

XVIII INTERNATIONAL SIIV SUMMER SCHOOL

Sustainable Pavements & Road Materials

Cold in Place Technology – Latest Developments

Mike Marshall & Davide D'Onza Wirtgen Group

COLD IN PLACE RECYCLING

SUSTAINABLE PAVEMENT REHABILITATION

08th September 2022



Recycle pavements

- ▶ Save Money or make maximum use of tight budget
- ▶ Past conventional overlay
- ▶ Long life
- ▶ Design in traffic growth
- ▶ Fast process
- ▶ Minimum disruption business
- ▶ Accommodate traffic
- ▶ Can be re-recycled - **sustainability**
- ▶ Green factor – **CO2 reductions**

▸ Cold Recycling

➤ In place rebuild of pavement using In place materials

Summer School Theme: Sustainable Pavements & Road Materials

- FDR – Full Depth Reclamation **WR**
- CIR – Cold in Place Recycling **CR**



WR 240i

Full Depth Recycling FDR

Pavement base recycling
Typically 15 – 35cms depth



W 240 CRI

Latest Developments

Cold in Place Recycling CIR

ALL Pavements layers

Typically 6 – 30cms depth

Cold Recyclers and Soil Stabilizers WR Series Technology well known and used in Italy



WR 2000

Cold Recycling in Italy



Asphalt on the truck lane milled out to a depth of 25 cm
Recycling of remaining 5 cm asphalt with underlying CTB to a depth of 25 cm

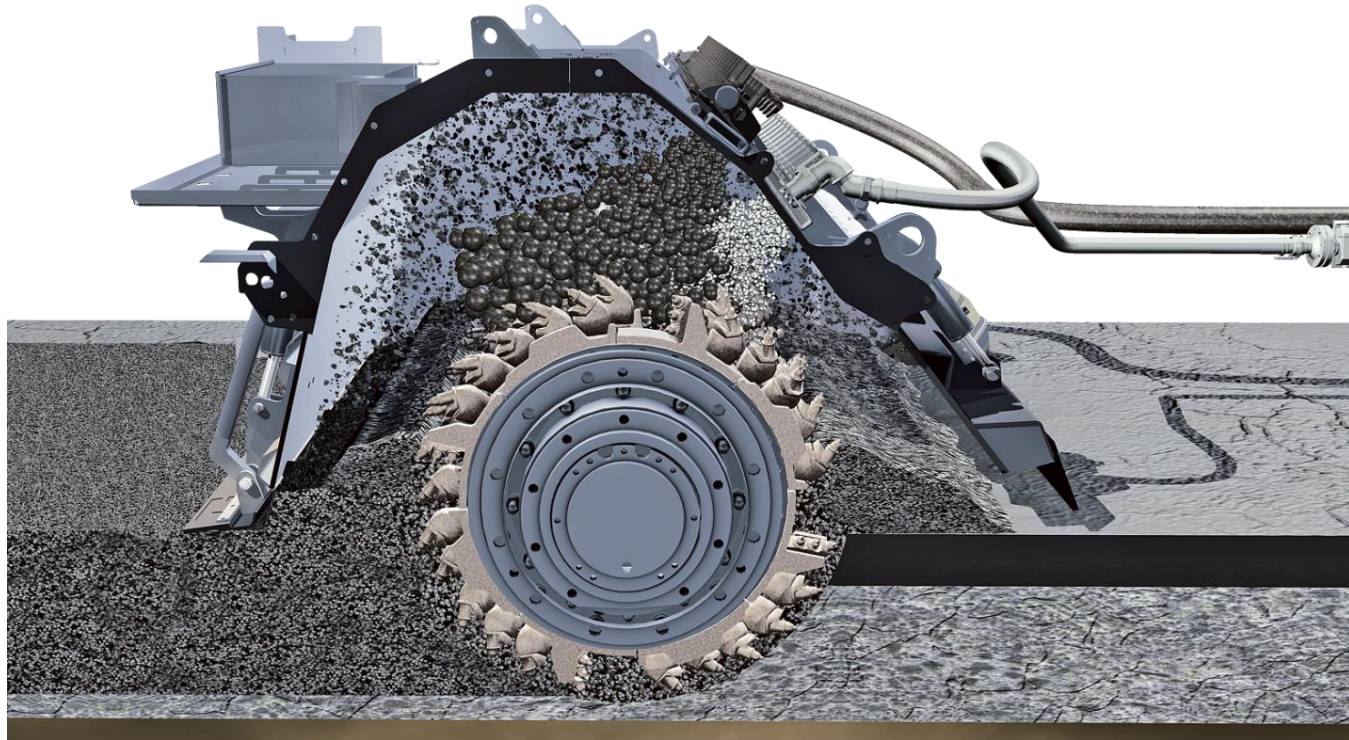
WR 2000

Cold Recycling in Italy



▶ The cement is first pre spread on the surface
The recycler pushes the water and emulsion bitumen tankers

Upcut process,



2 passes per traffic lane



HOMOGENIZATION



Stabilizer



Compactor



Motor grader



Compactor

SOIL STABILIZATION WITH LIME



Binding agent spreader



Spreader



Compactor



Motor grader



Compactor

SOIL STABILIZATION WITH CEMENT



Binding agent
spreader spreader



Water tanker



Spreader



Compactor



Motor grader



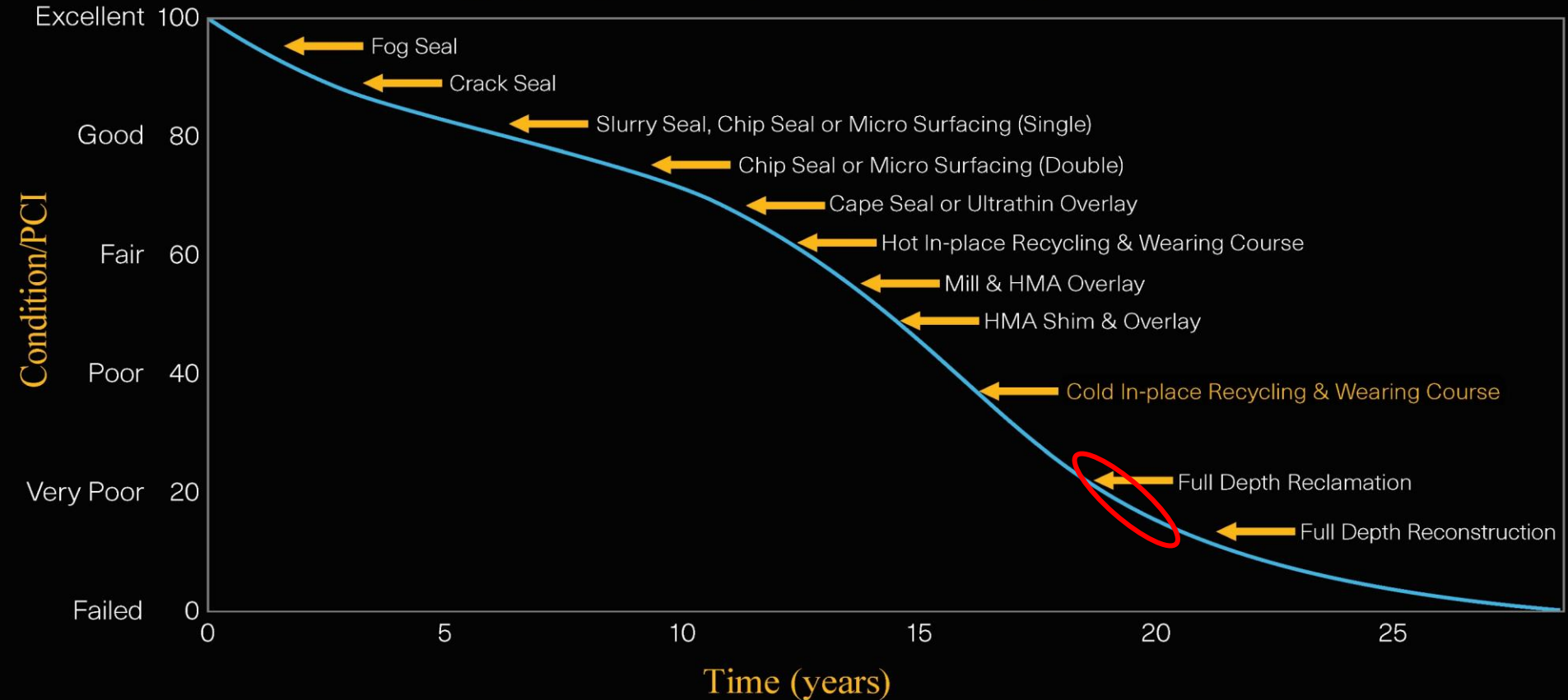
Tandem
roller



Pneumatic tired
roller

Deterioration Curve

Applying the right treatment, to the right road, at the right time....



COLD IN PLACE RECYCLING

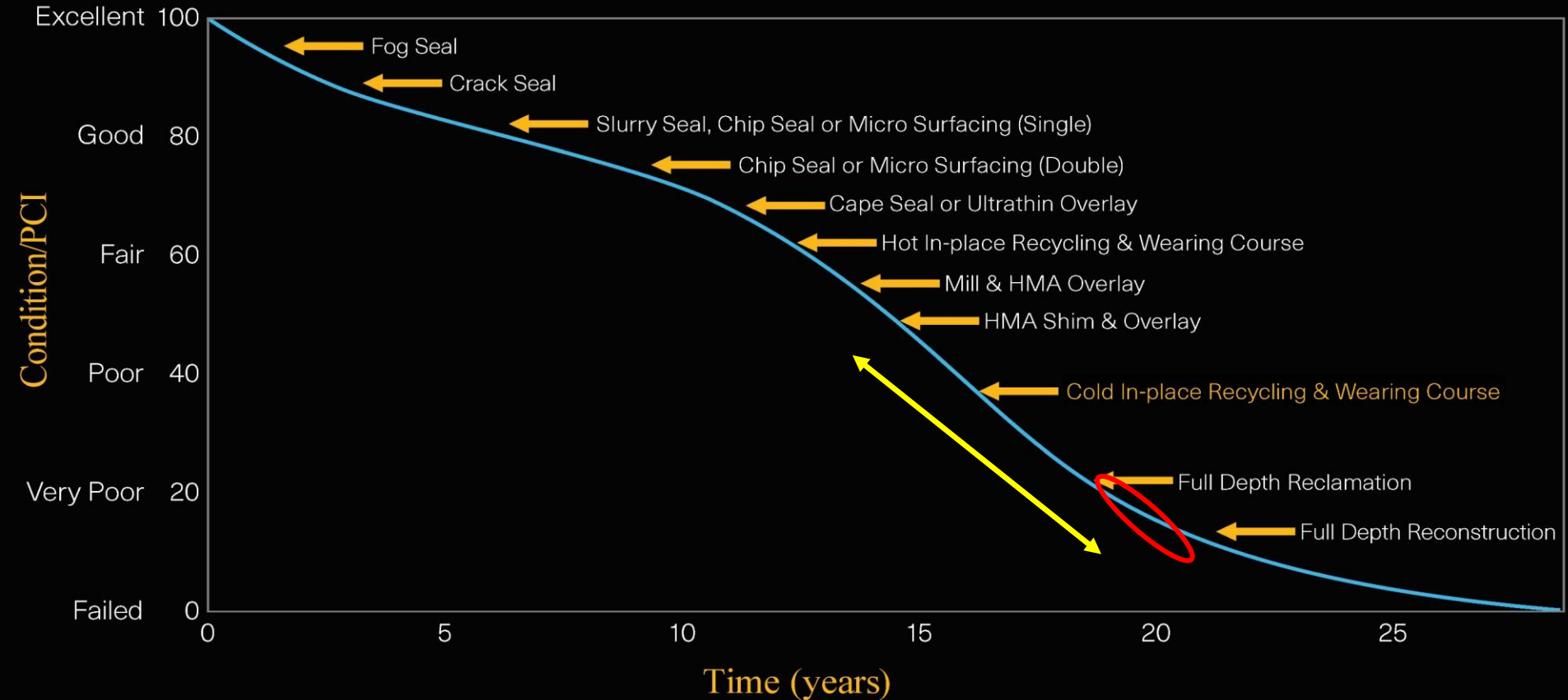
LATEST DEVELOPMENTS

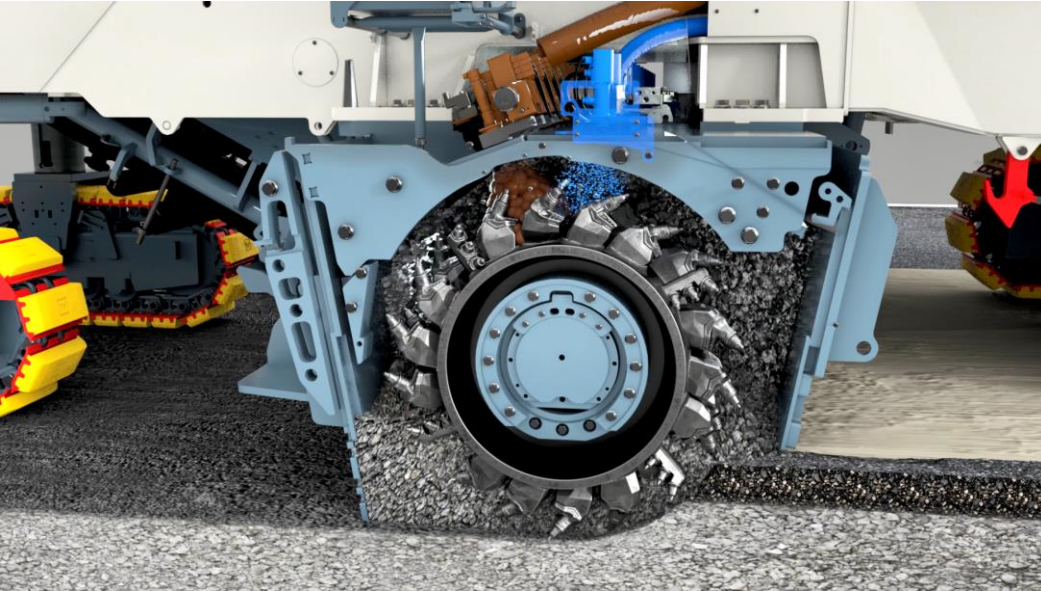
Cold recyclers – CR model series



Deterioration Curve

Applying the right treatment, to the right road, at the right time....

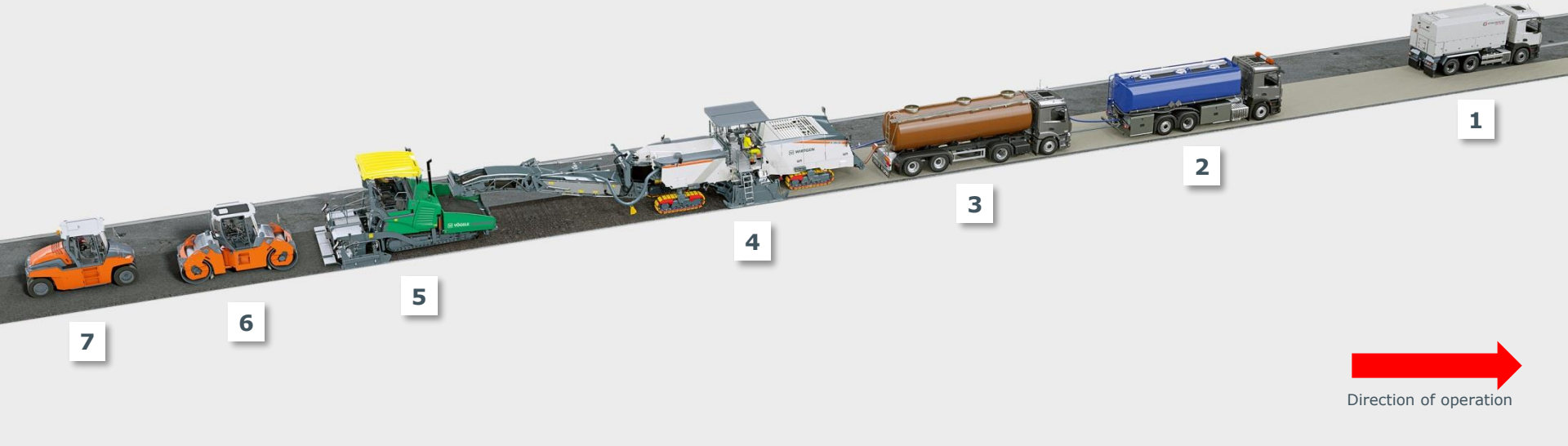




- ▶ Milling / Sizing existing pavement to depth
- ▶ Addition of new binder/additives
- ▶ Mixing all component materials
- ▶ Placement of the mixture
- ▶ Compaction of the mixture
- ▶ Open to traffic (fog seal if necessary)

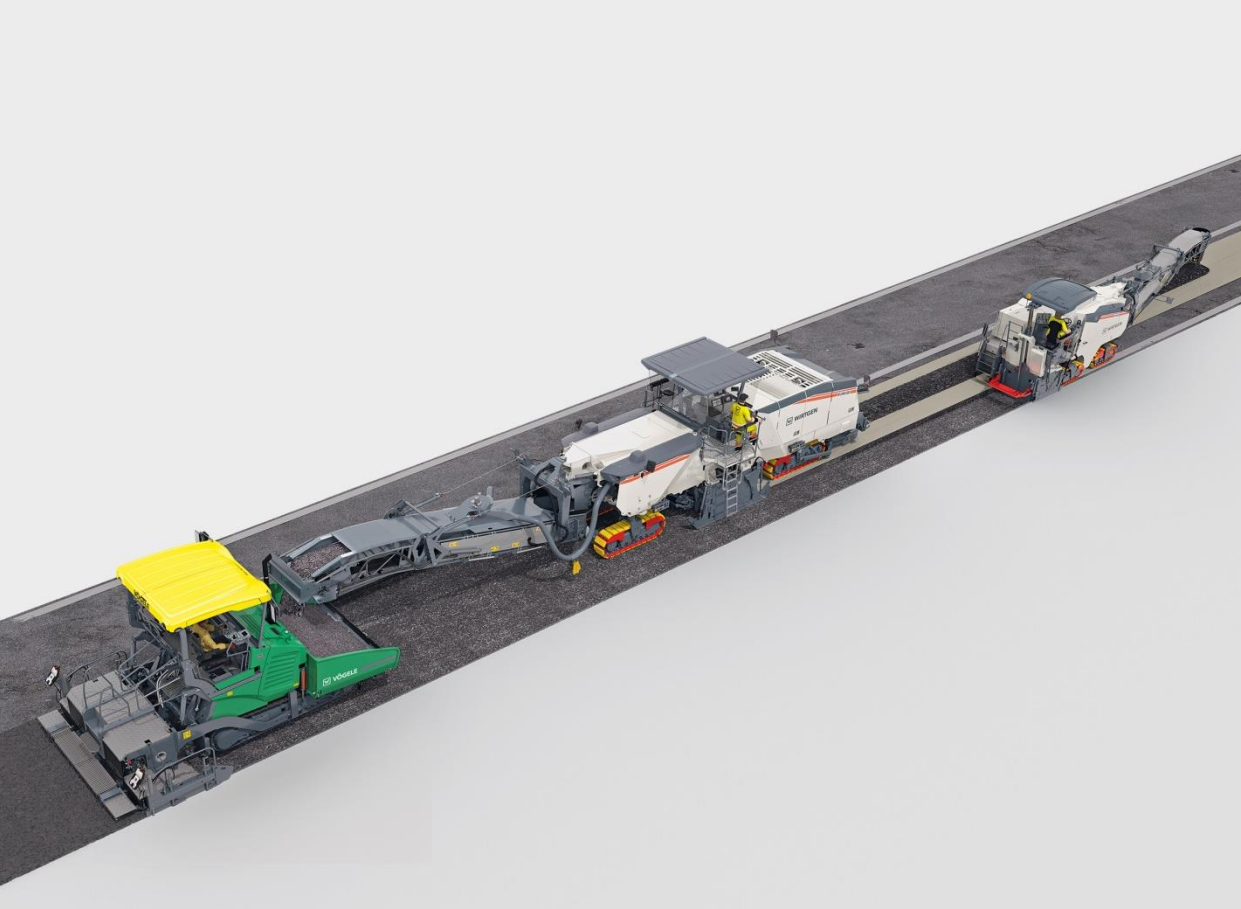
Cold recycling with integrated rear loading

Recycling train including the W240/380 CRI



- 1** Binder spreader
- 2** Water tanker truck
- 3** Binder tanker truck
- 4** Cold Recycler W240/380 CRI

- 5** Asphalt paver
- 6** Tandem roller
- 7** Pneumatic-tyred roller



▼ **Example of application using the W 240 CRI**

- ▼ Lateral premilling and recycling with loading conveyor and paver

The recycler picks up the granulated material produced in a previous milling operation via the integrated guide plate system to recycle the road pavement across the full width.



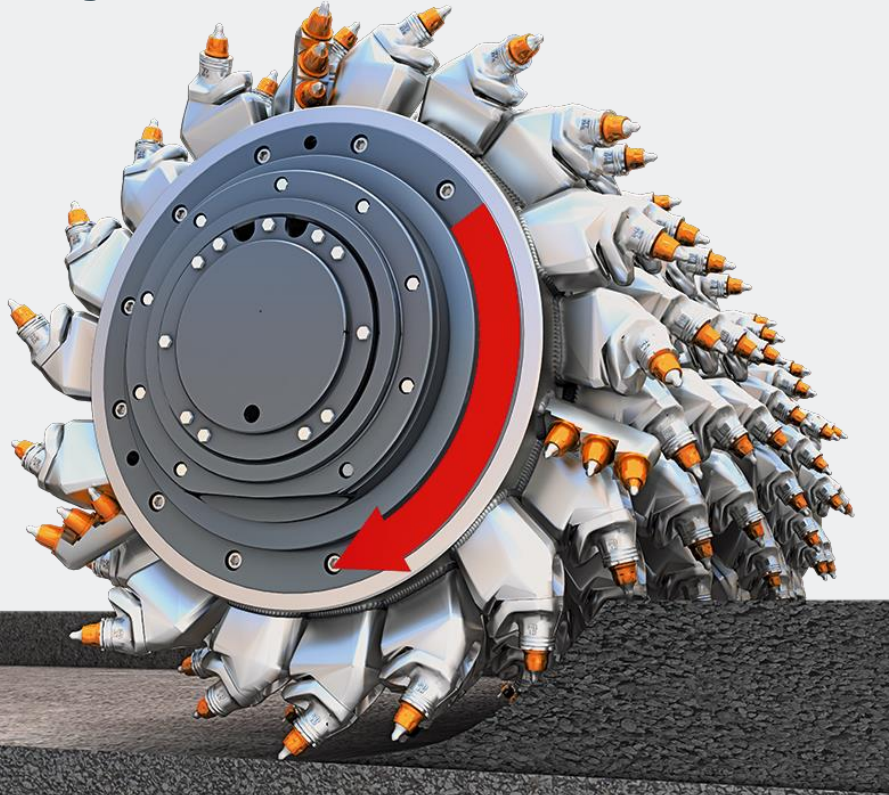
Example

- 300 t/hr
- No truck traffic

COLD IN PLACE RECYCLING

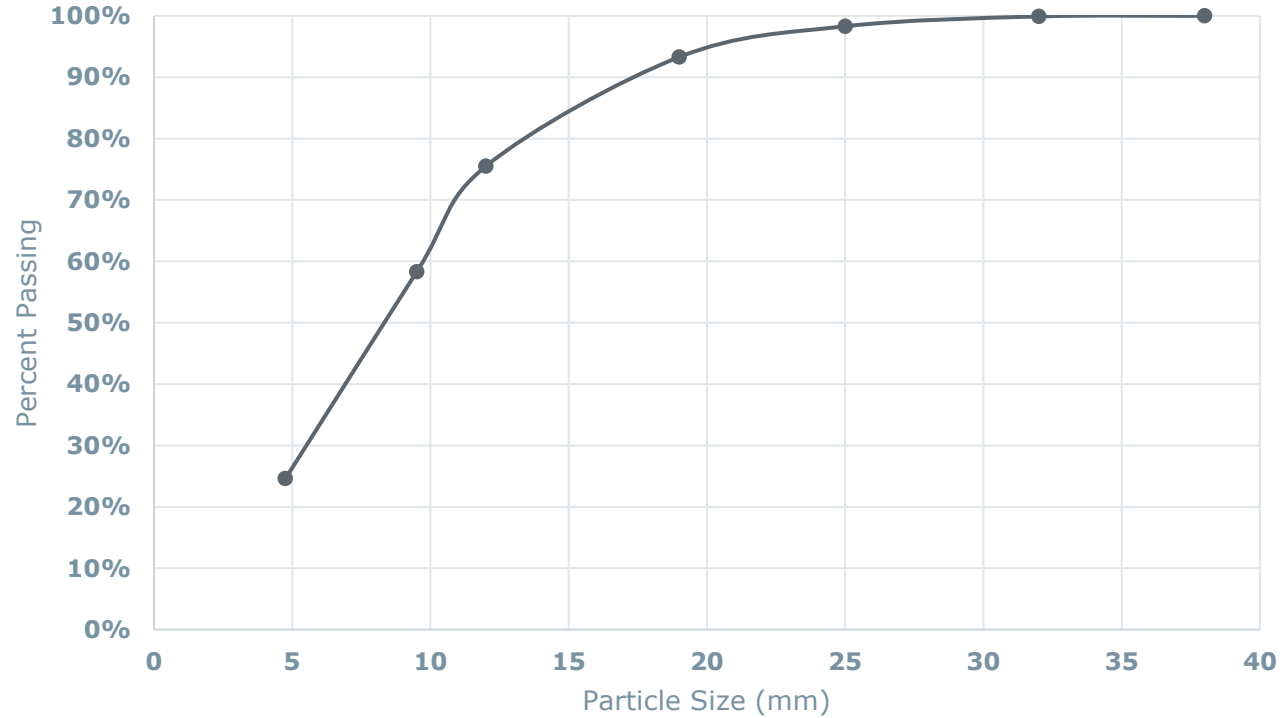
IMPORTANT FEATURES


Working direction



- ▶ In "Rear Load" design, the recycler uses the down-cut process developed by WIRTGEN in which the milling and mixing rotor operates in the direction of travel
- ▶ The process optimizes gradation control and prevents the material from breaking into larger chunks

Gradation Curve





- ▶ Typical paver laid recycled material – W 240/380 CRi downcut
- ▶ Smoother ride, thinner overlay, COST SAVING

DOWNCUT V UPCUT

COMPARISON TEST - ITALY

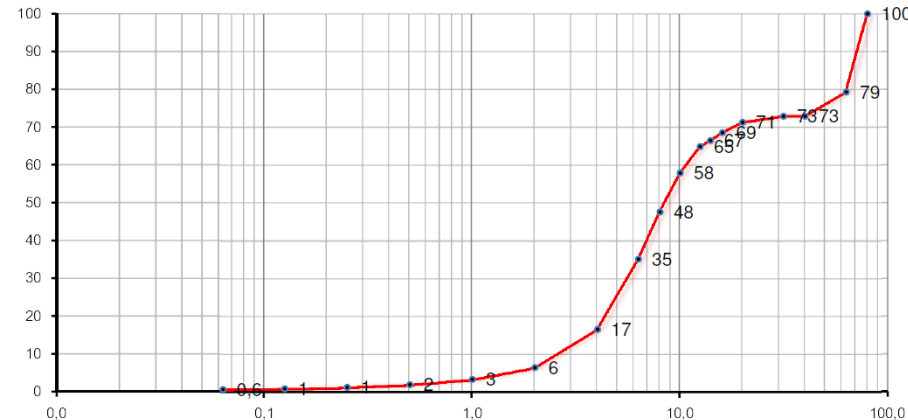
Prove per determinare le caratteristiche geometriche degli aggregati - Parte 1: Determinazione della distribuzione granulometrica - Analisi granulometrica per setacciatura

UNI EN 933-1

		serie	aperture mm	CURVA	Trattenuto cumulativo	Trattenuto parziale
% passante allo staccio	aggregato grosso	ISO 3310-2	80,0	100	0	0
			63,0	79	21	21
			40,0	73	27	6
			31,5	73	27	0
			20,0	71	29	2
			16,0	69	31	3
			14,0	67	34	2
			12,5	65	35	2
			10,0	58	42	7
			8,0	48	52	10
	6,3	35	65	13		
	4,0	17	84	19		
	aggregato fine	ISO 3310-1	2,000	6	94	10
1,000			3	97	3	
0,500			2	98	1	
0,250			1	99	1	
0,125			1	99	0	
filler		0,063	0,6	99,4	0	

granulometria

via umida

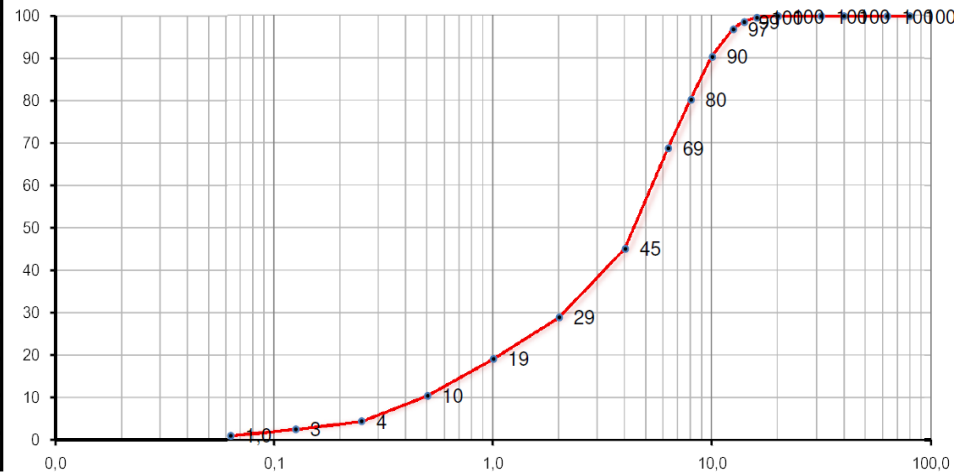


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			63,0	100	0	0
			40,0	100	0	0
			31,5	100	0	0
			20,0	100	0	0
			16,0	100	0	0
			14,0	99	1	1
			12,5	97	3	2
			10,0	90	10	7
			8,0	80	20	10
	6,3	69	31	12		
	4,0	45	55	24		
	aggregato fine	ISO 3310-1	2,000	29	71	16
1,000			19	81	10	
0,500			10	90	9	
0,250			4	96	6	
0,125			3	98	2	
filler		0,063	1,0	99,0	2	

granulometria
via umida



Both RAP Samples:

- Mixed with 4% water for compaction (NO BINDER)
- Gyratory compacted (180 turns)
- Cured for 7 days @ 40 Deg C

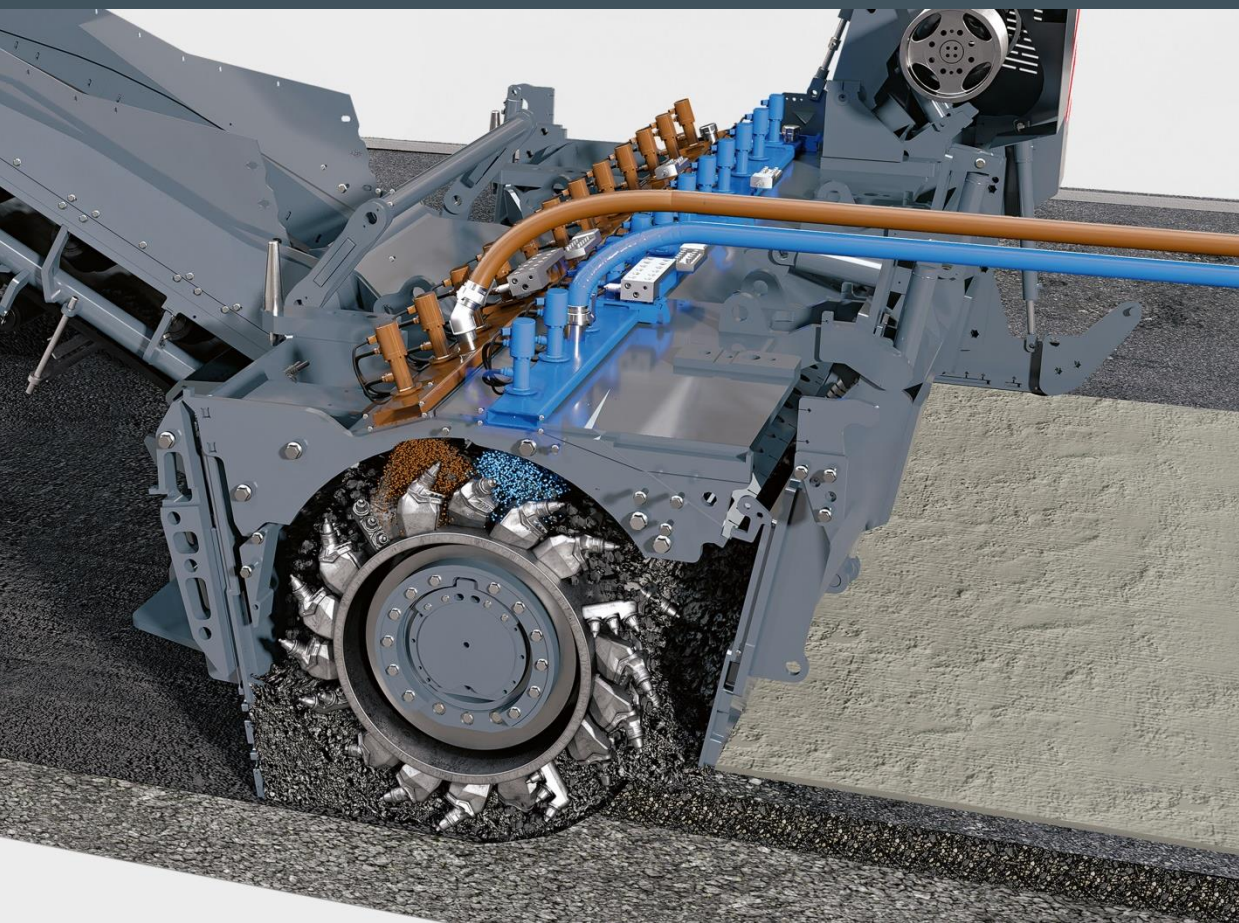
Miscele bituminose - Metodi di prova - Parte 54: Maturazione di provini per prove di miscele con emulsione bituminosa						
UNI EN 12697-54						
Temperatura °C	Umidità relativa %	Tempo di maturazione gg		Nomenclatura della fase di maturazione		
40 ± 2	nc	7		T40HncD7		
Miscele bituminose - Metodi di prova - Parte 23: Determinazione della resistenza a trazione indiretta di provini bituminosi						
UNI EN 12697-23						
Miscela n°	Provino	Diametro stampo mm	Altezza finale mm	Massa volumica Mg/m ³	Carico di rottura a 25°C kN	Trazione indiretta a 25°C kPa
1	1	150	119,9	2,122	6,35	224,8
	2	150	118,9	2,139	6,34	226,3
	3	150	118,7	2,142	6,64	237,3
Media				2,135	6,44	229,5

Miscele bituminose - Metodi di prova - Parte 54: Maturazione di provini per prove di miscele con emulsione bituminosa						
UNI EN 12697-54						
Temperatura °C	Umidità relativa %	Tempo di maturazione gg		Nomenclatura della fase di maturazione		
40 ± 2	nc	7		T40HncD7		
Miscele bituminose - Metodi di prova - Parte 23: Determinazione della resistenza a trazione indiretta di provini bituminosi						
UNI EN 12697-23						
Miscela n°	Provino	Diametro stampo mm	Altezza finale mm	Massa volumica Mg/m ³	Carico di rottura a 25°C kN	Trazione indiretta a 25°C kPa
1	1	150	113,9	2,237	11,82	440,4
	2	150	113,2	2,249	12,09	453,4
	3	150	112,8	2,259	12,09	454,9
Media				2,248	12,00	449,5

ANAS minimum requirement	0,27 Mpa
Standard UP CUT technology average	0,23 Mpa
Recycling DOWN CUT technology average	0,45 Mpa

With DOWNCUT technology an improved uniform homogeneous mix can be achieved

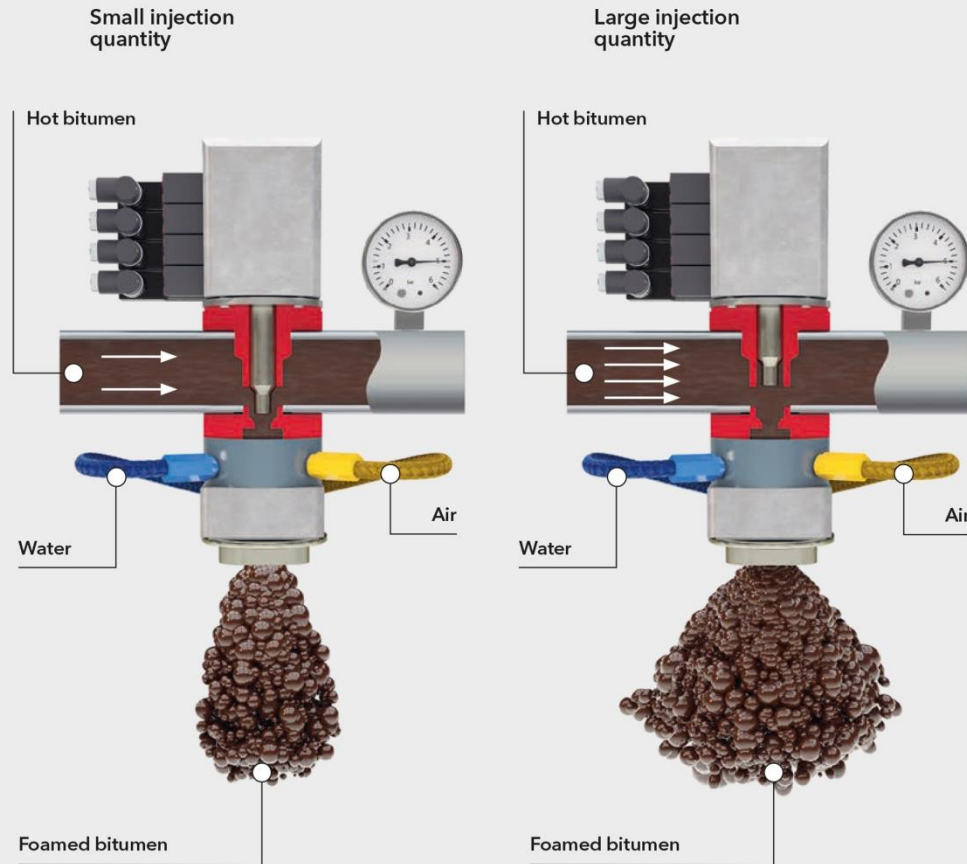
BINDER INJECTION SYSTEM ENSURE UNIFORM DISPERSION



▶ **Integrated injection systems**

High-precision, microcontroller-controlled injection systems can be relied on to precisely govern the addition of water, bitumen emulsion or foamed bitumen.

Two injection bars can be operated simultaneously when adding water and bitumen emulsion.



▶ **Process water monitoring for the production of foamed bitumen**

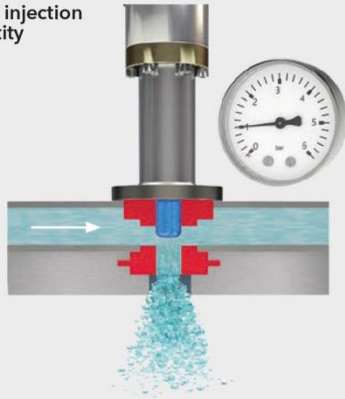
The continuous, unobstructed flow of the amount of process water injected into the expansion chamber during foamed bitumen production is monitored and displayed via the additional process water monitoring feature.

▶ **Automatic self-cleaning and flushing feature**

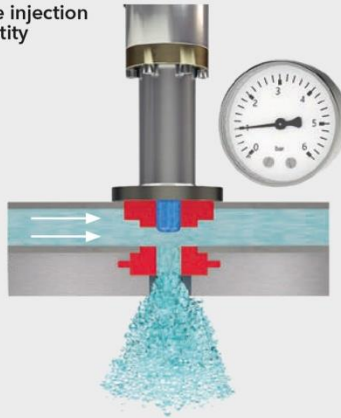
During the recycling operation, any foreign matter is removed from the **VARIO** injection bars by means of time-controlled cleaning (flushing) of the injection nozzles.

High-precision, reliable injection systems

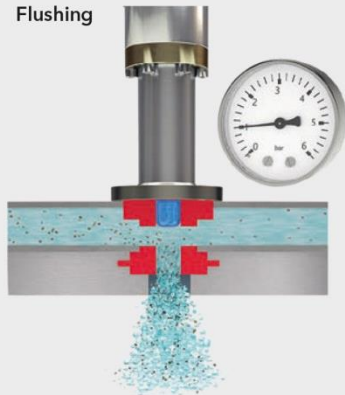
Small injection quantity



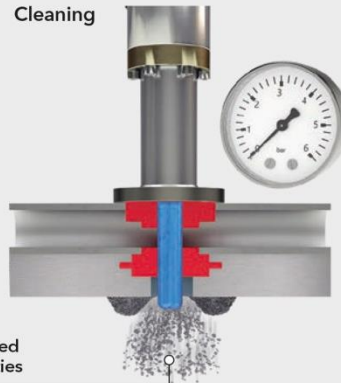
Large injection quantity



Flushing



Cleaning



Removed impurities

- ▶ Operating principle: variable nozzle cross-sections in the injection bar for water or bitumen emulsion.
- ▶ The injection system feeds water into the mixing chamber in a microcontroller-controlled process and in accordance with the mix formulation to achieve the optimum moisture content.

CONTROL SYSTEM HIGH QUALITY UNIFORM MIX



Recycling speed up to 10m/min

Combined mix, premill + W240CRi

325 tonnes/hour

COLD IN PLACE RECYCLING

WHERE IS IT USED

PROJECT EXAMPLES

All Types of Roads Low to High Volume Traffic

Low Volume Traffic Roads France & Slovakia



High Volume Traffic Roads Denmark & UK



EDN: MM 30.08.22

W380 CR(I) CITY APPLICATIONS

Cold in Place Recycling

W380 CR(I) URBAN RECYCLING, CITY SAN JOSE



Urban Cold In Place Recycling – Melbourne Australia



COLD IN PLACE RECYCLING

FOCUS PROJECTS

L902 SPAIN

COLD IN PLACE RECYCLING

Including Lateral pre-Mill



27 04 2022



 **Generalitat de Catalunya**

Rehabilitació del ferm entre Almacelles i la província d'Osca

Promoure el desenvolupament tecnològic, la innovació i una investigació de qualitat

 **Unió Europea**
Fons Europeu de Desenvolupament Regional

Gràcies per la vostra col·laboració



PROJECT OVERVIEW

L902 Project – W240CRi

- 13kms each direction (total 26 lane kms)
- Recycle paving width 3,70m, each lane
- including 2.35m CR + 1.50m pre-mill
- Recycle depth 6cms
- 3.3% Binder Emulsion (No Cement or Lime additive)
- Pavement grade height can be increased to accommodate recycling bulking, no excess material removal from site required
- Fog seal application end each working day
- 3cms HMA finish seal

L902 CIR Project – Existing Pavement Alignment



Generally straight project with some undulation



Extensive alligator cracking





Adjacent traffic lane open during recycling operation, both traffic lanes open end of each working shift

Construction & Finish - > 2kms/day recycled lane



09 05 2022



Fog Seal applied to recycled lane at end of working day,

Agricultural traffic immediately using the recycled lane, applying a fog seal adds some protection until final HMA applied

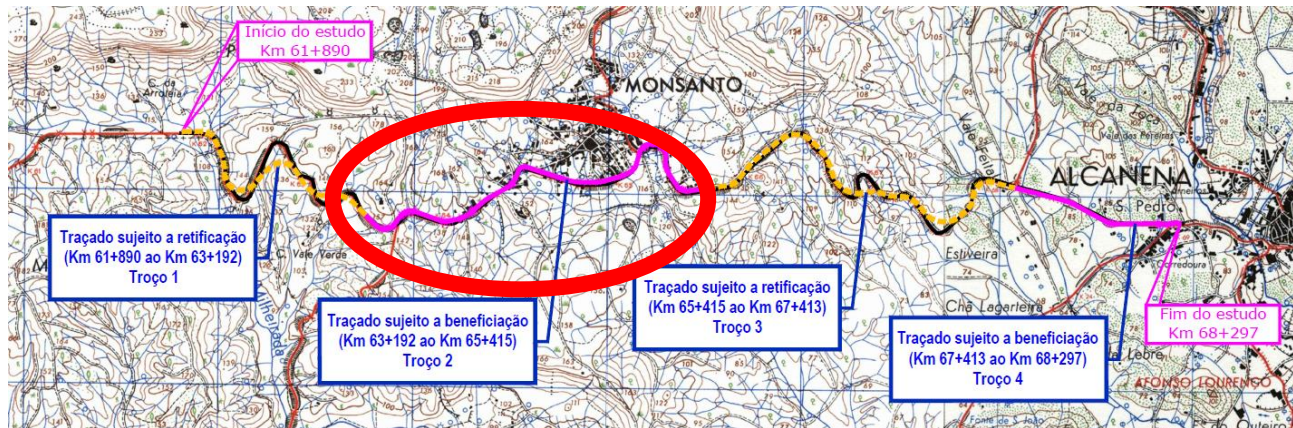
09 05 2022



CIR Lane, fog seal and temporary striping,
prior to HMA final seal

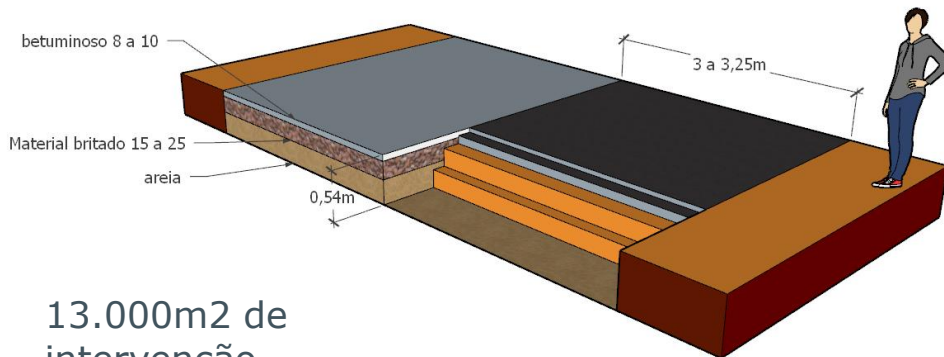
PORTUGAL ER361 RECONSTRUCTION PLAN

Considerar para intervenção da tecnologia de reciclagem a frio o troço 2 do PK 63+192 ao 65+415



Extensão de 2.223m

ER 361 – AMIAIS DE CIMA (KM 61+890)/ALCANENA (KM 68+910)
REQUALIFICAÇÃO



13.000m² de
intervenção

7.500m³ de materiais a vazadouro

900 m³ de misturas betuminosas – Remove 900m³ Asphalt & haul off site

3.500 m³ de materiais britados – Remove 3,500m³ Aggregate Base & haul off site

2.900 m³ de areias – Remove 2,900m³ of base and haul off site

Approx 730 truck trips @ 20 tonne/truck out + same imported materials

Import New Materials & Reconstruct Section – Estimated 12 weeks Program

COLD IN PLACE RECYCLING CONCEPT

ER361 Amiais de Cima Pragosa CIR Concept Proposal – Recycle depth 16cms

- **Project:**
ER 361, Amiais de Cima in the Monsanto Region
- **Scope:**
2.23 kms, 2 lane pavement
- **Existing pavement:**
8-10 cms asphalt,
15-25 cms material britado
(crushed aggregate)
- **Existing lane width:**
varies 2.75 m – 3.25 m
- **Traffic:**
T5 Category, up to 262 trucks
per day





W380CR

MCS System

Recycling width 3.2m

Rearload to Vogele Paver

21 07 2020



Recycling speed 5m/min

@16cms depth

320 tonnes/hour

21 07 2020





Compaction:

Hamm HD110i

Hamm GRW18

Hamm GRW18

**** Added Moisture**

23.07.2020





Recycling through the town of Monsanto



Minimum disruption to local business, Fork Lift crossing Recycled Lane after 30mins, NO damage

COLD IN PLACE RECYCLING

POST CONSTRUCTION

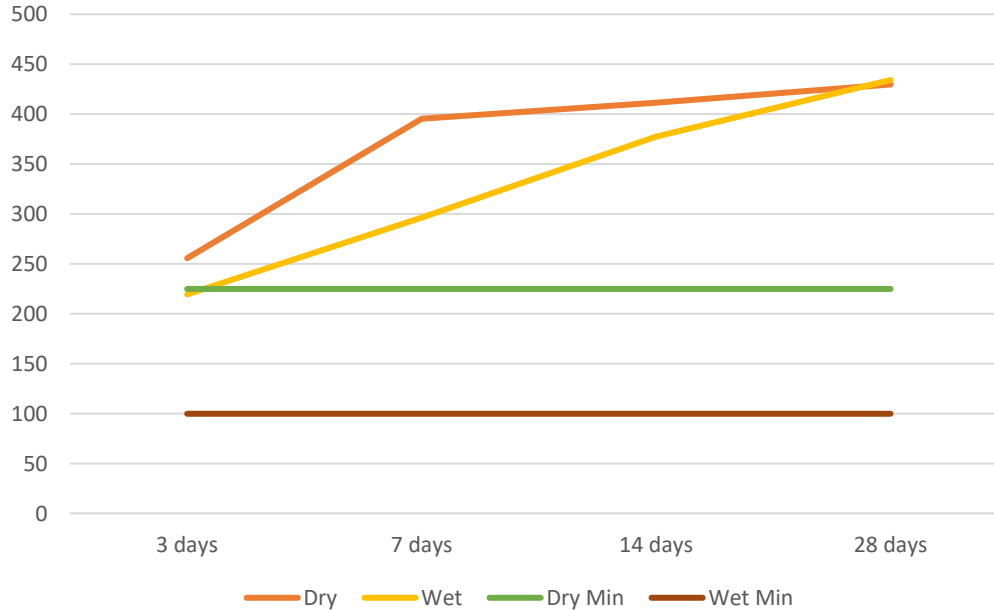
Original Reconstruction Plan for ER361 – 12 weeks

Cold In Place Recycling Option Completed in 4 days

Average 1.25kms x 3.2m width completed each day

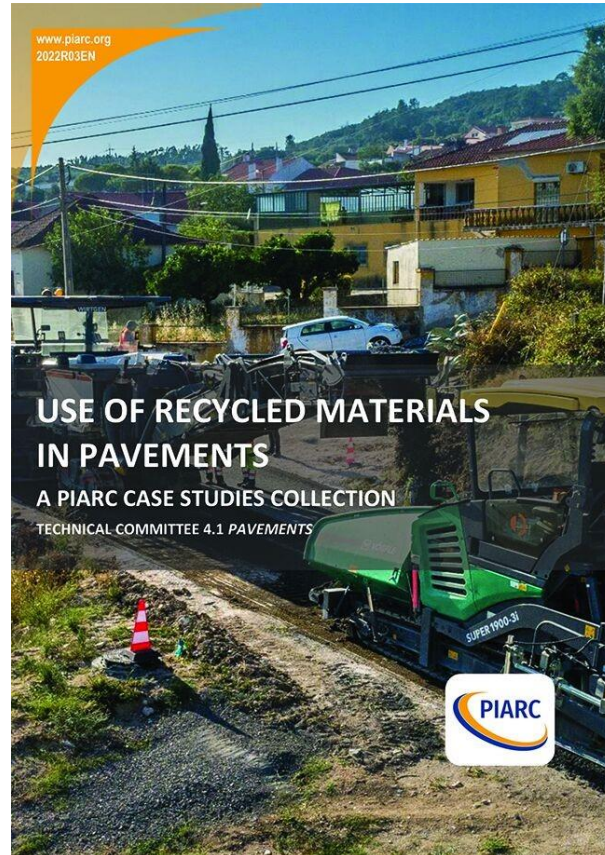
Post Construction ITS Values

	3 days	7 days	14 days	28 days
Dry	256	395	411	430
Wet	220	296	377	434



EMMISSION REDUCTION EXAMPLE

PORTUGAL / PIARC



PIARC Use of Recycled Materials in Pavements

CO2e (ton) equivalent emission comparison								
					Ton kgCO2e/ton	TonCO2e		
CO2 (ton) emission	inicial design solution						646,38	100%
	Materials							
		Asphalt concrete mix			787,50	255,00	200,81	
		Coarse Aggregates			17988,27	1,07	19,25	
	Materials transport (diesel)					37,55	2700,00	101,39
	Execution site operations (diesel)					188,00	2700,00	203,04
	Civil construction waste - load & transport to authorised reception point (diesel)							
		Asphalt concrete mix			0,99	2700,00	2,68	
		Coarse aggregates			44,15	2700,00	119,21	
CO2(ton) - emission recycling deisgn solution							81,17	13%
	Materials							
		Asphalt concrete mix (top layer)			281,25	255,00	71,72	
		bitumen (recycling process)			62,40	3,15	0,20	
		lime (recycling process)			132,00	0,80	0,11	
	Material transport (diesel)					0,39	2700,00	1,05
	Execution site operations (diesel)					3,00	2700,00	8,10
	Civil construction waste - load & transport to authorised reception point (diesel)					0,00	0,00	0,00

EDN: MM 30.08.22

W380 CR(I) HIGHWAY APPLICATION N. AMERICA

Cold in Place Recycling



W 380 CRI

Highway 123, Pickens County, South Carolina, USA

- ▶ 4-lane-highway
 - width of each lane: 3.65 m
- ▶ In-situ 20 cm hot mix asphalt / 12 cm aggregate base
- ▶ Average daily traffic:
20,000 vehicles with 15% trucks



- ▶ W 380 CRi: Recycling of 20 cm thick asphalt layer



- 2.3% foamed bitumen
- 2.5% foam water
- 3.0% compaction water

- 20 cm recycling depth
- 1.6% slope



Project Start Date:

22nd July

**Project Completion Date
inc HMA Paving:**

05th September

34 working days – Average
1.47 kms/day Production

COLD IN PLACE RECYCLING W240CRI ITALFRESE A55 TORINO



- 25cms of existing milled off traffic lane and removed from site
- CIR 10cms remaining ***asphalt/base combination***
- Mix design
 - 3.0% emulsion
 - 1.0% cement



- Working speed 7m/min, approx. 420 t/hr
- Emulsion 3.0%
- Compaction water 1.0% to 1.5%
- Depth 10cms
- Paving width 4.4/4.3m

A55 Torino CIR W240CRI



A55 Torino CIR W240CRI (NO Truck traffic in/out)



A55 Torino CIR W240CRI (free flowing traffic)





- 100% use of existing pavement materials
- No trucks in/out of site
- No disruption to traffic in adjacent travel lanes
- Fast process up to 7m/min working
- Over 400 t/hr of recycled material that would have gone to waste

27 07 2022

A55 Torino CIR Hamm HD+120i



A55 Torino CIR W240CRI

 WIRTGEN



A55 Torino CIR W240CRI



A55 Torino CIR Mobile Lab with Gyrotory Compactor



A55 Torino CIR W240CRI, 150mm sample made on site



Average ITS Value:
331.9 kPa

**A55 Torino CIR W240CRI (*USA with greater experience*
20cms asphalt recycling)**

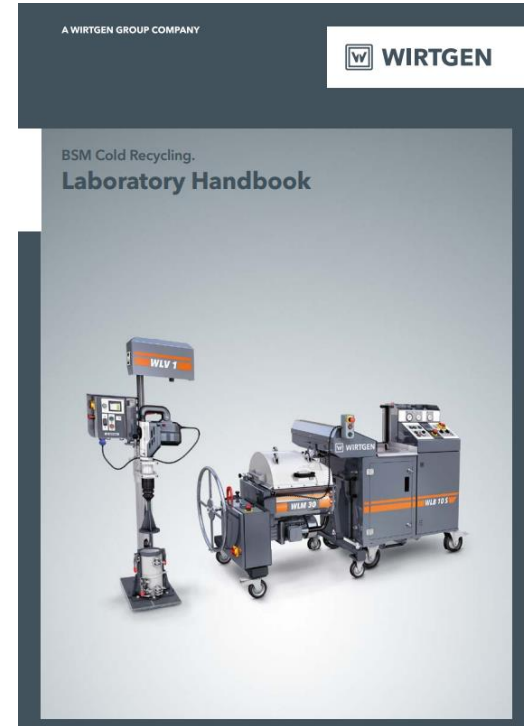


COLD IN PLACE RECYCLING

SUMMARY

Recycle pavements

- ▶ Save Money or make maximum use of tight budget YES
 - ▶ Past conventional overlay YES
 - ▶ Long life YES
 - ▶ Fast process Saved 11 weeks
 - ▶ Minimum disruption business / residences YES
 - ▶ Accommodate traffic YES
 - ▶ Can be re-recycled YES
 - ▶ Green factor 87% CO2 Reduction **
- ▶ ** See PIARC Report



Thank you for your attention