



UČINKOVITI – EKONOMIČNI - EKOLOŠKI kolnici s bitumenom s dodatkom gume EFFECTIVE – ECONOMIC – ECOLOGICAL

PAVEMENTS WITH ASPHALT-RUBBER BINDER

ALEKSANDER ZBOROWSKI, PH.D., ENG.

Međunarodni seminar ASFALTNI KOLNICI 2017 International seminar ASPHALT PAVEMENTS 2017 Opatija, 05.–06. 04. 2017.



ASPHALT MODIFICATION IN ORDER TO IMPROVE VISCOELASTIC PROPERTIES OF BINDER

Polymer SBS



3÷5%

> Styren-Butadien-Styren

Rubber from scrap tires



15÷20%

- Synthetic rubber (Styren-Butadien Rubber)
- Natural rubber
- Carbon black (antioxidant)
- > Sulphur (increases resistance to rutting)
- > UV filters (protection from long-term aging)
- > Oils and plasticizers (binder upgrading)



photo: Internet

© TPA (5/2014) 2

SECOND LIFE OF TIRES

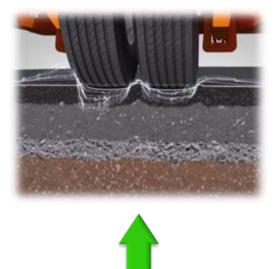




photo: Internet

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METHODS FOR INTRODUCTION OF CRUMB RUBBER INTO HOT MIX ASPHALT

- "DRY" METHOD adding crumb rubber directly to the mixer, in exchange to fine aggregates (1÷3% of HMA)
- "WET" METHOD modification based on blending, heating and co-reacting of hot binder and crumb rubber, reaction time after blending min. 45 minutes

"Field Blend" method (rubber is min. 15÷20% of total binder mass)

"Terminal Blending" method (PMB with 4÷8% rubber addition)



ADDING "RAW" RUBBER GRANULATE IN "DRY" METHOD NEGATIVE EXAMPLES



- crumbs of rubber visible on a pavement surface
- > initial skid resistance improvement
- low amounts of rubber are being utilized (rubber partially replacing the aggregate)
- with time rubber particles are being pulled out from the surface by the traffic
- problems with adhesion between rubber and asphalt
- rubber properties are not fully used
- possibility of potholes occurrence
- slight HMA properties improvement



ADDING "RAW" RUBBER GRANULATE IN "DRY" METHOD NEGATIVE EXAMPLES



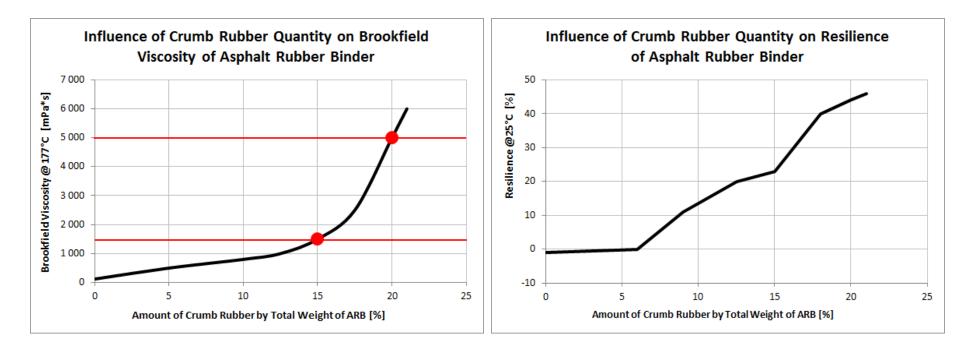
Fot. TPA



WHAT IS ASPHALT BINDER MODYFIED IN "WET" METHOD?

ASPHALT-RUBBER BINDER (ARB) is a blend of asphalt cement, reclaimed tire rubber, and certain additives in which the rubber component is at least 15% by weight of the total blend and has reacted in the hot asphalt cement sufficiently to cause swelling of the rubber particles.

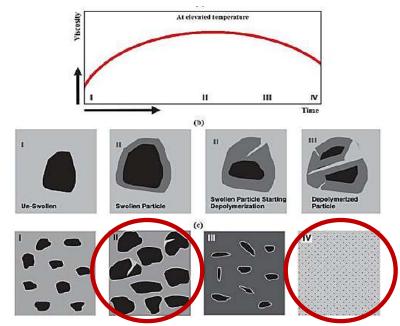
Definition acc.to ASTM D8



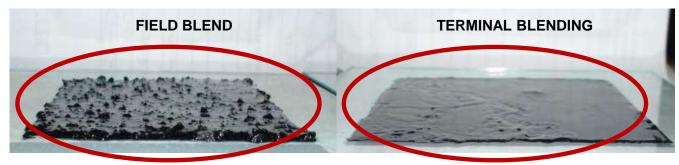
G. B. Way, K. E. Kaloush i K. P. Biligiri, "Asphalt-Rubber Standard Practice Guide, Second Edition," Rubber Pavements Association, Phoenix, 2012



PHASES OF REACTION PROCESS BETWEEN RUBBER AND BINDER IN "WET" METHOD



E.J.F. Peralta "Micro-Analysis of Physicochemical Interaction between the Components of Asphalt Mixtures with Rubber", Iowa State University, 2013



G. B. Way, K. E. Kaloush i K. P. Biligiri, "Asphalt-Rubber Standard Practice Guide, Second Edition," Rubber Pavements Association, Phoenix, 2012



ADVANTAGES OF RUBBER MODIFIED HMA USING "WET METHOD"

DURABILITY

- Increased fatigue resistance and reflective cracking resistance
- Increased low temperature cracking resistance
- Improved rutting resistance
- Increased resistance to aging

SAFETY

- Improved skid resistance
- > Aquaplaning reduction and better visibility during rain when using porous asphalt

ECOLOGY

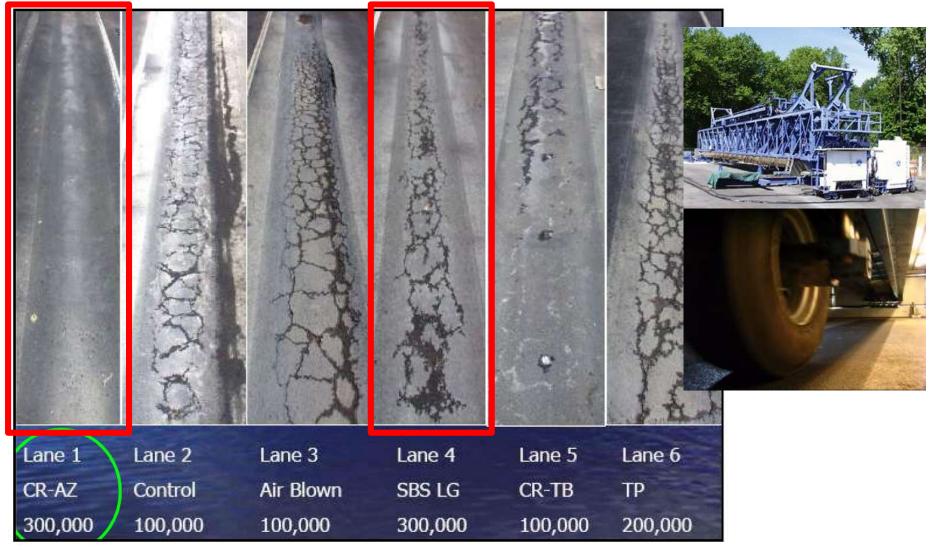
- Effective utilization of scrap tires
- Noise reduction when applied in "quiet pavements"

ECONOMY

- Longer pavement service life
- Lower expenses on maintenance and repairs



RESISTANCE TO FATIGUE CRACKING AND RUTTING RESULTS OF ALF TESTS CARRIED OUT BY US FHWA

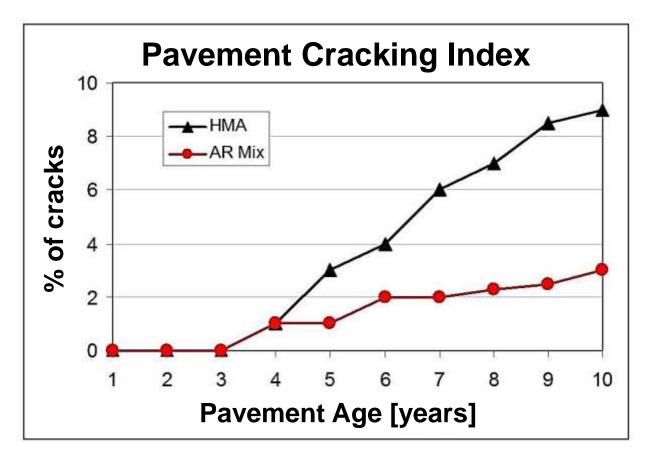


G. B. Way "History of Rubber-Asphalt National Perspective" Rubber Pavements Association, Phoenix, 2012

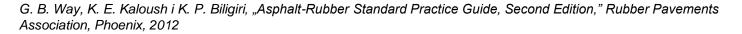
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DATA FROM LTPP PROGRAM CRACKING RESISTANCE



DATA BASED ON 500+ PROJECTS





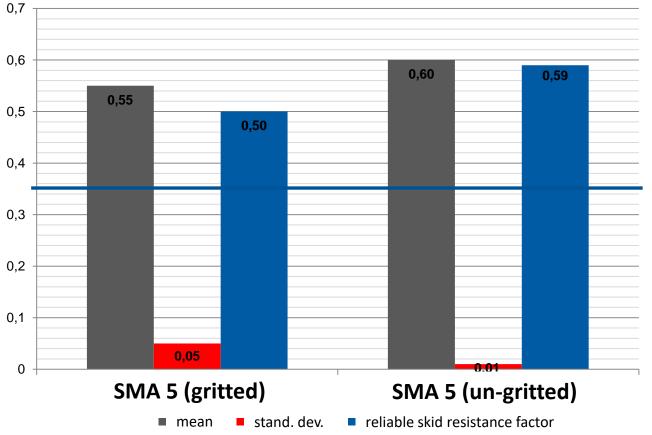
COMPARISON BETWEEN SMA 11 PMB vs SMA 11 ARB

HMA PARAMETERS	SMA 11 S PMB 45/80-55 KR 5-6	SMA 11 S ARB KR5-6
Binder content, %	6,6	7,0
Air voids, % PN-EN 12697-8:2005	2,9	3,5
VMA, % PN-EN 12697-8:2005	17,7	18,8
VFB,% PN-EN 12697-8:2005	83,7	81,3
Density, Mg/m ³ PN-EN 12697-5:2010/AC:2012	2,420	2,418
Bulk density, Mg/m ³ PN-EN 12697-6:2012	2,349	2,333
ITSR, % PN-EN 12697-12:2008	93	96
PRD _{AIR} , % PN-EN 12697-22:2008	6,9	5,2
WTS _{AIR} , PN-EN 12697-22:2008	0,06	0,04
Drainage, % PN-EN 12697-18:2007	0,2	0,1
TSRST, C° PN-EN 12697-46	-26,1	-29,5



SKID RESISTANCE PROPERTIES IMPACT OF GRITTING OF SMA 5 AMG ON SKID RESISTANCE PROPERTIES SRT-3 DEVICE (BARUM BRAVURIS 185/70 R14)

RELIABLE SKID RESISTANCE FACTOR AT 60 KM/H SPEED WITH TIRE BLOCKED AGAINST THE SURFACE





ECOLOGY – SUSTAINABLE DEVELOPMENT – RECYCLING OPTIMAL USAGE OF WASTE MATERIALS

UE directive forbids storage of whole scrap tires after 2003, and shredded scrap tires after 2006.





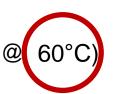
Foto: www.rubberpavements.org



QUALITY CONTROL OF CRUMB RUBBER GRANULATE

Moisture test

conditions for drying rubber (4-6h @



- Gradation test
- Fiber contamination test



rednica 30, 37, 47 mm a na sicianania shit i resetteriat vie da wierunketw (Haid)



- Mineral contamination test
- Metallic contamination test



TPA procedure

test in denaturant



Rubber density

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TESTS AND REQUIREMENTS FOR ARB

No.	PARAMETER	TEST METHOD	REQUIREMENT
1	Dynamic viscosity @ 177ºC [mPa·s]	PN-EN 13302	1500÷5000
2	Resilience @ 25°C [%]	PN-EN 13880-3	min. 18
3	Softening point using Rind an Ball [ºC]	PN-EN 1427	52÷74
4	Cone penetration @ 25°C [0,1 mm]	PN-EN 13880-2	25÷70



Dynamic viscosity PN-EN 13302

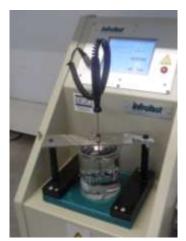
Resilience PN-EN 13880-3

Softening point PN-EN 1427



Foto: TPA





Cone penetration PN-EN 13880-2





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TEST METHOD FOR ASPHALT-RUBBER HOT MIX (ARHM) DETERMINATION OF BINDER CONTENT BY IGNITION

IGNITION OVEN TEST



Foto: TPA.

- PN-EN 12697-39 "Determination of binder content by ignition oven method"
- ARHM sample size ~ 1000g,
- Calibration factor C_F materials properties and test conditions
- Test temperature 480 540 [°C]

Advantages

Fast determination of asphalt content, around 20 – 30 [min]



TYPE TESTING OF ASPHALT-RUBBER BINDER (ARB)

			BADANIE TY	PU				5	
	1	ASFALTU N	ODYFIKOWAN		IMĄ (AN	IG)			
	oadania typu:	TPA/WP/A/15/00		Data:		12.2	20.07.2015		
lec	seniodawca:	Strabag Sp.z.o.o., 05-800 Pruszków	ul. Patzniowska 10	Nr laborator	yjny:		TPA/WP/15	TPA/WP/15/0066	
	MATE			2	PA	RAMETRY	MODYFIKA	511	
Producent asfaltu: Rodzaj asfaltu:			Lotos	Zawartość RDG w lepiszczu, %:			and of the stores	16%	
			70/100		lastyfikatora,			24	
Producent dodatku gumowego (RDG):			Orzeł		a modyfikacji,	°C:	190		
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	izaj plastyfikatora:	(i)	5- -	Inne:				12	
nne	a:		-						
		BADANIA SKL	ADNIKÓW LEPISZCZA GI	MOWO-ASI	FALTOWEGO	0		172	
ρ.	Badana cecha	Warunki	Norma lub procedura	Sprawozdanie z badania		Wynik		1.	agi
Ŧ.	Chapter to Counter	badania	badawcza					Consign	
_			Badania asfaitu bazo					84	
	Penetracja iglą 0,1mm	w 25°C	PN-EN 1426		8/401/15/001 8/420/15/001	37	14		
	Penetracja stožkiem, 0,1mm Elastyczność, % Odpreżenia	w 25°C	PN-EN 13880-2		s42015/001 3/419/15/001		15 3	8 8	
	Temp mieknienia metoda PiK. ⁶ C	w 25°C	PN-EN 13880-3 PN-EN 1427		3/402/15/001	C 80	3.4		
-	Lepho6C dynamiczna przed RTFOT, mPa's	w 90°C	FINED 1967	TFA/WP/SB/416/15/001		6058		-	
		w 135°C PN-EN 13302 w 160°C				338		<u>8</u> 1	-
5			PN-EN 13302				16	8	
		w 200°C				31			
		Badania	rozdrobnionego dodatku	gumowego	(RDG)			12	
	Uziarnienie, frakcja przy tolerancji G ₉₀₁₀			TPAWF/S8/212/15/001		0,125/0,8		•	
	Zawartość wody, %		TPA/PB/001/14			0,60		2	
	Zawartość włókna, % Zawartość części metalicznych, %			8	2	0,18			
	Zawartość części mieralnych, %		TPA/PB/003/14	TRAWPISE	TPA/WP/SB/429/15/001 0,63			8 2	
11	Gestość, Ma/m ³		TPA/PB/002/14	TEAWPISE	10830/15/001	1,19		•	
4		BADA	NIA PROFILU MODYFIKA	CJI LEPISZ	CZA			98 1	
	Distance in	Norma lub		an and a stranger of the stran		Czas reakcji w minutach		1	
	Badana cecha	procedura badawcza	Sprawozdanie z badania	45	60	90	240	360*	1440
12	Lepkość dynamiczna w temp. 177°C po czasie reakcji, mPa*s	TPA/PB/005/14	TPAWP/SB/416/15/002	3215	3300	3520	3930	3770	3620
13	Temp mięknienia metodą PiK po czasie reakcji, °C	PN-EN 1427	TPA/WP/SB/402/15/002-007	65,6	65,6	65,8	66	65,4	65,4
14	Elastyczność po czasie reakcji, % Odprężenia	PN-EN 13880-3	TPA/WP/SB/419/15/002-007	33	33	33	34	31	30
15	Penetracja stožkiem po czasie reakcji, 0,1mm	PN-EN 13880-2	TPA/WP/SB/420/15/002-007	36,8	36,9	39	42,1	45	45

		OZNACZENIE	TEMPERATURY ZAPLONU METODA	CLEVELANDA	
ιφ.	Badana cesha	Norma lub procedura badawcza	Sprawozdanie z badania	Wynik badania	
16	Temperatura zapłonu ze względu na ciśnienie T _o . °C	PN-EN ISO 2592	TPAWP/SB/409/14/009	310	



TECHNICAL APPROVAL FOR A NEW PRODUCT

INSTYTUT BADAWCZY DRÓG I MOSTÓW 03-302 Warszawa, ul. Instytutowa 1 tel. sekretariat: 22 814 50 25, fax: 22 814 50 28



Warszawa, 03 lipca 2014 r.

APROBATA TECHNICZNA IBDIM

Nr AT/2014-02-3076

Na podstawie § 16 pkt 2 rozporządzenia Ministra Infrastruktury z dnia 8 listopada 2004 r. w sprawie aprobat technicznych oraz jednostek organizacyjnych upoważnionych do ich wydawania (Dz. U. Nr 249, poz. 2497 ze zm.), po przeprowadzeniu postępowania aprobacyjnego, którego wnioskodawcą jest producent o nazwie:

STRABAG Sp. z o.o.

z siedzibą:

ul. Parzniewska 10, 05-800 Pruszków

Instytut Badawczy Dróg i Mostów stwierdza pozytywną ocenę techniczną i przydatność wyrobu budowlanego:

Asfalty Specjalne

o nazwie handlowej:

RUBBERBIT

do stosowania w budownictwie - w inżynicrii komunikacyjnej, w zakresie stosowania i przeznaczenia oraz przy spełnieniu warunków podanych w niniejszej Aprobacie Technicznej IBDiM.

Instytut Badawczy Dróg i Mostów, dla wyżej wymienionego wyrobu budowlanego wskazuje obowiązujący system 4 oceny zgodności.



Data wydania Aprobaty Technicznej: Data utraty ważności Aprobaty Technicznej:

03 lipca 2014 r. 03 lipca 2019 r.

Dokument Aprobaty Technicznej IBDiM Nr AT/2014-02-3076 zawiera stron 9 w tym Załącznik.

- > Special binder "RUBBERBIT"
- Designated for: SMA, BBTM, AP, AC, MA and stress absorbing membranes SAMI and SAM.

> Technical Approval valid until 3rd of July 2019



FACTORY PRODUCTION CONTROL FOR A NEW TYPE OF BINDER

STRABAG

ZARLADOWA KONTROLA PRODUKCJI

STRABAG

KSIĘGA ZAKŁADOWEJ KONTROLI PRODUKCJI ASFALTÓW MODYFIKOWANYCH GUMĄ

Niniejsza Księga Zakładowej Kontroli Produkcji jest dokumentem ustanawiającym wewnętrzną kontrolę wyrobu i procesu produkcji astatów modyfikowanych gumą w celu zapewnienia stabilności procesu produkcyjnego oraz uzyskiwania powtarzalnych cech wyrobu zgodnych z założonymi wymaganiami technicznymi.









TEST SECTIONS – PRUSZKÓW, PARZNIEWSKA STREET AUGUST 2013



- Test sections of total length of 585 m.
- Four different pavement structures
- > Six different layers:
 - ✓ SMA 11
 - ✓ BBTM 8A
 - ✓ AC 5 AF
 - ✓ AC 16 TD
 - ✓ AC 16 W
 - ✓ SAMI





CURRENT APPLICATIONS OF ARB MAY 2014 – LOCAL ROAD KAMIEŃ-BYKÓW



- Wearing course
 SMA 11 ARB KR 3-6
 Aggregate: gabbro
 B = 6,9%
 Vm = 3,5%
- Length: 2,5 km
- > Total amount of ARHM used: ~2 200 t



QUIET PAVEMENT WITH USAGE OF ARB AUGUST-SEPTEMBER 2014 – PROVINCIAL ROAD 880 JAROSŁAW-PRUCHNIK



> Quiet pavement SMA 5 ARB KR 3-4 Aggregate: basalt B = 6,8% Vm = 4,4%

Length: 14 km

> Total amount of ARHM used: ~6 600 t

Foto: TPA



RUT-RESISTANT AND HEAVY TRAFFIC RESISTANT WEARING COURSE NOVEMBER 2014 – RECONSTRUCTION OF SECTION OF NATIONAL ROAD DK4 AS A PART OF CONTRACT KORCZOWA LOGISTIC PARK



> Wearing course SMA 11 ARB KR 5-6 Aggregate: melaphyre

B = 7,0%Vm = 4,9%

> Length: ~600 m



QUIET PAVEMENT WITH ARB AUGUST 2015 – OCTOBER 2016 – WARSAW - WAWER



> Quiet pavement SMA 8 ARB KR 5-6 Aggregate: melaphyre B = 7,2% Vm = 6,3%

> Total amount of ARHM used: ~2 500 t

Foto: TPA



QUIET AND RUT-RESISTANT PAVEMENT WITH ARB SEPTEMBER-NOVEMBER 2015 – WARSAW, WOŁOSKA STREET



Foto: TPA

Wearing course
BBTM 8A ARB KR 6
BBTM 8B ARB KR 6
Aggregate: melaphyre
B = 6,7% and 6,1%
Vm = 7,3% and 10,6%

Length: ~3 km

> Total amount of ARHM used: ~3 500 t



RUT-RESISTANT AND HEAVY TRAFFIC RESISTANT WEARING COURSE OCTOBER 2016 – PRUSZKÓW, PRZEJAZDOWA STREET



> Wearing course

SMA 11 S AMG KR 5-6

Aggregate: melaphyre B = 7,0% $V_m = 3,5\%$

- ≻Length: ~ 1,2km
- Total amount of ARHM used: 880 t



Foto: TPA

© TPA, 10.02.2017 Strona 27

PROVINCIAL ROAD DW 637, OKUNIEW JULY 2016 – MAY 2017



> Wearing course

BBTM 8A AMG KR 6

Aggregate: melaphyre B = 6,7%Vm = 7,3%

- ≻Length: ~ 11km
- Current amount of ARHM used: 5 630 t



SOME NEWS ABOUT TECHNOLOGY – WORLD







INTERESTS AND MARKET OF "RUBBER APSHALTS" IN POLAND





izolacje plyt objektów mostowych

Technologia przyjazna środowbitu Asfalt modyfikowany guma

z zużytych opon





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"Gumowe" lepiszcze szansą na trwałe nawierzchnie

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Zastosowanie odpadów gumowych w budownictwie drogowym

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LATEST NEWS ABOUT TECHNOLOGY – POLAND

3 GDDKIA

Kierunki Innowacyjnych działań w dziedzinie technologii nawierzchni drogowych

Pointed out as 1 of 12 desirable directions of technological development



Wacław Michalski

Dyrektor DepartamentuTechnologii GDDKiA

Kielce 13 maja 2015 r.

3 GDDKIA

Asfalty modyfikowane gumą

Obniżenie emisji hałasu









Foto: TPA

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