

**DIRECT  
MAT**

# DIRECT-MAT

WP4: Uklanjanje asfaltnih kolovoza  
i reciklaža putnih materijala  
u asfalt

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# WP 4: Ciljevi

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Osvrt na objedinjenu literaturu i podatke sa terena:  
Razmena i širenje nacionalnih (evropskih) iskustava i prakse sa terena:

- Uklanjanje i reciklaža putnih i drugih materijala
- Upotreba recikliranih materijala za održavanje i izgradnju novih saobraćajnica
- Najnovija rešenja / Specifikacije
- Iskustva i rezultati istraživanja

Uputstva za primenu u praksi

- Razmatranje društveno-ekonomskih uslova
  - Dostupne tehnologije
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# Prvi rezultati: Dokument D5



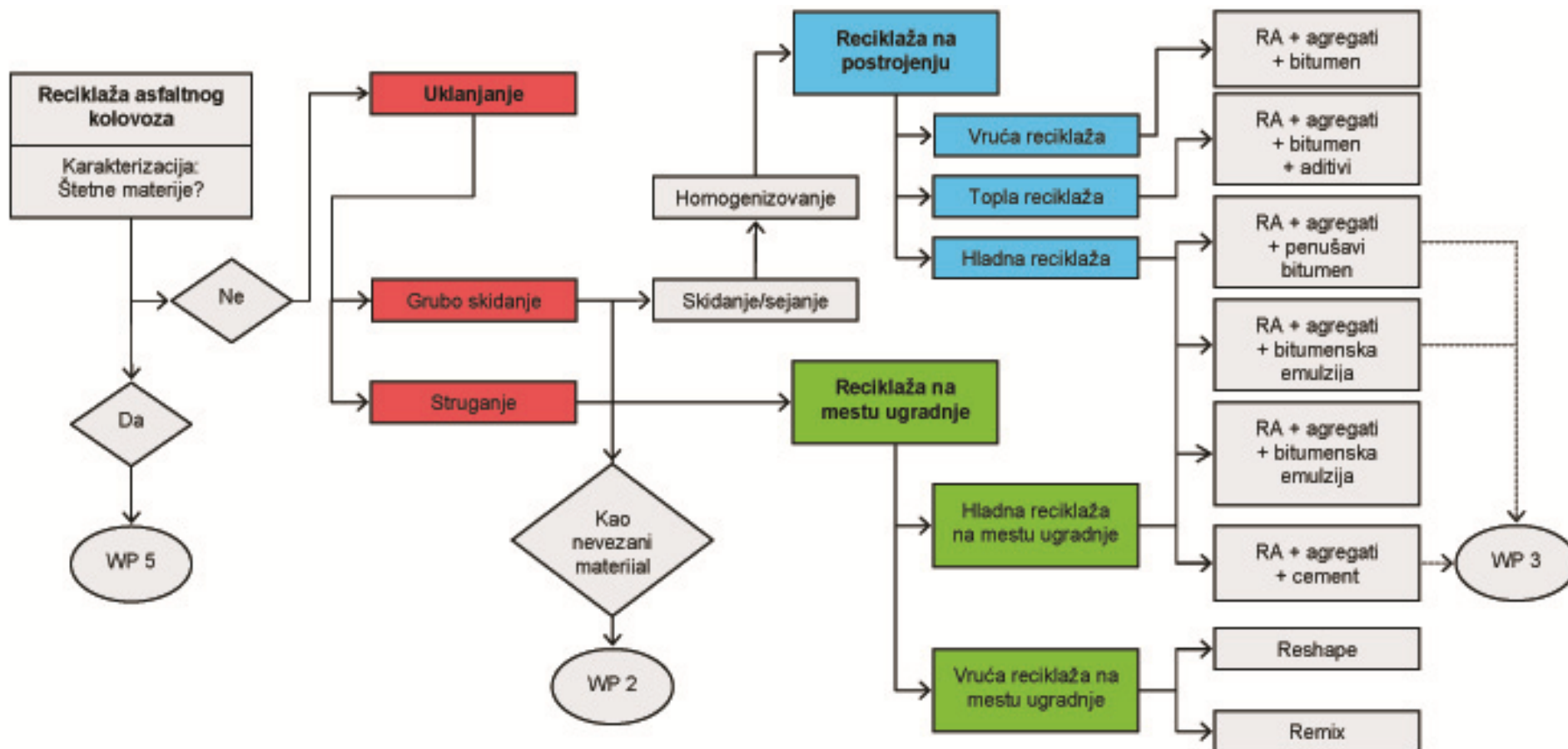
## Sinteza nacionalnih i međunarodnih dokumenata o nivou postojećeg znanja u vezi sa reciklazom materijala za puteve u asfalt

**Table 1 List of Authors**

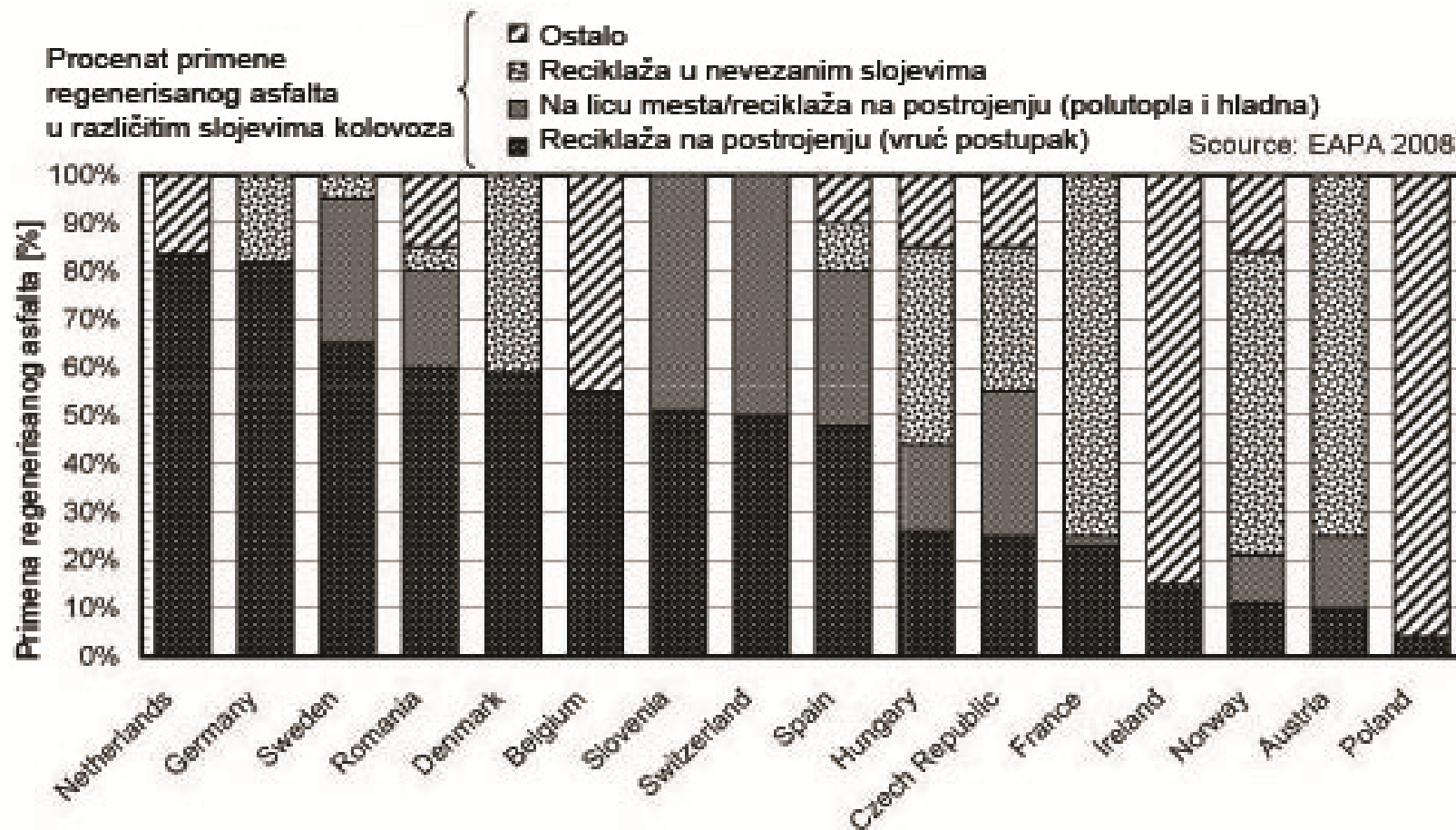
Country	Beneficiary	Authors
Belgium	BRRC	Luc e Bock
Denmark	DRI	Erik Olesen
France	LCPC	Yves Brosseaud
Germany	TUBS	Konrad Mollenhauer
Hungary	KTI	Laszlo Gaspar
Ireland	UCD	Ciaran McNally, Amanda Gibney
Poland	IBDiM	Krzysztof Mirski
Portugal	LNEC	Fatima Batista, Maria L Antunes
Serbia	IP	Milorad Smiljanic
Slovenia	ZAG	Aleksander Ipavec, Primoz Pavsic
Spain	CEDEX	Baltasar Rubio, Francisco Sinis
Sweden	VTI, SGI	Robert Karlsson, Ola Wik



# WP 4: Tehnike reciklaže asfalta



# Reciklaža asfalta u Evropi



# Metode uklanjanja asfaltnih kolovoza



Table 2 Recommendations for the demolition of asphalt pavements

Country	Recommended or usually applied demolition technique				Recommended after treatment and storage condition		
	Milling layer by layer	Milling	Crushing to blocks	Prior Removal of road marking	Crushing	Homogenisation	Storing separately by characteristics / source
Belgium		X			X	X	X
Denmark							
France							
Germany	X			X	X	X	X
Hungary							X
Ireland	X*	X	X		X	X	
Poland	X**						
Portugal							
Serbia	X		X				
Slovenia	X			X	X	X	X
Spain	X*				X		X
Sweden	X			X	X	X	X

\* for In-Situ recycling  
 \*\* for road maintenance



# Reciklaža putnih materijala u asfalt

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- **Reciklaža nevezanih materijala:**
    - Moguća u većini zemalja
  - **Reciklaža hidraulički vezanih materijala:**
    - Moguća u većini zemalja
  - **Reciklaža regenerisanog asfalta:**
    - Korišćenje RA na postrojenju za vruć asfalt ("standardni" asfalt)
    - Hladne mešavine (postrojenje i na mestu ugradnje) za donje slojeve i puteve sa lakim saobraćajem
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# RA: Tehnički zahtevi



Table 7 Requirements on RA for the use in HMA												
Property		Country										
		Belgium	Denmark	France	Germany	Hungary	Ireland	Poland	Portugal	Serbia	Slovenia	Spain
Reclaimed asphalt	Maximum grain size U [mm]	x			x		28	40	32		32	
	Binder content [%]	x			x		x		x		x	
	Max. Density $\rho_m$				x						x	
	Content of foreign matter				x			x	x			
Aggregates	Type of aggregate	x			x			same as for virgin aggregates				
	Grading	x			x		x			x		
	Shape index	x			x						x	
	Flakiness index				x							
	Crushed surfaces				x						x	
	Los Angeles Coefficient				x							
	Polished stone value				x <sup>2</sup>							
	Water absorption				x							
	resistance to freezing and thawing				x							
	resistance to freezing and thawing (NaCl)				x <sup>2</sup>							
Binder	Type of binder				x				x		x	
	T <sub>R&amp;B</sub> [°C]	x			70			70	70		70	
	Pen [1/10 mm]	10 <sup>1</sup>			15		15 <sup>4</sup>	15	15			
	Viscosity @ 135°C	x										

x: Specification needed for the characterisation of RA  
<sup>1</sup> or 50 % of initial value  
<sup>2</sup> for the recycling in surface courses  
<sup>3</sup> no specification on the constituent materials needed  
<sup>4</sup> for RA content of > 10 %





# Homogenost RA

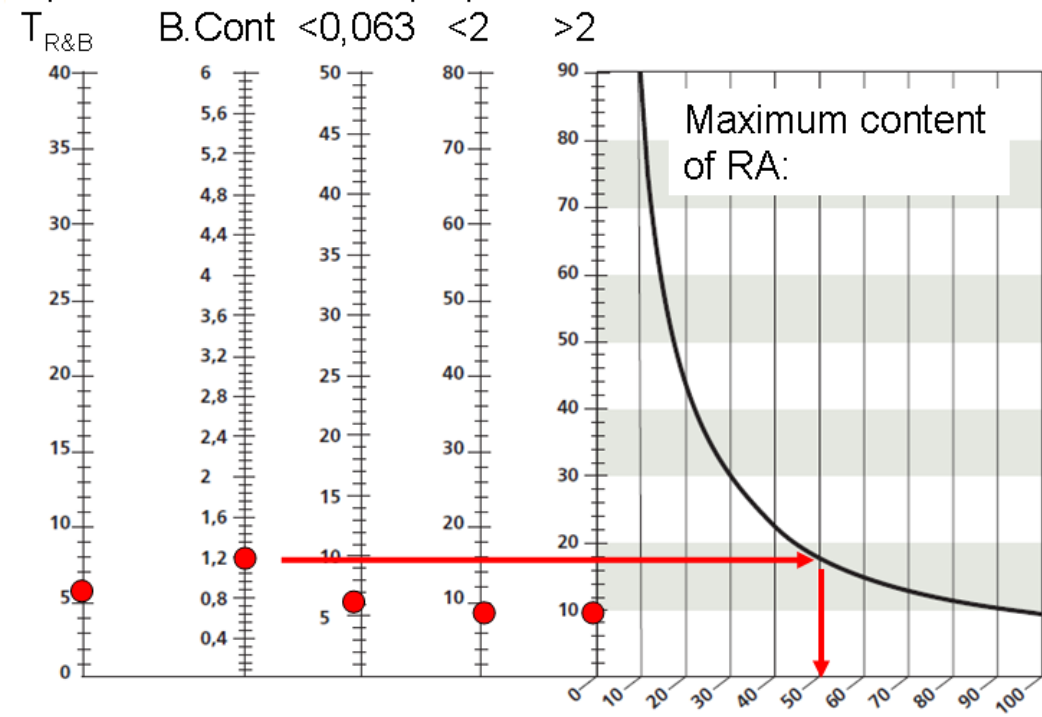


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Table 8 Limits on the variations of the RA characteristics

Country	Grading [%] by mass			Binder content [%] by mass	Penetration [1/10 mm]	Softening point $T_{R\&B}$ [°C]
	< 0,063	>0,063; < 2	> 2			
Belgium <sup>1)</sup>	±3		±10			
Denmark						
France						
Germany <sup>2)</sup>	X	X	X			
Hungary						
Ireland						
Poland <sup>2)</sup>	X	X	X			
Portugal	±1,5	±3	±5			
Serbia						
Slovenia						
Spain	±1,5	±3	±5			
Sweden						

Span of measured RA properties:



1) If tolerances are not met, the allowed RA

2) The homogeneity of the indicated charac



# Maksimalni sadržaj RA i projektovanje mešavina



Table 10 Maximum allowed percentage of RA in HMA and mix design requirements

Country	Maximum allowed percentage of RA in HMA for			Use of equation 1 and/or 2	$D_{RA} \leq D$	Other mix design requirement
	Surface course	Binder course	Base course			
Belgium	25 %		50 %	x	x	x <sup>1)</sup>
Denmark	20 %	20 %	100 %			
France	$T_{R\&B,m} = \frac{b_0}{100} \times T_{R\&B,o} + \frac{b_n}{100} \times T_{R\&B,n}$ $\log \text{pen}_m = \frac{b_0}{100} \times \log \text{pen}_o + \frac{b_n}{100} \times \log \text{pen}_n$ $\log \log G^*_m = \frac{b_0}{100} \times \log \log G^*_o + \frac{b_n}{100} \times \log \log G^*_n$			x		
Germany				x	x	x <sup>2),3)</sup>
Hungary				x	x	
Ireland						
Poland				x	x	x <sup>2),3)</sup>
Portugal						
Serbia						
Slovenia	not defined			-	x	x <sup>3)</sup>
Spain	-	10 % – 50 %				x <sup>1)</sup>
Sweden	20 %	30 %		Performance specifications		

<sup>1)</sup> in Flanders, the proportion of bitumen originating from RA in the binder of RHM for base courses of roads is limited

<sup>2)</sup> The virgin binder used in asphalt mixes with RA may be one grade to the lower viscosity than the usual suitable binder

<sup>3)</sup> virgin binder should not be softer than 70/100



# Tehnike projektovanja mešavina

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## Postupci projektovanja asfaltnih mešavina:

- Homogenost RA:
  - prema klasama: Belgija, Portugalija, Španija
  - prema funkciji: Nemačka, Poljska
- Tehničko rešenje asfaltne baze:
  - Belgija, Francuska, Nemačka, Poljska, Španija
- Rezultati učinka:
  - Švedska, Francuska, (Nemačka)
- Bez zahteva za mali sadržaj RA
  - Irska, Francuska (10 %)



# Reciklaža na mestu ugradnje



## Summary of the use of in-situ recycling in Direct-mat countries

Portugal (PT)	Cold recycling used since 1993. Hot recycling on some demonstration projects in the late 1980's.
Sweden (SE)	Cold, warm and hot techniques are used on a regular basis. A treatment selection guide and a handbook support recycling actions.
Denmark (DK)	Uses hot remixing.
Spain (ES)	Has gained considerable experience in cold recycling.
Belgium (BE)	Hot techniques were used for ten years beginning in 1977, but thereafter outcompeted by in-plant techniques.
Germany (DE)	Experience from hot remixing and from manufacturing of remixing equipment. Reported favourable calculations of reduced CO2 emissions using cold recycling.
France (FR)	Cold recycling with foamed bitumen and bitumen emulsions are used. Hot techniques have been abandoned because of their great need for heat and poor workers conditions.
Serbia (SRB)	Cold recycling with bitumen emulsions and foam bitumen are used. Hot recycling in-place (remix-plus).



# Zaključak



## Zaključci iz uvida u literaturu:

- Regenerisani asfalt se koristi u većini zemalja kao novi materijal i do 100 %
- Znatne razlike u primenjenim rešenjima usled različitih društveno-ekonomskih uslova
- Inovativne tehnologije i iskustva nisu svuda dostupni
- Generalne Specifikacije često dozvoljavaju viši stepen reciklaže nego što se primenjuje u praksi
- Objedinjavanje podataka sa terena mora da se potvrdi



# Primeri reciklaže asfalta u Srbiji 1



# Primeri reciklaže asfalta u Srbiji 2



HVALA NA PAŽNJI !