

# THE INTRODUCTION OF CIPR

by : Ir Pok Sum Loong




CLOSE TO OUR CUSTOMERS



## **Topics**

---

- Introduction – road base in road construction
- Production and construction of bound road base layer (in plant method)
- Production and construction of bound road base layer (in place method)
- Working process from A to Z
- How do we made the construction possible?
- Track records

<b>Glossary</b>	<b>Description</b>	<b>Picture</b>
Asphalt (premix or hot mix asphalt)	Mixture of aggregate, bitumen and other additive produce from hot asphalt plant for pavement / road construction	
Bitumen	Dark brown to black cementitious materials from distillation of crude oil in the refinery process.	
RAP or Milling waste	Reclaimed Asphalt Pavement (RAP) is the used or aged asphalt recovered from road via milling or excavate processes.	



**Mobius  
logo**

The universal recycling symbol is an internationally recognized symbol used to designate recyclable materials. It is composed of three mutually chasing arrows that form a Mobius Strip (an unending single-sided looped surface).

In 1969 and early 1970, worldwide attention to environmental issues culminated in the first Earth Day. Subsequent to that, the recycling symbol was designed by a 23-year-old student from the University of Southern California.

This recycle image now known as the universal recycling symbol is widely used to represent the Reuse, Recycle and Reduce (3R) concept. This 3R concept is now widely applied in road construction industry especially with regard to the pavement maintenance purpose.

# Reuse, Recycle and Reduce (3R) of Asphalt in Road construction



## Reuse

**Reuse**, to reuse a material more than one time in a same function and purpose, typical example is reused of RAP in the hot mix asphalt.

*Example :*

*Hot in-plant asphalt re-use  
(HIPR -in plant) :*  
- RAP into fresh ACWC / ACBC.

*Hot in-situ asphalt re-use  
(HIPR - in situ):*  
- RAP into fresh ACWC.



## Recycle

**Recycle**, breaking down of the used item into raw materials which are used to make new items. Typically example is recycle of RAP into road base material.

*Example :*

*Cold in-plant asphalt re-use  
(CIPR -in plant) :*  
- RAP into Bound Road Base.

*Cold in-situ asphalt re-use  
(CIPR - in situ):*  
- RAP into Bound Road Base.



## Reduce

**Reduce**, the first and most effective component of the waste hierarchy is reducing the waste. Reduce is to use less and this means fewer resources are expended in making and disposing of the item.

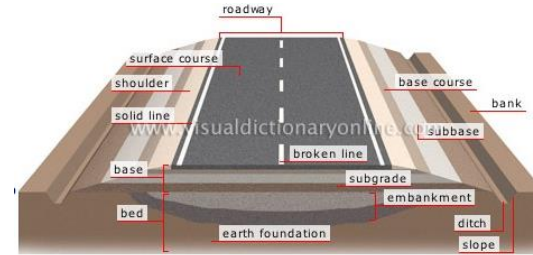
*Example :*

*Very Thin Overlay (VTO) of asphalt  
i.e. laying thinner asphalt with higher quality of materials*

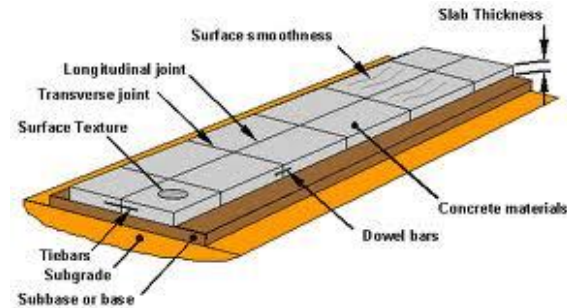
# New road construction

## Road base in various type of pavements

Flexible pavements  
(unbound base)



Rigid pavements  
(bound or unbound base)



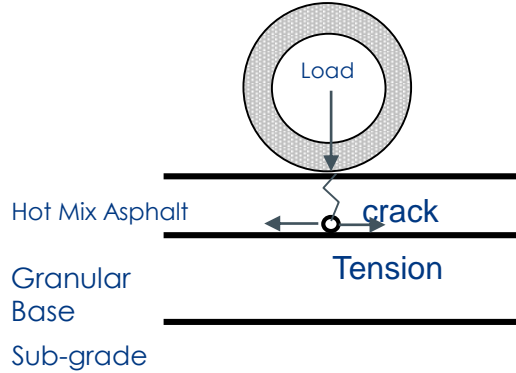
Composite pavements  
(bound base)



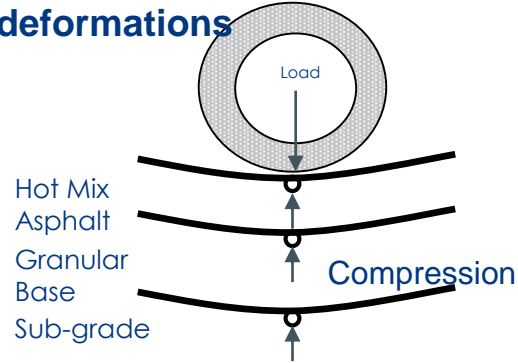
# Road rehabilitation

When do we select bound road base ?

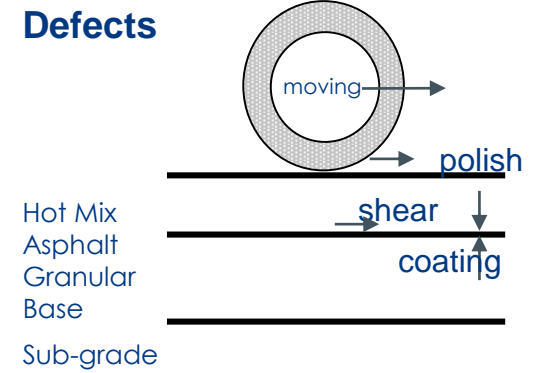
## Cross section view for cracks



## Cross section view for deformations



## Cross section view for Surface Defects



# Typical construction materials for flexible pavement



<b>HMA 1st layer and 2nd layer</b>  <b>Wearing course layer and Binder course layer</b>	<b>Dense graded</b> <ul style="list-style-type: none"> <li>Asphaltic concrete</li> <li>Coated Macadam</li> <li>Hot rolled asphalt</li> </ul>	<b>Gap graded</b> <ul style="list-style-type: none"> <li>SMA</li> <li>Thin surfacing</li> </ul>	<b>Open graded</b> <ul style="list-style-type: none"> <li>Porous asphalt</li> </ul>
	<b>Road base layer</b>	<b>Unbound road base</b> <ul style="list-style-type: none"> <li>Crushed aggregate (crusher run)</li> <li>Uncrushed stone</li> <li>Wet mix macadam</li> </ul>	<b>Bound road base</b> <ul style="list-style-type: none"> <li>Cement treated base (CTB)</li> <li>Bituminous stabilized material (BSM).</li> </ul>
<b>Sub base layer</b>	<b>Unbound sub base</b> <ul style="list-style-type: none"> <li>Crushed aggregate (crusher run)</li> <li>Sand</li> </ul>		
<b>Subgrade (soil)</b>	<b>Soil stabilization</b>		





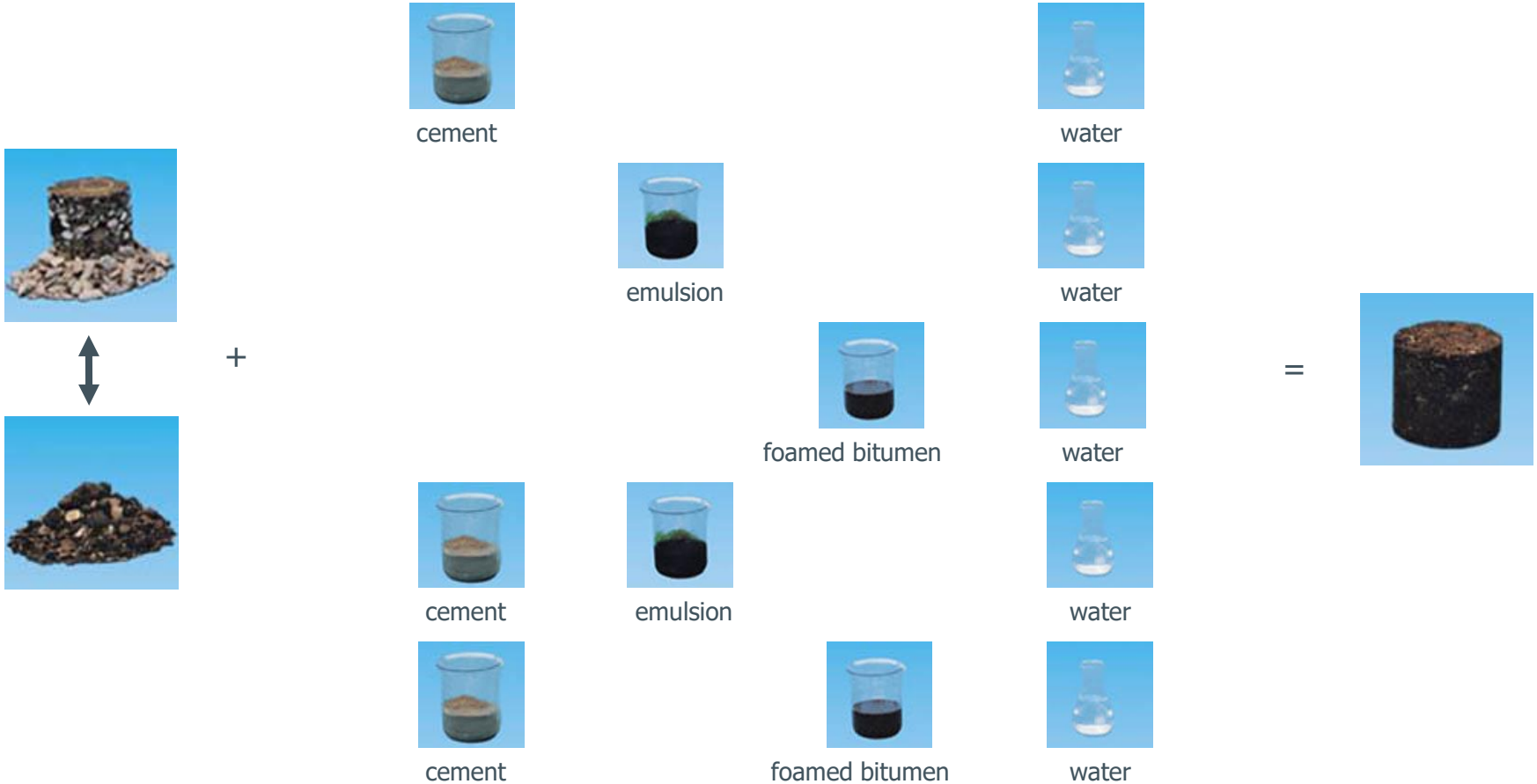
The road base and sub base are the main structural element in the pavement. Its function is to distribute the imposed loading so that the underlying materials are not overstressed.

It must resist permanent deformation and cracking caused by fatigue through repeated loading. It must also be capable of withstanding stresses induced by temperature gradients through the structure.

For light traffic =  
an unbound granular base materials may be perfectly adequate. Materials such as sand and crushed rock are commonly used.

For heavy traffic =  
Bound granular base materials added with imported bonding agents such as cement, bitumen, emulsion and chemical addition will increase the strength of material.

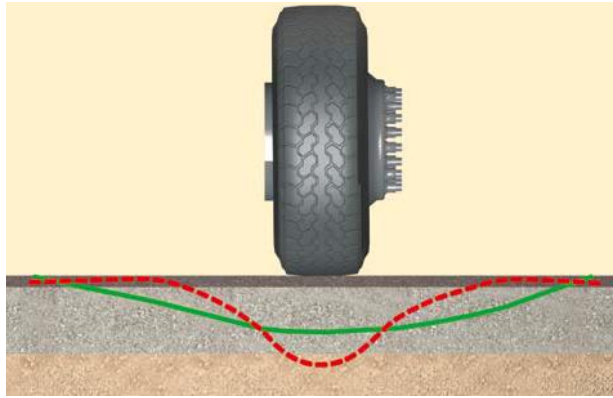
# Choices of material selection in the road base construction




Typical cement application rates (percent by mass)		
Material type \ Target UCS value	< 4 MPa	Up to 10 MPa
RAP/crushed stone (50/50 blend)	2.0 to 3.0	3.5 to 5.0
Graded crushed stone	2.0 to 2.5	3.0 to 4.5
Natural gravel (PI < 10, CBR >30)	2.5 to 4.0	4.0 to 6.0


Resilient Moduli ranges for BSMs after curing		
Material type	Bitumen Content of BSM (%)	Resilient Modulus MR(MPa)
100% RAP	1.6 to 2.0	1,000 to 2,500
RAP/crushed stone (50:50 blend)	2.0 to 2.5	800 to 2,000
Graded crushed stone	2.0 to 3.0	600 to 1,500
Natural gravel (PI < 10, CBR>45)	2.0 to 3.5	400 to 800
Natural gravel (PI < 10, CBR>25)	2.5 to 4.0	300 to 600
Non-plastic sands	3.0 to 5.0	200 to 500

# Purpose of bound road base as pavement material



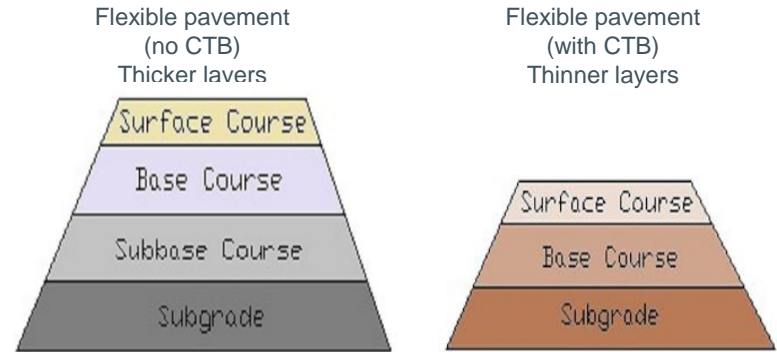
Note :

 Load deflection line for pavement with unbound road base

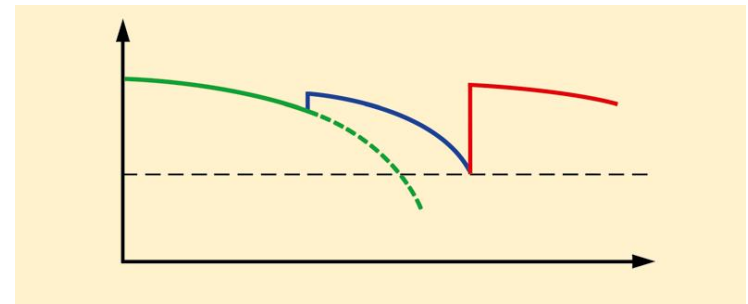
 Load deflection line for pavement with bound road base

Advantage of using bound road base

Overall thinner pavement structure if used bound road base material



Longer service life if used bound road base material



# Production and construction of bound road base in Malaysia

Bound road base mixture can be produce in plant and as well as in situ (on site) by adding cement, foam bitumen, emulsion, water and other mineral materials depend to the recommendation in the mix design.



Option of materials :

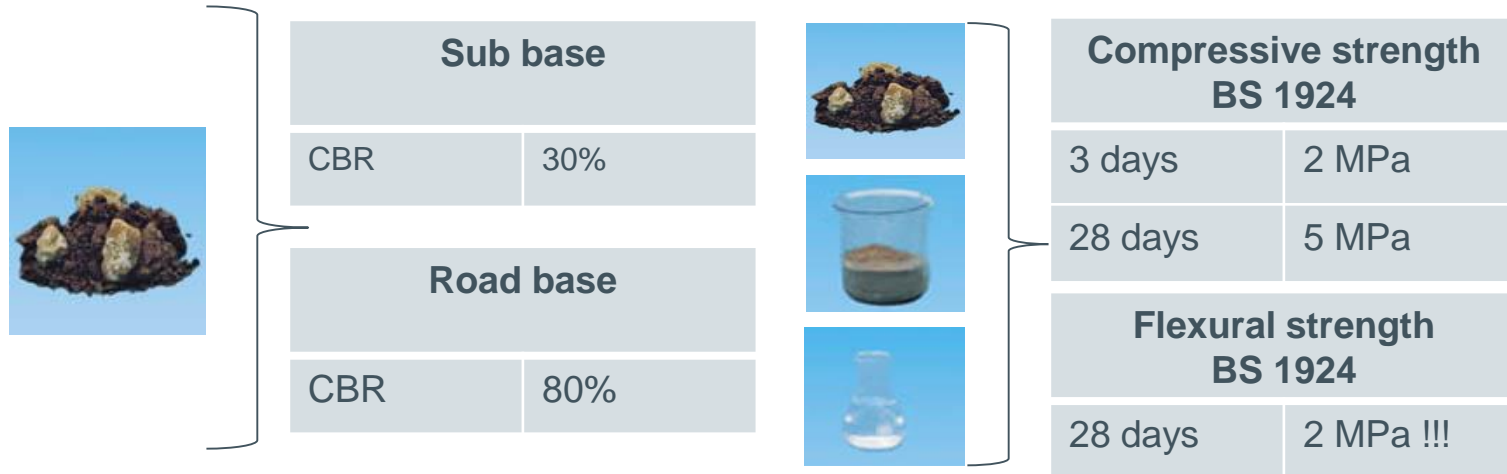
- 1) 100% fresh crushed aggregate or
- 2) Recycle materials or
- 3) Combination of 1 and 2.

Production and construction of  
bound road base layer  
(in-plant method)  
(for new material or recycle)

# The most commonly use in plant bound road base material in Malaysia, Cement Treated Base (CTB)

Cement-Treated Base (CTB) is the most commonly used bound road base material in Malaysia.

CTB is an intimate mixture of aggregate material and/or granular soils combined with measured amounts of Portland cement and water that hardens after compaction and curing to form a durable paving material. A bituminous or Portland cement concrete wearing course is placed on the CTB to complete the pavement structure. CTB is widely used as a pavement base for highways, roads, streets, parking areas, airports, and materials handling and storage areas.



# The production of CTB (in plant) by Wirtgen KMA 220



- 1** Powerful diesel engine
- 2** Large water tank
- 3** Large, twin-chamber proportioning hopper
- 4** High-precision injection systems
- 5** Quick setup procedure
- 6** Slewing conveyor
- 7** Auger conveyor including weighing unit
- 8** Hopper take-off conveyor including material weighing
- 9** High mixing performance
- 10** Ease of transport



# The laying of CTB

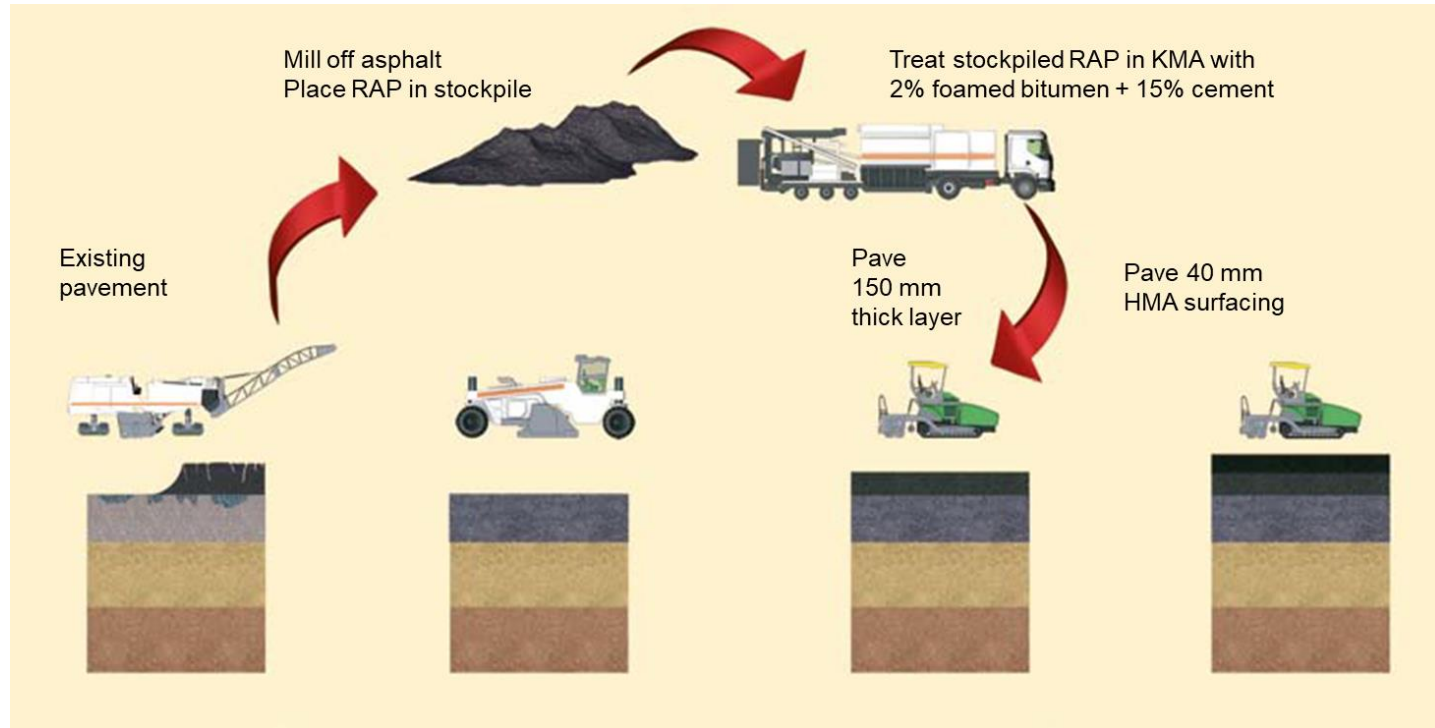


# The curing of CTB and the final product



# Other type of in plant bound road base

Foam bitumen or bitumen emulsion as additive  
Cold in plant recycling (CIPR-plant)



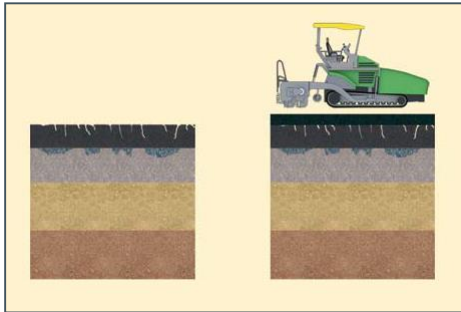
---

Production and construction of  
bound road base layer  
(in-place method)  
(fresh or recycle)

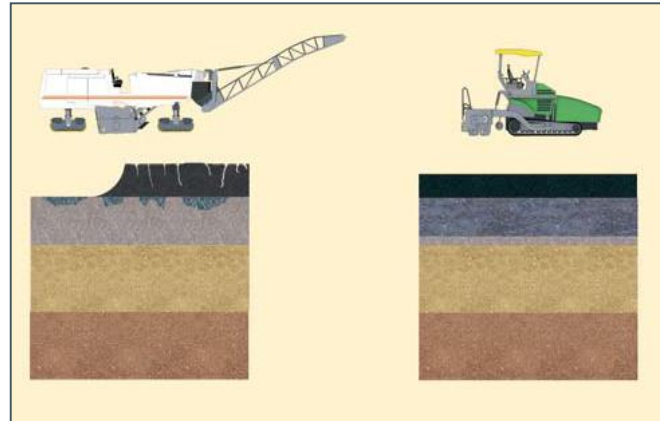
Surface rehabilitation measures address problems that are confined to the upper part of the pavement, usually within the top 50 mm to 100 mm. These problems are normally related to aging of bitumen and cracking that initiates at the surface due to thermal forces.

The most commonly used methods for dealing with this type of problem include:

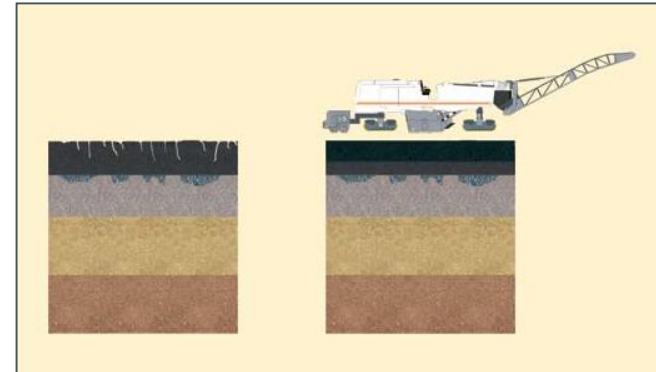
Asphalt overlay



Mill & Replace



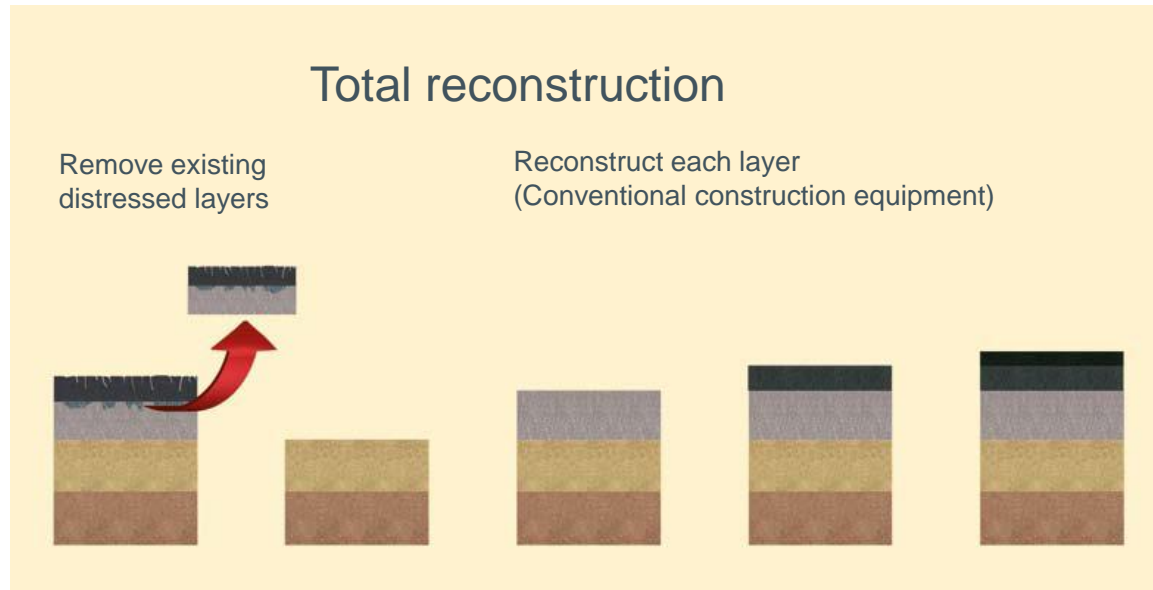
Recycle upper 200 mm



Many roads found having high severity defects required total reconstruction.

In many cases the repairs involved removal of surface courses and also the entire road base materials.

The cost to perform the total repair are significant and Cold In Place Recycle (CIPR-place) is the most famous option.



# The most commonly use in situ bound road base concept in Malaysia

## Cold in place pavement recycler (CIPR-inplace)

CIPR-place is the most famous method in road maintenance in Malaysia due to due to:

1. Repair cost are relatively lower compare to conventional method via saving from transporting material in and out of work site.
2. Reuse the existing material which is still in good condition.
3. Cement and bitumen as additive is commonly selection to improve structural strength and pro long pavement's life.
4. Cement and bitumen is easily available.
5. Longer working window.
6. Fast open to traffic.

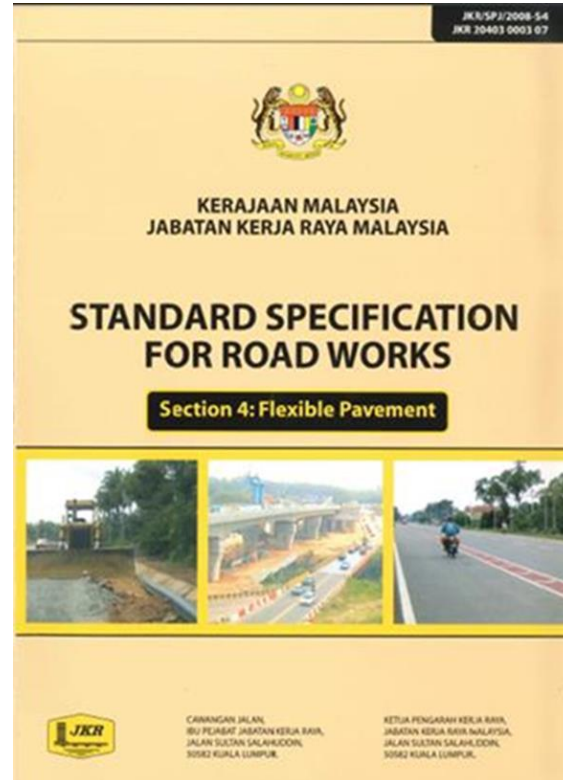
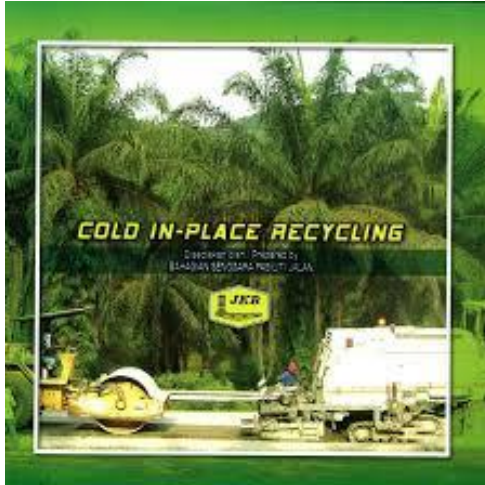
Recycle 250 mm deep

Add 2.5% foamed bitumen +1% cement  
or  
3%-5% cement

Existing  
pavement

Pave  
HMA surfacing





JKR/SPJ/2008-S4

#### 4.10 SPECIALTY MIX 5 - COLD IN-PLACE RECYCLING

4.10.1 Description	S4-90
4.10.2 Materials	S4-90
4.10.3 Mix design	S4-92
4.10.4 Equipment	S4-97
4.10.5 Construction Method	S4-99

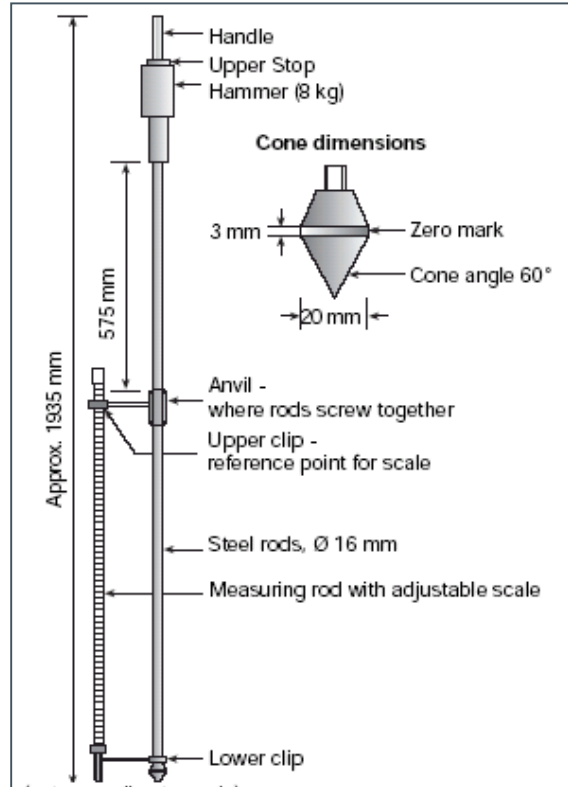


# Working process from A to Z

## Core extraction (bound layers)



# Perform DCP survey to evaluate existing material



Site pits if necessary



# FOAMED BITUMEN MIX DESIGNS

## Wirtgen WLB10







# Field tests





---

How do we make the construction  
possible ?

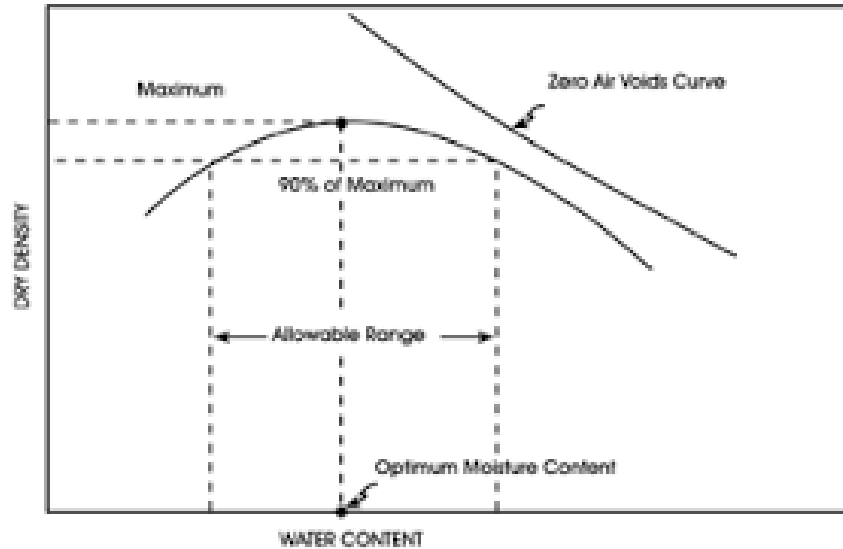
## Machine programm



# Accurate cement spreader



**Back to basic, the compaction is extremely important**



#### 4.10.5.3 Compaction

##### (a) *Initial Compaction*

The recycled layer shall be initially compacted immediately, or as soon as any deficiencies are made good in accordance with Sub-Section 4.10.5 above. Initial compaction shall be undertaken by a smooth-drum or pad foot vibrating roller, operating on high-amplitude vibration. The static mass of the roller shall be selected in accordance with Table 4.10.7.

**TABLE 4.10.7: MINIMUM STATIC ROLLER MASS**

Thickness of compacted layer	Minimum static mass of roller (tonne)
< 150mm	12
150mm to 200mm	15
200mm to 250mm	19
> 250mm	24

*Note:* The operating speed of the primary roller shall never exceed 3km/hr and rolling shall be applied over the full width of each cut.

# Choose wisely the compactor



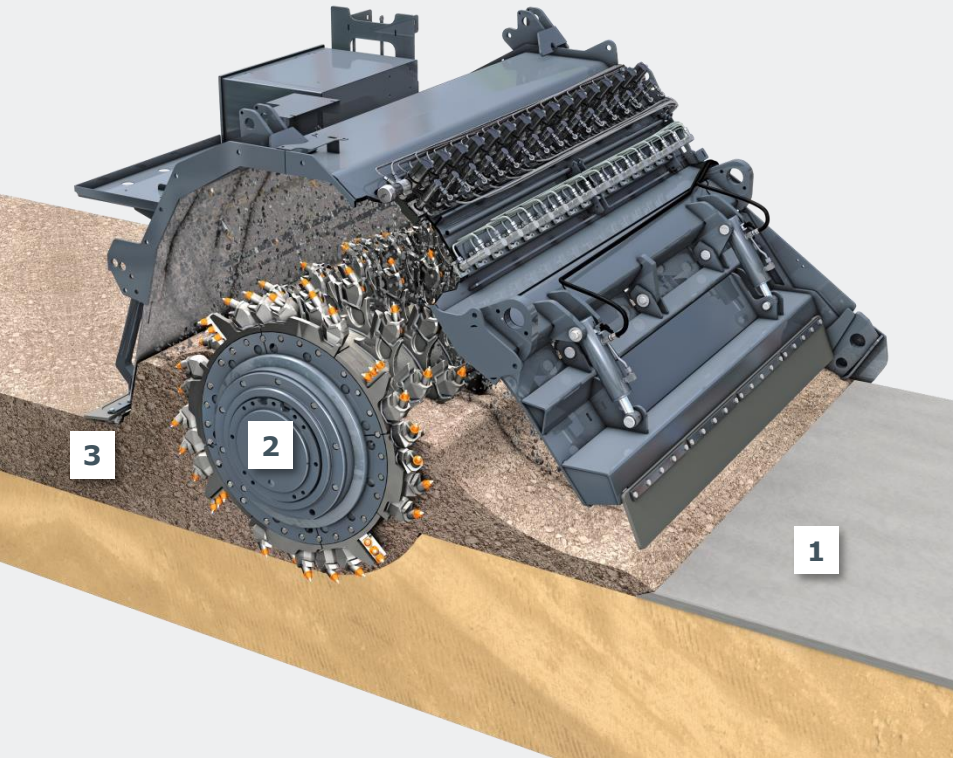
20mt compactor is crucial to provide deep penetration for full thickness compaction



15mt PTR is an option when kneading effect is required to provide good surface especially with foam bitumen CIPR



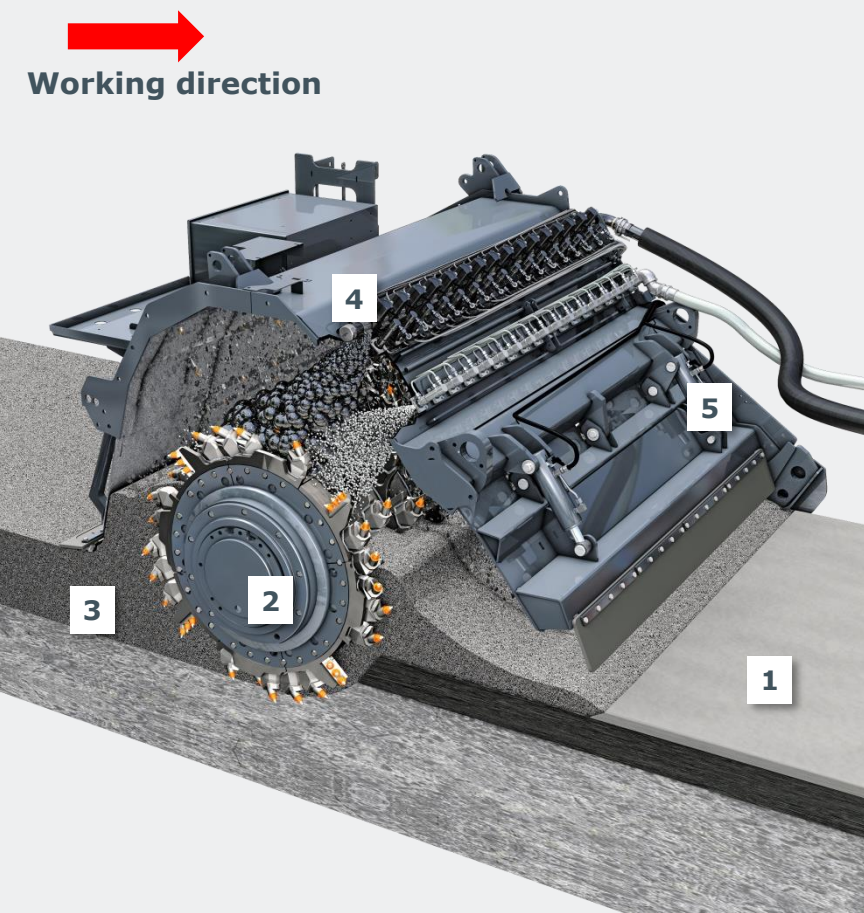
Working direction



## Soil stabilization

The milling and mixing rotor mixes the existing soil, any required amounts of pre-spread lime or cement and water to produce a homogeneous soil-binder mixture

- 1** Pre-spread binder
- 2** Milling and mixing rotor
- 3** Stabilized, homogeneous soil-binder mixture



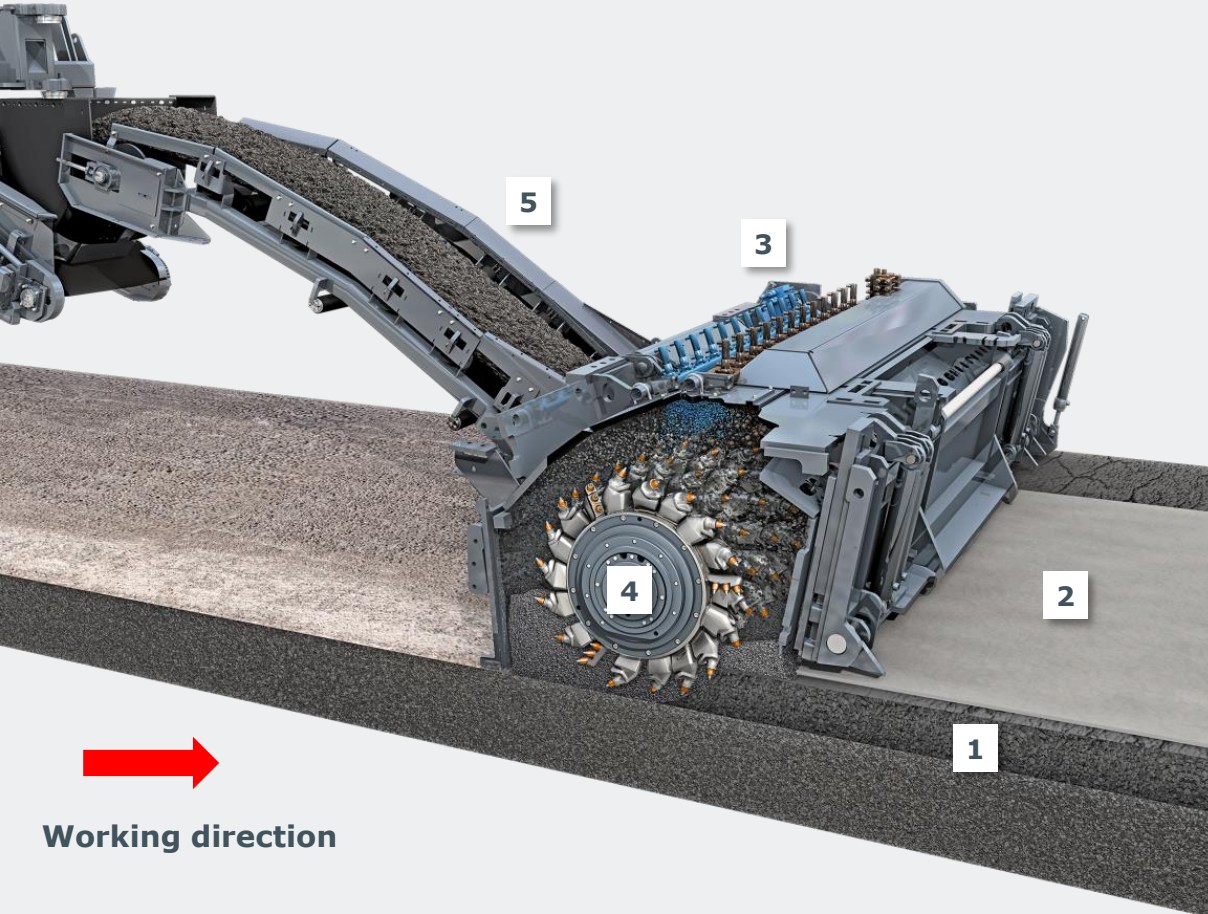
## Cold recycling

The milling and mixing rotor mills and granulates the asphalt layers. Binders and water are added via injection bars and mixed in to produce a homogeneous recycled material

- 1** Pre-spread cement
- 2** Injected water
- 3** Injected foamed bitumen
- 4** Milling and mixing rotor
- 5** Recycled, homogeneous construction material

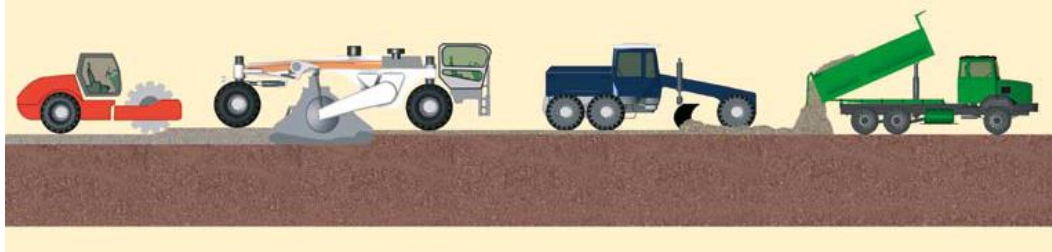


# Operating principle of the 3800 CR "Rear Load"



- 1** Damaged asphalt layer
- 2** Pre-spread cement
- 3** Injection bars for water and binders
- 4** Milling and mixing rotor
- 5** Conveyor for transfer of material to asphalt paver

# Standard traditional construction processes



CIPR Cement bonding



CIPR Cement slurry and bitumen emulsion



CIPR Cement and foam bitumen bonding

# New full width construction processes

**A** Example of application using the W 240 CR / W 240 CRi  
Recycling with integrated paving screed



**B** Example of application using the W 380 CR / W 380 CRi  
Recycling with loading conveyor and paver



**C** Example of application using the W 240 CR / W 240 CRi / W 380 CR / W 380 CRi  
Lateral premilling and recycling with loading conveyor and paver



**D** Example of application using the W 240 CR / W 240 CRi / W 380 CR / W 380 CRi  
Cold milling with discharge conveyor and truck



# Track records



Track record 1 :  
CIPR with OPC.



Track record 2 :  
CIPR with OPC by S pack.

Track record 3 :  
Spreading cement.



Track record 4 :  
Foam bitumen.

# Laying of Asphalt



# Other applications





**Construction of a dam  
for reliable  
flood protection**

Soil stabilization at peat area



**High productivity -  
even in cramped conditions**

Soil stabilization at factory  
foundation



**Highest mix quality  
for the subgrade  
of high - speed traffic routes**

Soil stabilization at subgrade  
level for highway



**Coarse rock  
is powerfully crushed**

Crush hard shale

**Thank you very much for your attention!**