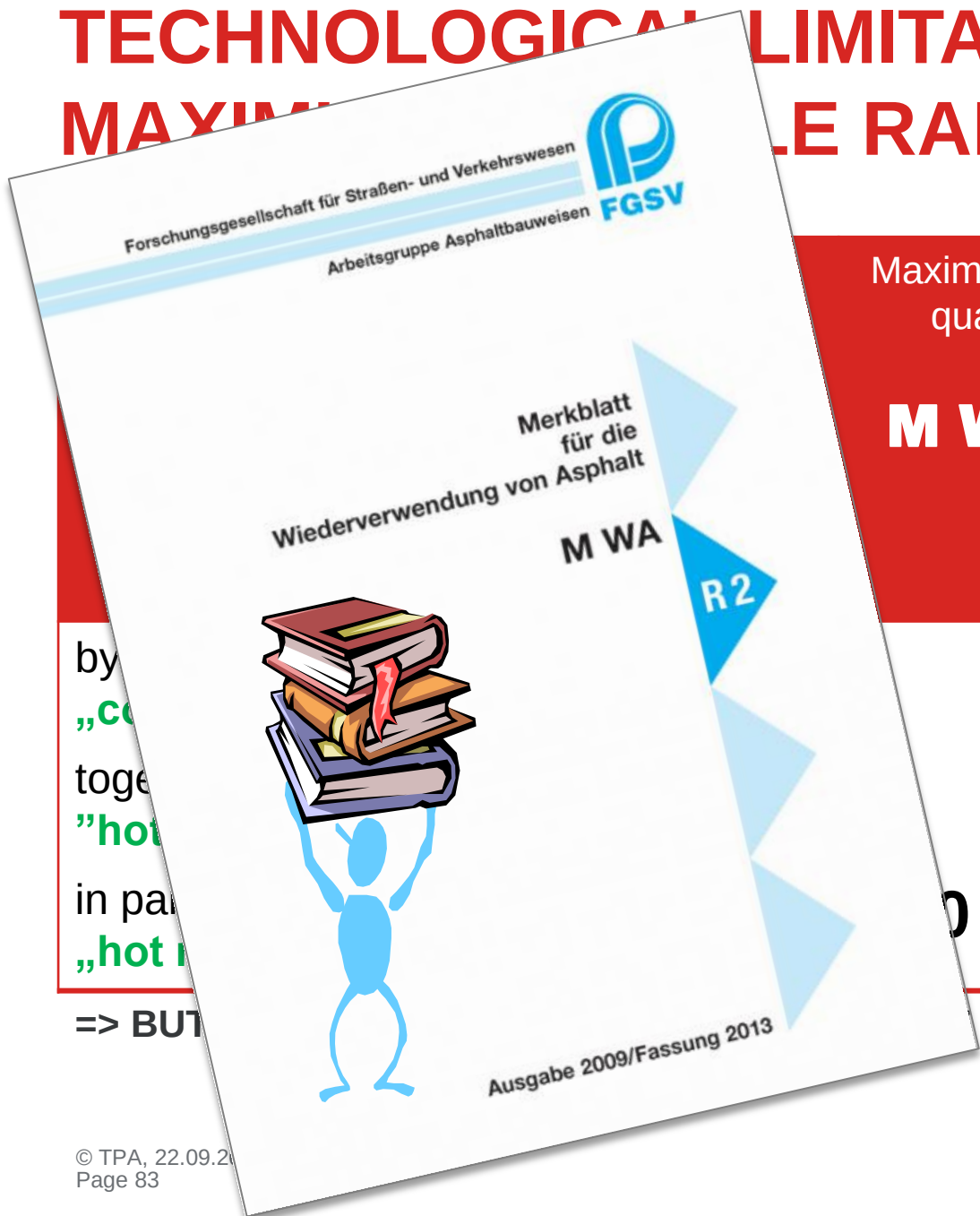
THE STANDARDS  
AND LAW HAS  
TO BE CHANGED  
TO PROTECT  
ENVIRONMENT!



THE FINAL  
PRODUCT HAS  
TO MEET THE  
REQUIREMENTS,  
SUCH AS  
NEW ONE!



# TECHNOLOGICAL LIMITATIONS MAXIMUM POSSIBLE RAP QUANTITIES



Maximum possible RA  
quantity acc. to

**M WA 2009**



**30 %**

**40 %**

**100 (100) %**

Maximum possible RA  
quantity acc. to

**WT-2 2014**



**20 %**

**30 %**

**30 %**

Maximum possible RA  
quantity acc. to

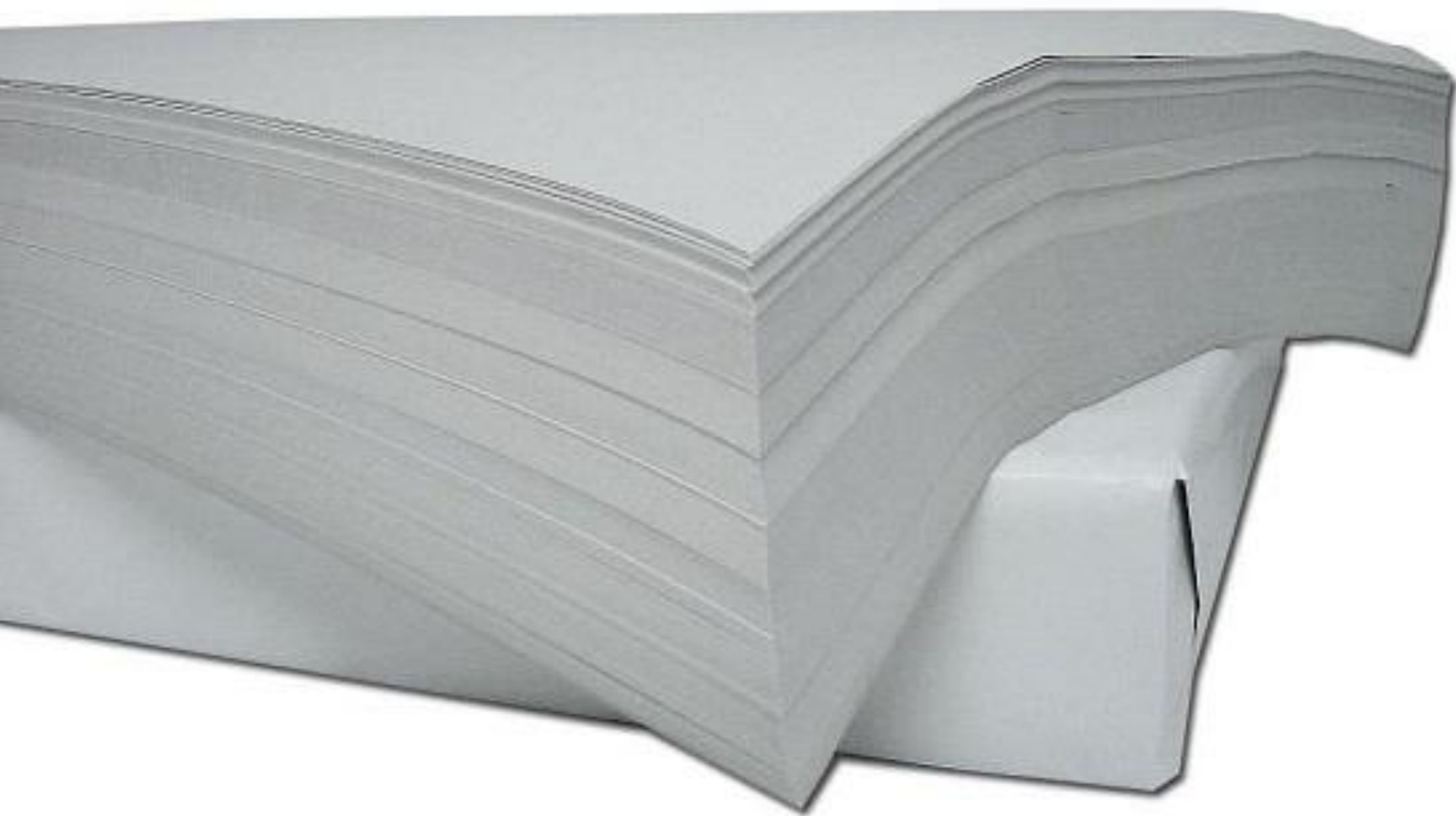
**WT-2 2022  
(?)**

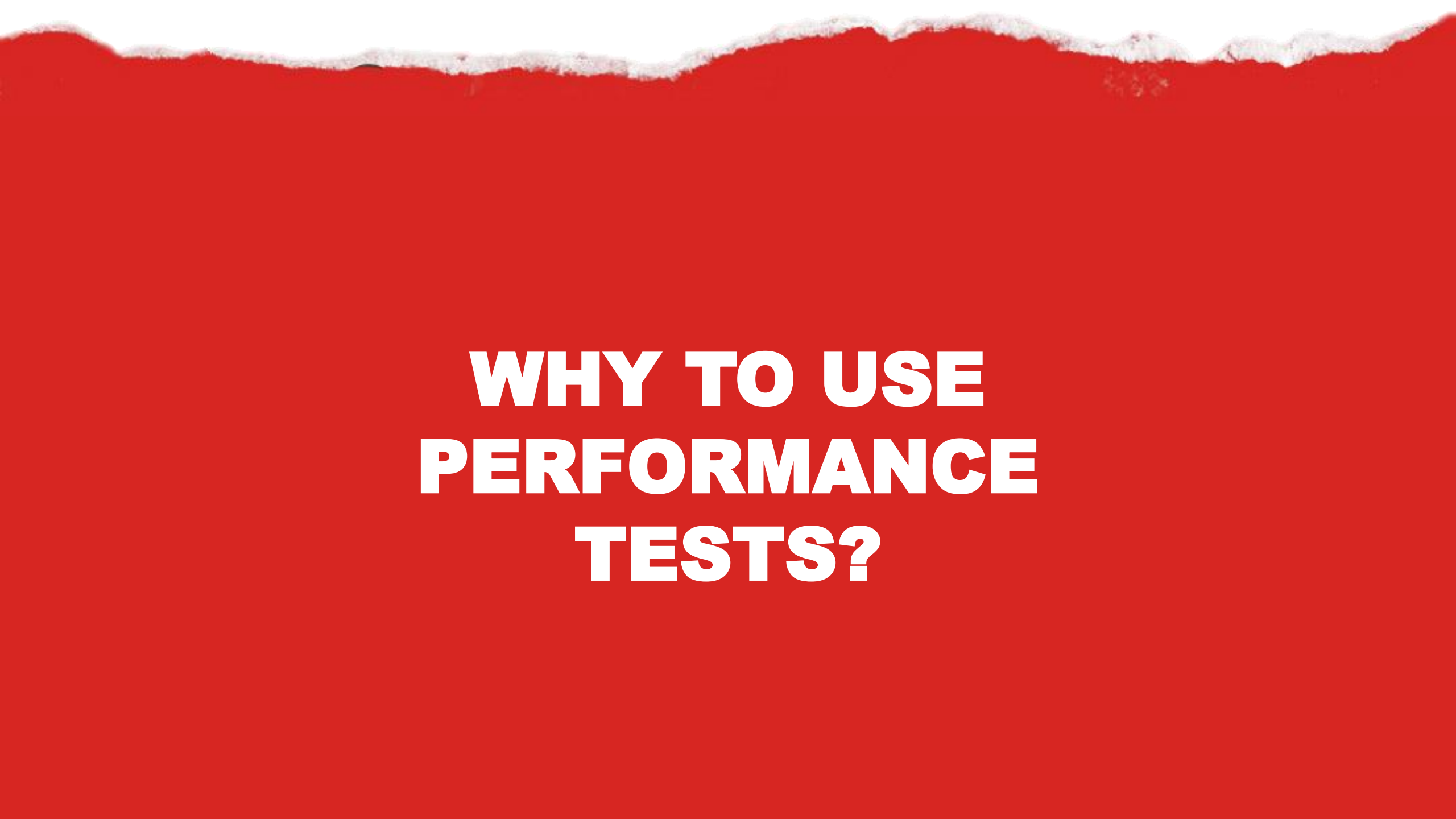
**30 %**

**40 %**

**50 (70) %**

YEAR 10% ALLOWED





# **WHY TO USE PERFORMANCE TESTS?**

# WHY TO USE PERFORMANCE TESTS?



## **TAYLOR MADE DESIGN**

direct usage of  
results in  
pavement design  
and better  
performance  
prediction



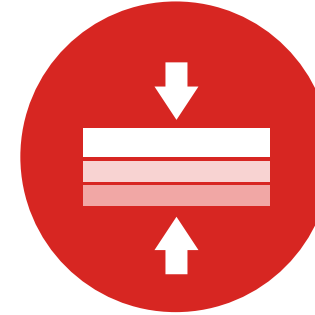
## **ROOM FOR INNOVATIONS**

comparison and  
performance  
prediction for new  
or innovative  
materials



## **LCA & LOWER LCC**

usage of more  
durable materials  
in order to  
decrease life cycle  
costs



## **LESS MATERIAL USED**

optimized  
pavement design  
utilizing better  
safety factors and  
better materials



## **LOWER ENVIROMENTAL IMPACT**

lower CO<sub>2</sub> foot-  
print during  
production and  
transportation,  
recycling

# RESUME / TO DO:

---

- MAXIMIZE PAVEMENT LIFE – DURABLE ROADS ARE SUSTAINABLE
- MAXIMIZE RECYCLING IN ORDER TO PROTECT ENVIROMENT
- DO NOT INVENT TWICE THE SAME – IMPROVE THE BEST PRACTICE
- LEARN FROM MISTAKES OF OTHERS

MAY THE  
FORCE BE  
WITH YOU!





**WHAT TO DO  
TO BE INNOVATIVE?**

WHAT TO DO  
TO BE INNOVATIVE?

“You must  
unlearn what  
you have  
learned.”

*Yoda, The Empire Strikes Back*



# QUESTIONS?

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IGOR.RUTTMAR@TPAQI.COM



# INNOVATION

Artificial chipping containing luminophors with prolonged phosphorescence up to 10 hours

# QUALITY OF LIFE

Unusual joy of bike or walk by foot.  
Promotion of healthy way of life.

# ECOLOGY

Charging by the day light, at least 30 to 60 minutes only. No hazard to environment.

# SAFETY

Better user visibility in the dark.  
Safety improvement of the users.

LUMIPHALT® POWERED BY STRABAG, Lidzbark Warmiński, Poland,  
2016