COLD RECYCLING OF PAVEMENTS

CHALLENGE IS NOT TO CONSTRUCT FAST, CHALLENGE IS TO CONSTRUCT SUSTAINABILY

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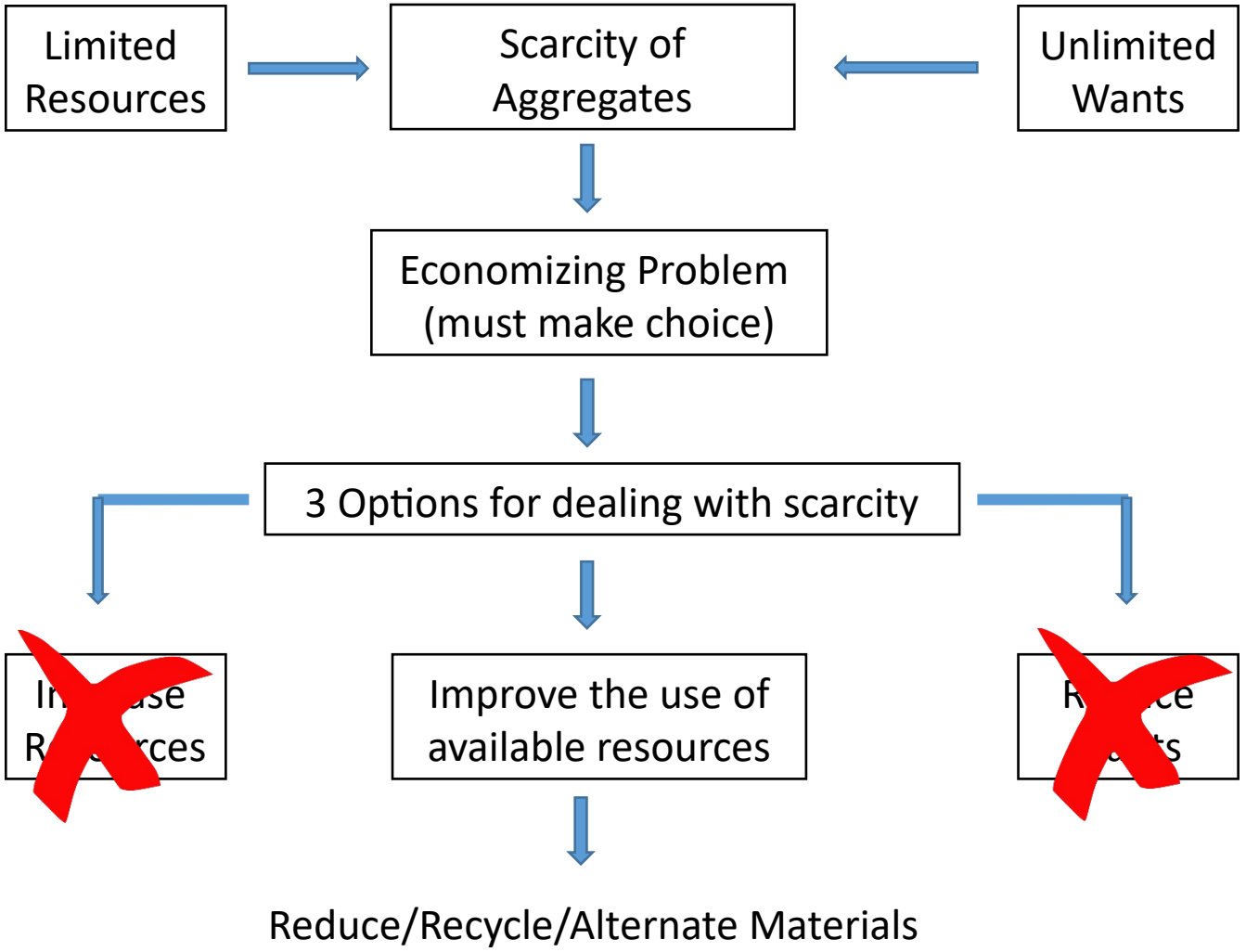
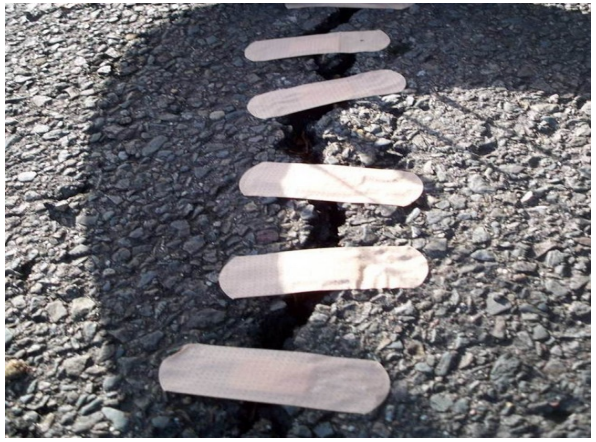
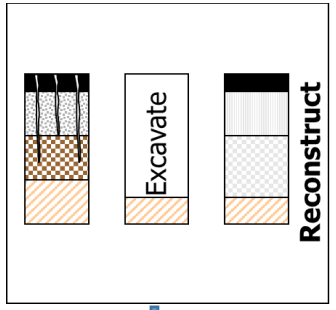
We're Depleting Natural Resources Twice As Fast As Nature Can Recover

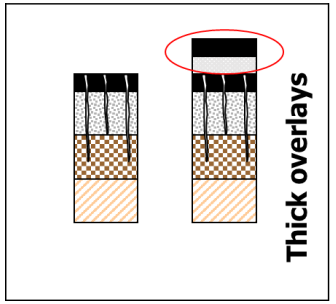


Pavement Recycling

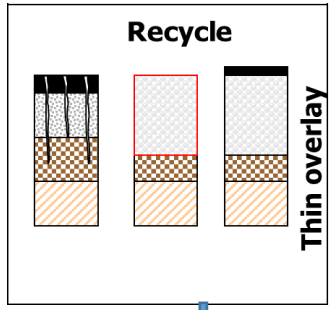




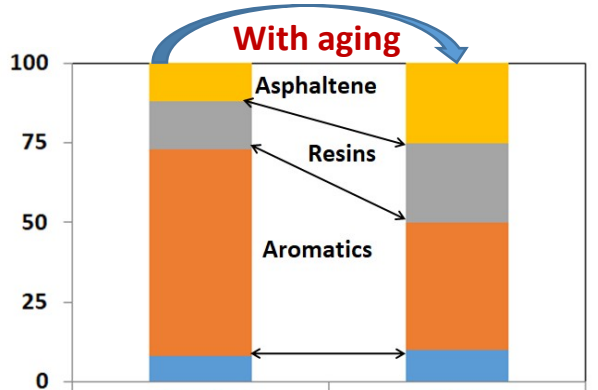
- Energy exhaustive
- Expensive
- Long construction time
- Wastage of materials & time



- Simple & quick method
- Pavement thickness problems
- Reflection cracks



- Effective & Quick
- Saves natural resources
- Environmentally friendly
- Reduces carbon intensity



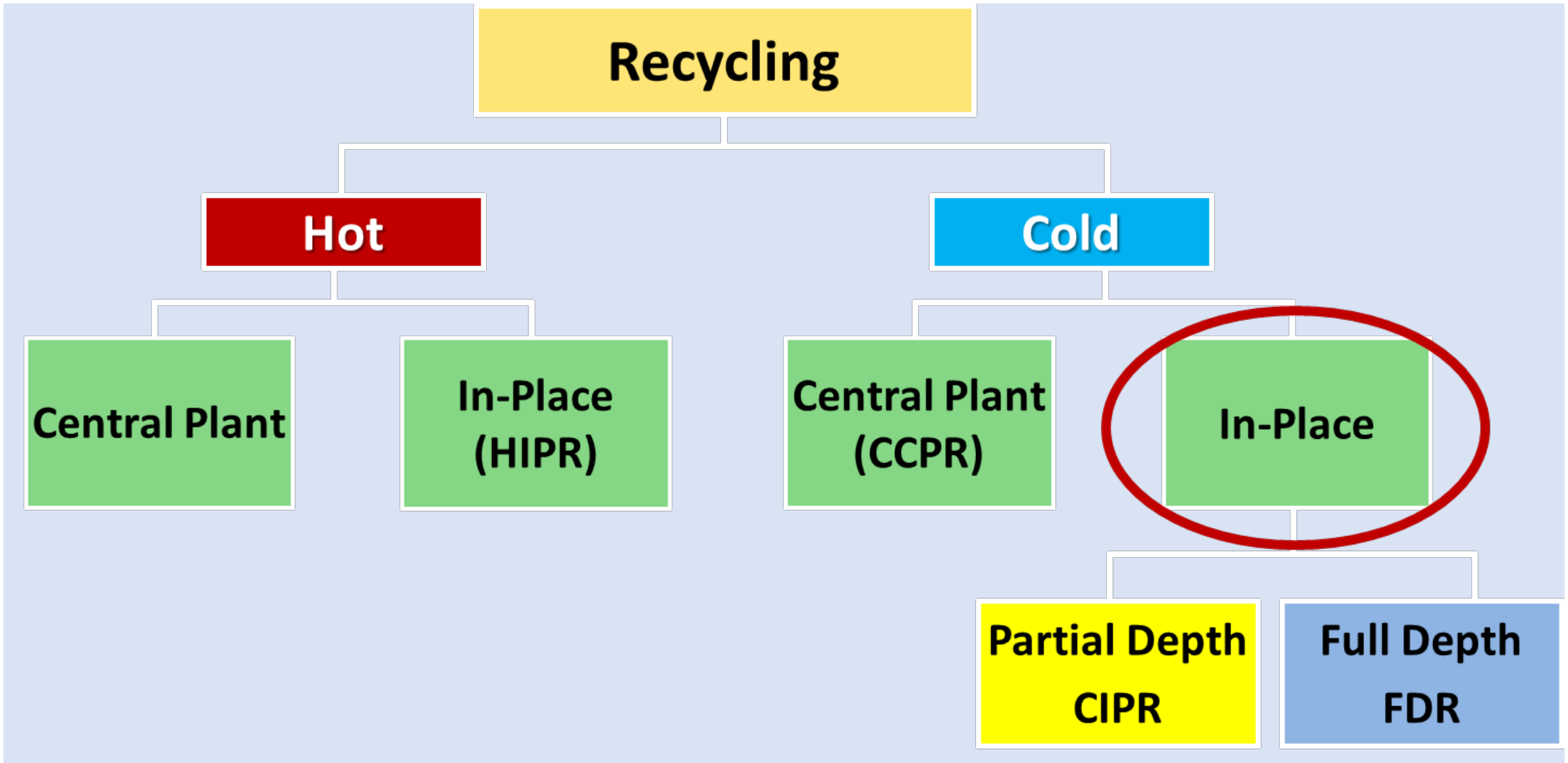
	Bitumen	RAP
Asphaltene	12	25
Resins	15	25
Aromatics	65	40
Saturates	8	10

Existing Composition

damaged

Recommended

- ✓ Significant structural improvements can be obtained with little or no change in thickness.
- ✓ Surface and base distortion problems can be corrected.
- ✓ Existing mix deficiencies can be corrected.
- ✓ Material Savings.
- ✓ Time Saving


Recycling
Hot
Cold
Central Plant
In-Place (HIPR)
Central Plant (CCPR)
In-Place
Partial Depth CIPR
Full Depth FDR

Pavement Rehabilitation Selection

Understanding the Problem

- Pavement assessment is the first step in making good decisions.
- The condition of the existing pavement is assessed through:

–Pavement History

–Pavement Condition/Distress Survey

–Pavement Strength Evaluation

–Surface, Base and Subgrade Analysis

–Surface and Subsurface Drainage Review

– Traffic level

– Expected life & Cost

–Others?

Right treatment on the right pavement at the right time

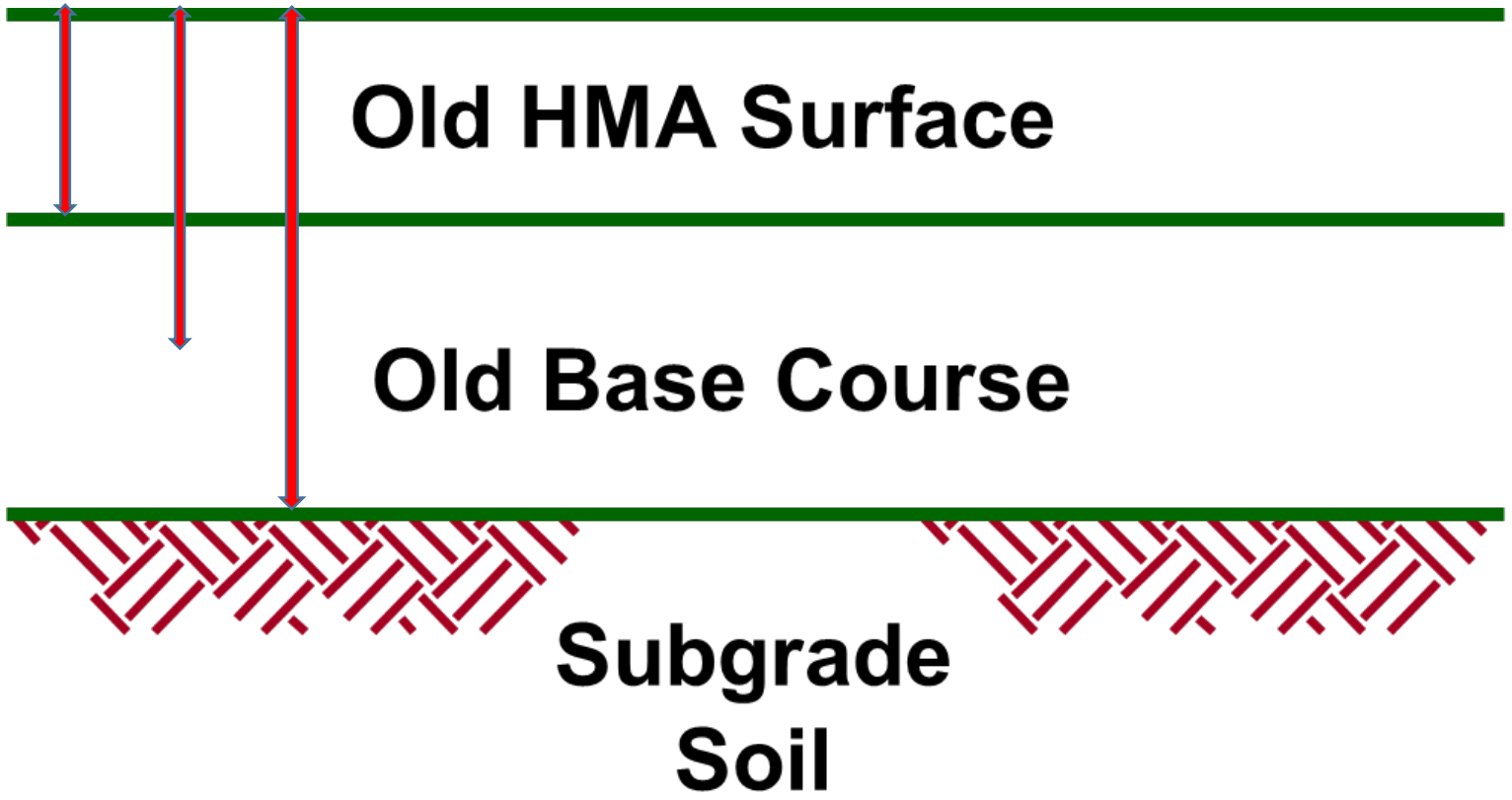
Pre-Project Evaluation

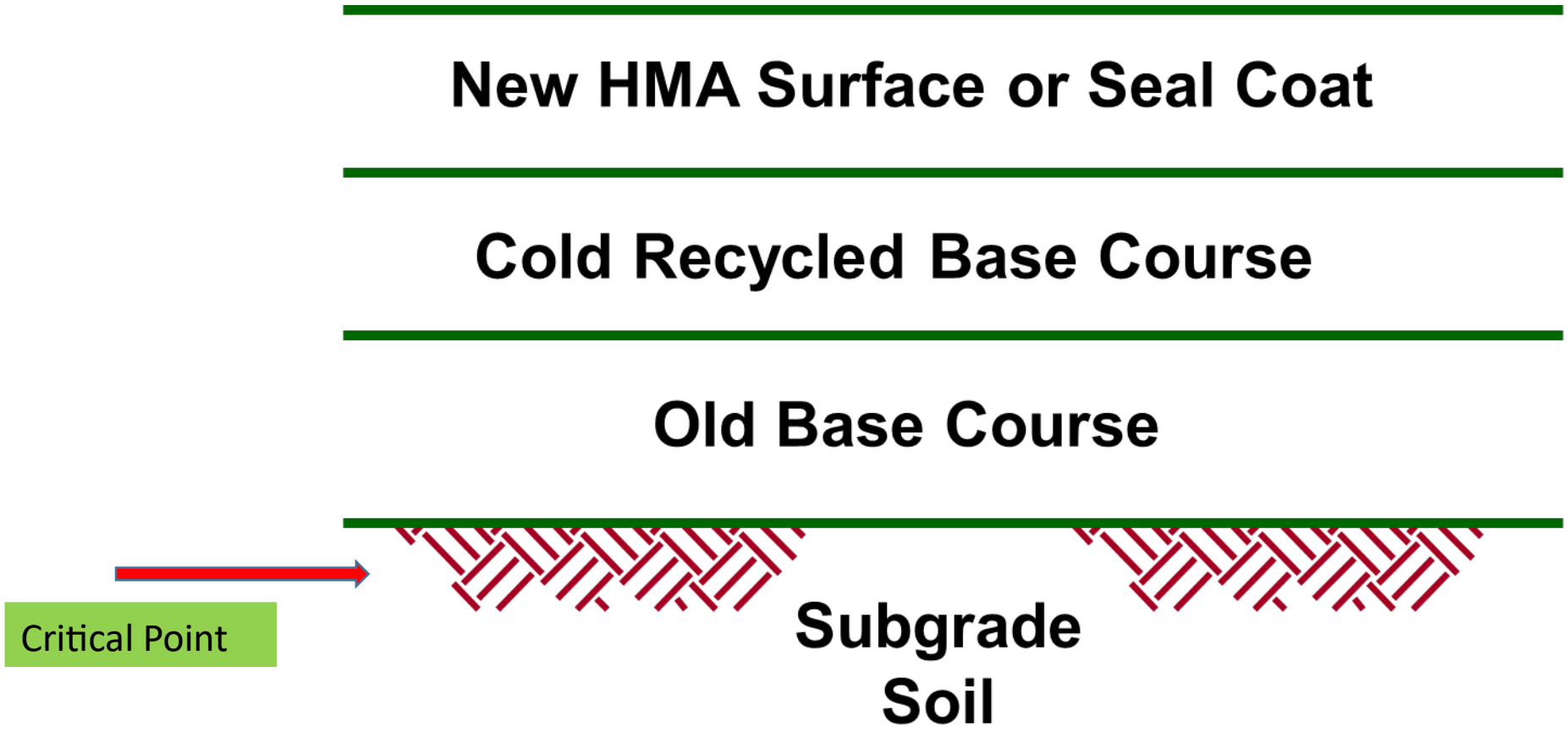
- Core Sampling
  - asphalt layer
  - base/sub-base
  - sub-grade
- Pavement Condition Survey
  - buried obstacles
  - cracking
  - rutting/shoving
  - settlement
  - heaving
  - potholes

PAVEMENT RECYCLING

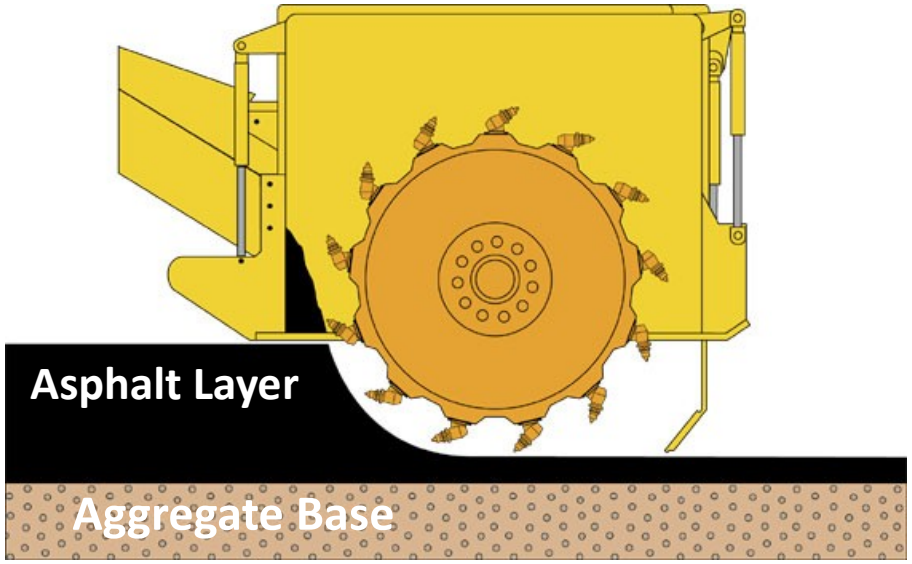
CIPR/FDR

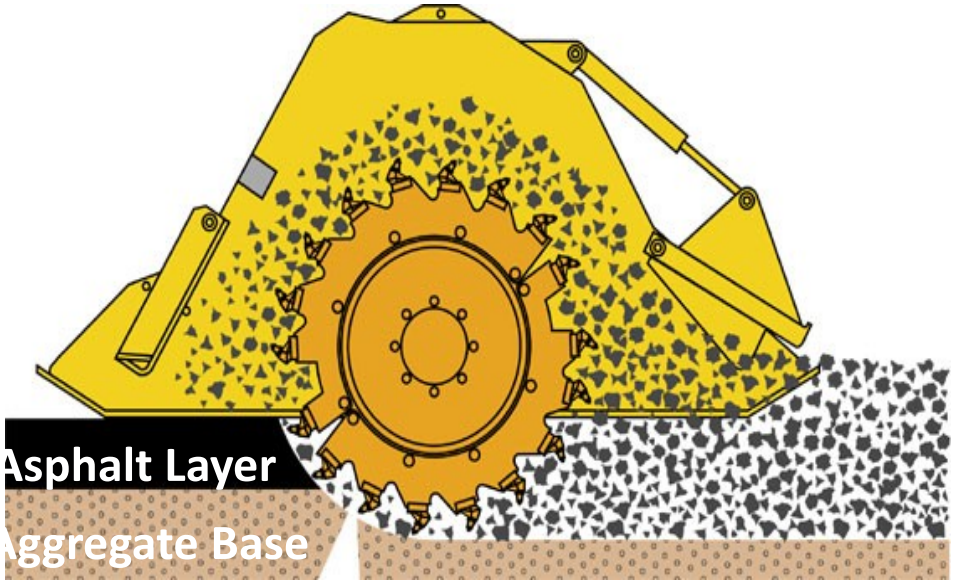
Partial vs. Full Depth




New HMA Surface or Seal Coat
Cold Recycled Base Course
Old Base Course
Subgrade
Soil
Critical Point

Cold Recycling / FDR Recycling





- Cold Recycling removes a portion of the asphalt layer (profiling)
- Process suitable when base is in good condition and will support axle loads
- Process suitable when cracks do not extend to full depth of asphalt layer
- Cold recycling does not remedy base problems

- Eliminates full depth cracking
- Rotor depth can be set to blend desired portion of the existing base/sub-base with the asphalt layer
- Opens base for stabilization
- Provides better support for new asphalt layer

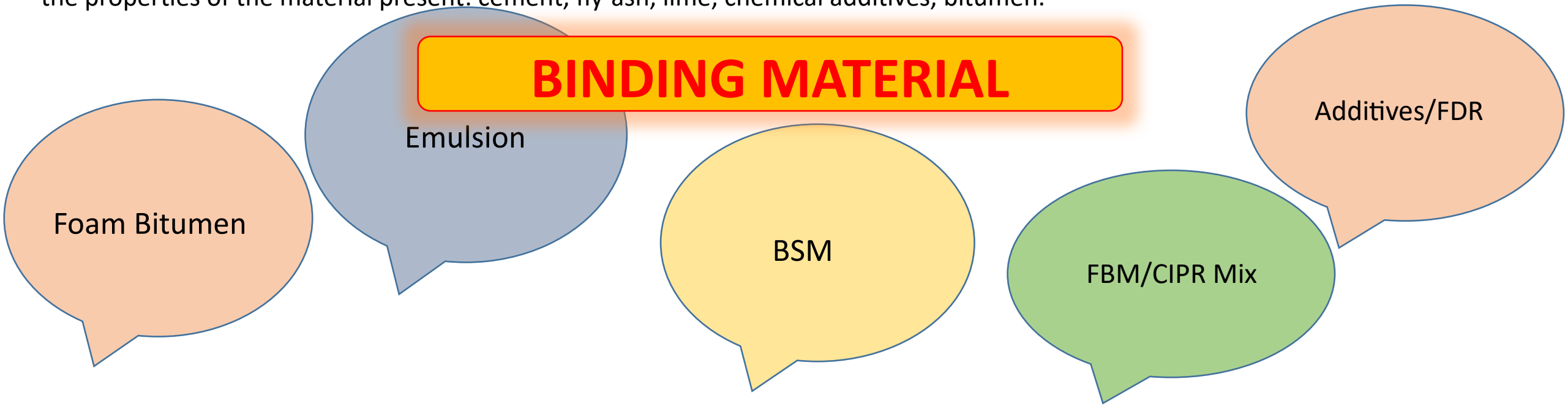
Cost savings by re-using existing pavement material and done in-place

Cold Recycling

Cold In-place Recycling (CIR) is defined as a rehabilitation technique in which the existing pavement materials are reused in **place** without the application of heat. The RAP material is obtained by milling or crushing the existing pavement.

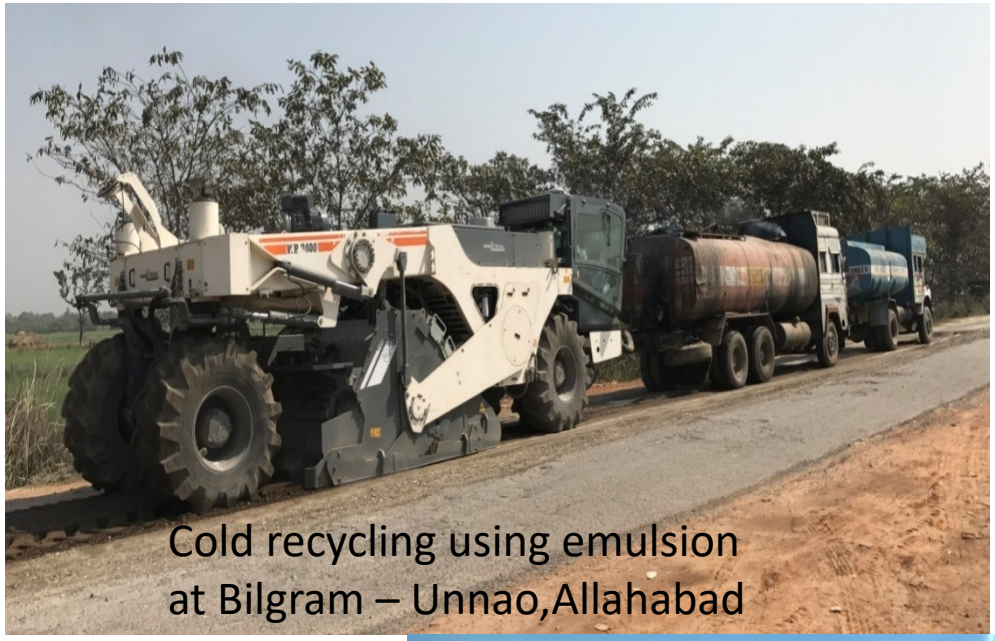
- If existing pavement structure is adequate to take loads then simple pulverization and regrading may be required before applying surface layer.

- If structural enhancement is required then stabilizing additives are required. Type of agent used should be selected based on the properties of the material present: cement, fly-ash, lime, chemical additives, bitumen.



NH Projects

LOW VOLUME ROAD PROJECTS: Cold Recycling



Cold recycling using emulsion
at Bilgram – Unnao,Allahabad

PMGSY: Thekrejuma Village Road: Dimapur- Stabilization

CIR Project Design

- The project design involves two distinctive design activities: asphalt mixture design and pavement design.
- The asphalt mixture design is carried out in four stages:
  - Field sampling (samples collected from each layer)
  - Materials testing
  - Additive selection and
  - Laboratory mixture design

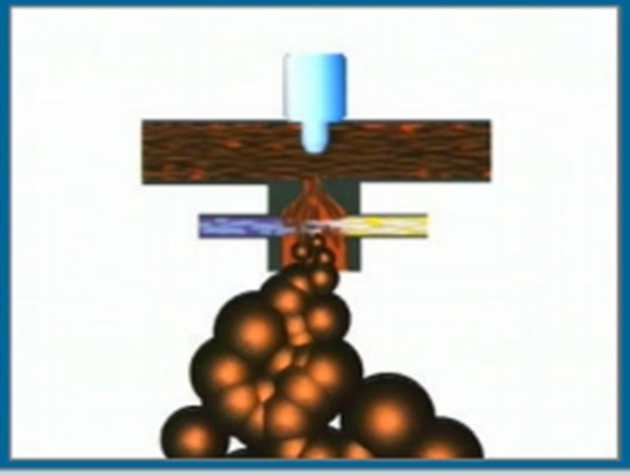
Design Procedure

- Obtain samples of RAP from field
- Determine RAP gradation: gradation of extracted aggregate
- Select amount and type of additional aggregate if required
- Select type and grade of recycling additive (Emulsion or Foam bitumen)
- Estimate recycling additive demand
- Determine pre-mix moisture content for coating
- Test trial mixtures: moisture sensitivity, modulus
- Establish job mix formula
- Make adjustments in field

Cold in Place Recycling

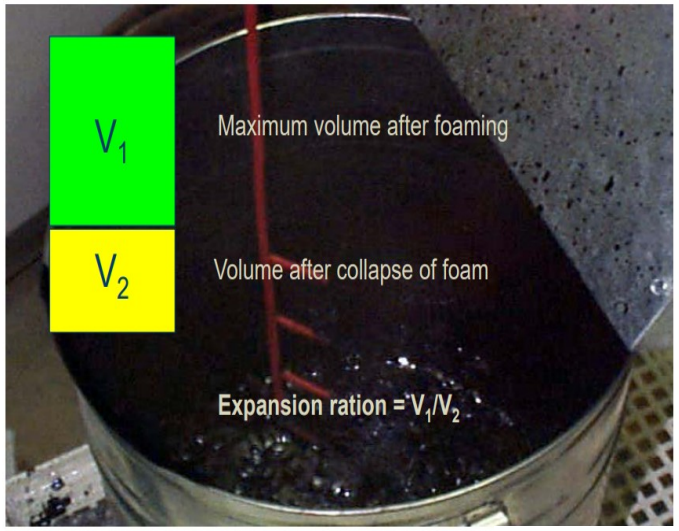
What is Foamed Bitumen ?

2 – 3 % water in 180 °C hot bitumen:
The bitumen expands 15 to 20 times its original volume.

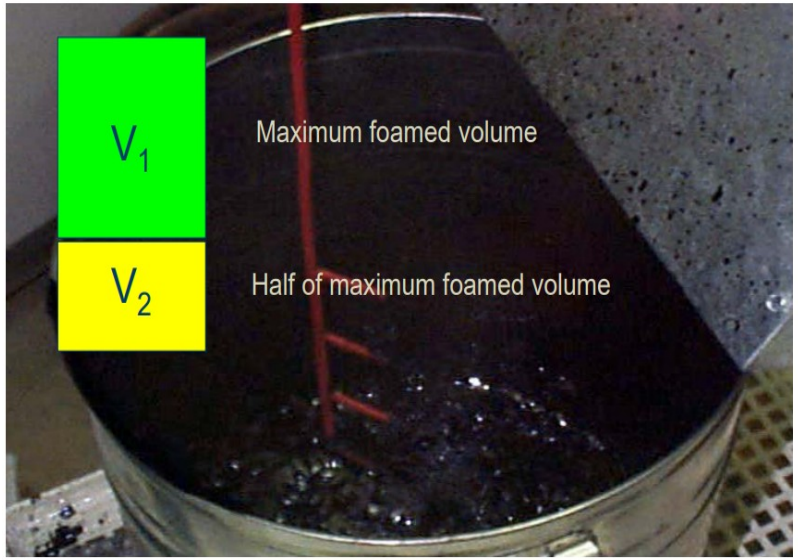


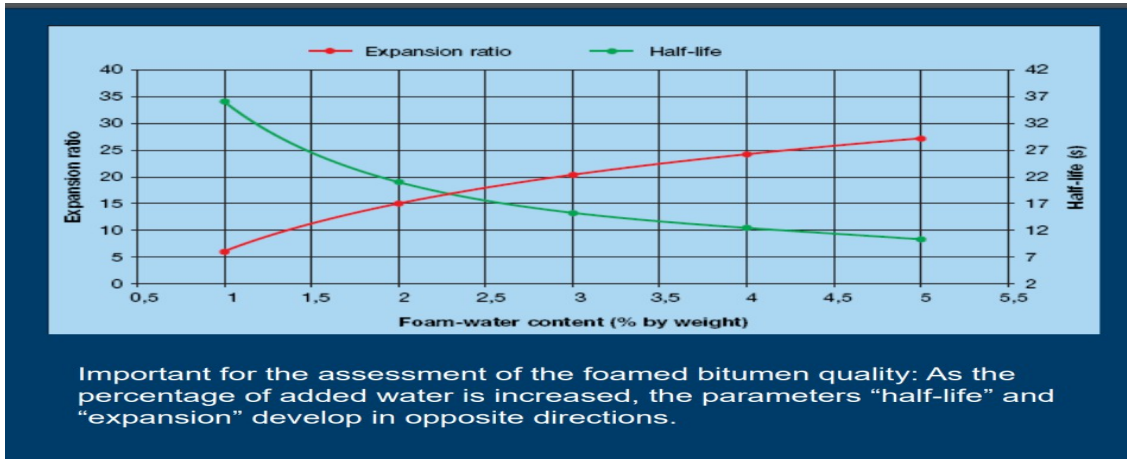
The increased surface area makes it possible to mix hot bitumen with cold and damp aggregates

Expansion ratio



Half life – time



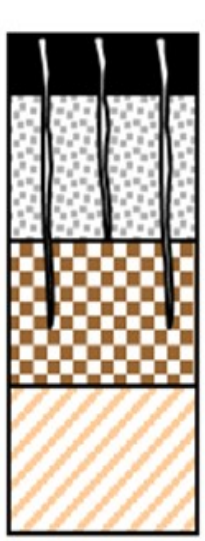


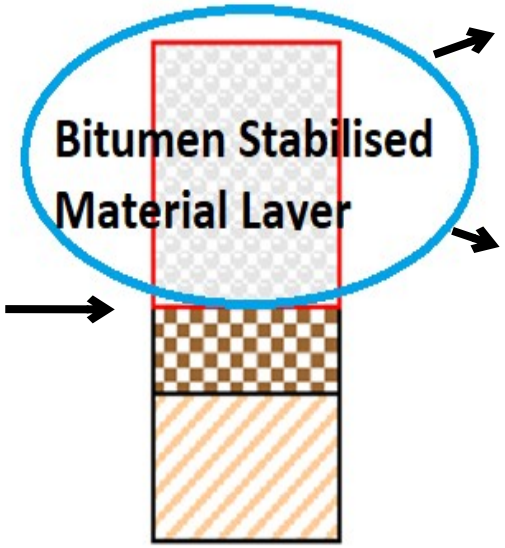
Important for the assessment of the foamed bitumen quality: As the percentage of added water is increased, the parameters “half-life” and “expansion” develop in opposite directions.

CIPR: What is BSM ?

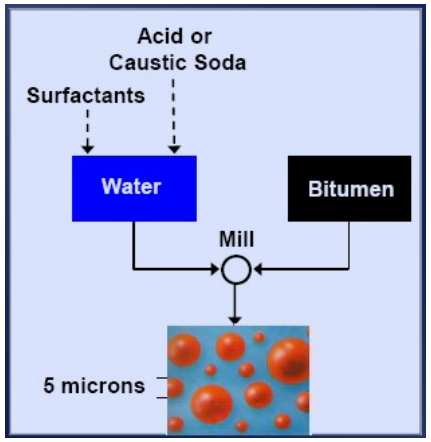
Stabilization of base layer using small amount of bitumen as binding agent without heating

Recycle the bituminous layer

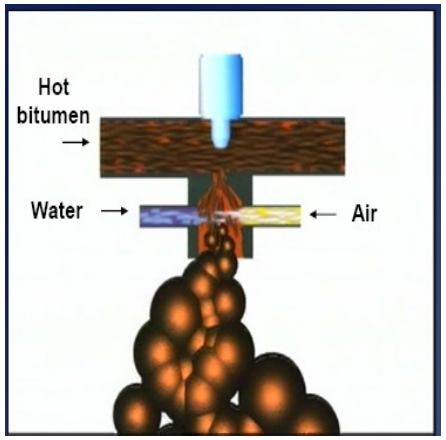


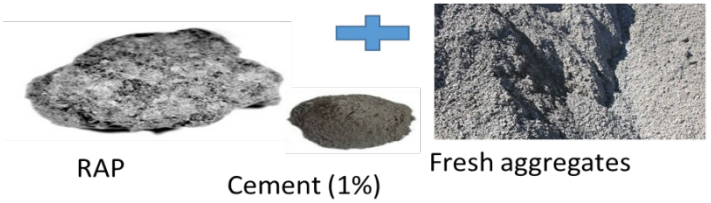


Bitumen Emulsion



Foamed Bitumen





COLD IN-SITU RECYCLING USING FOAM BITUMEN

For RAP mix design

Optimum foamed bitumen content- 2.25%

Optimum moisture content – 6%

Optimum foaming characteristics were achieved at temperature of 180°C and foaming water content of 5%.

Foaming was done with VG-30 binder

1% cement OPC 43 grade was added to improve the stability and better dispersion of foamed bitumen in fine particles of the mix

Similarly, if using Bitumen emulsion

Emulsion Characteristics to be checked as per IS 8887

Min residual bitumen content should be 60%

Optimum fluid content, Optimum emulsion content

Dry ITS Values

Sample No/set (3)	Indirect Tensile Strength, kPa		
	2.0% Foamed Binder Content	2.25% Foamed Binder Content	3.0% Foamed Binder Content
1	272	390	327
2	332	408	339
3	273	401	330

Wet ITS Values

Sample No/set (3)	Indirect Tensile Strength, kPa		
	2.0% Foamed Binder Content	2.25% Foamed Binder Content	3.0% Foamed Binder Content
1	201	302	227
2	233	307	242
3	203	309	219

Resilient Modulus Values

	Resilient Modulus, MPa					
Sample No/set (3)	2.0% Foamed Binder Content		2.25% Foamed Binder Content		3.0% Foamed Binder Content	
	25C	35C	25C	35C	25C	35C
1	1597	1143	2649	1499	2296	1481
2	1508	926	2506	1389	2343	1619

Site Execution: CIPR

Spreading of aggregates

Site Execution

Checks to be done

The Green Effect-NH Project

Conventional Overlay

- Granular Sub Base (GSB)+ Granular Base (WMM) : 450mm
- Dense Bituminous Macadam (DBM): 185mm
- Bituminous Concrete (BC): 50mm

CIR

- Granular Sub Base (GSB)+ Granular Base (WMM) : 450mm
- **Bitumen Stabilized material (BSM): 175mm**
- Dense Bituminous Macadam (DBM): 70mm
- Bituminous Concrete (BC): 50mm

- By using foam stabilized technique, app 80% of recycled aggregate was used and about 60% less bitumen have been used for construction of pavement.
- For 85 Km and 4 lanes construction project carbon emission reduction of about 13600 tonne equivalent C02 was achieved. And 2,83,220 tonne of aggregate and 10,540 tonnes of bitumen was saved.

Green Effect-Low Volume Road Project

Full Depth Recycling:

Using Cement /Additive

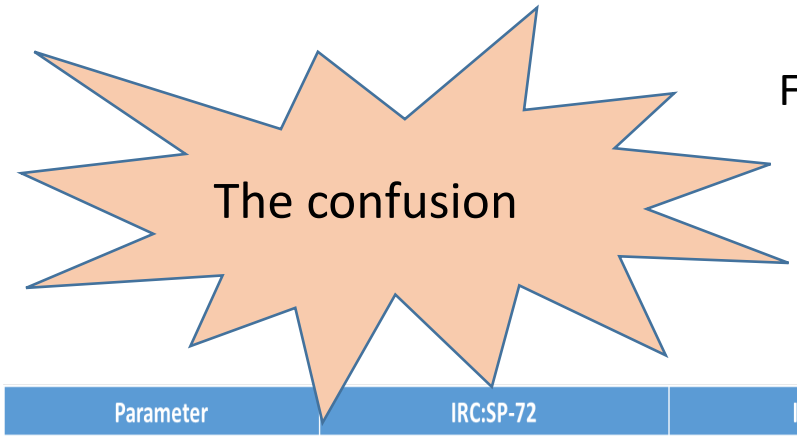
- Depth:- 300mm
- Width:-7Mt ,45km
- Subgrade +Existing Pavement stabilization ⟶ Converted to stabilized base +subbase.
- 200,000.00 Tonne of aggregate saved.
- Emission reduction :6000 Tonne CO2-Eq

Parameter	IRC:SP-72	IRC:37	IRC:SP-89
Material	Gravel, Soil, Agg. or Soil-Agg. Mix	Gravel, Soil, Agg. or Soil-Agg. Mix	Gravel, Soil, Agg. or Soil-Agg. Mix
Recommended Aggregate Gradation	Table 400.5 of MORD LL<45, PI<20	Grading –IV of Table 400-1 of MoRTH Indirectly Control	Grading –IV of Table 400-1 of MoRTH LL<45, PI<20
Min Thickness	100 mm	200 mm	200 mm
Design UCS 7 Days	> 1.7 MPa	1.5 – 3.0 MPa 0.75-1.5 MPa, Traffic Less Than 10 MSA	1.5 – 3.0 MPa
Evalue 28 Days UCS	-	For UCS – 1.5-3.0 MPA, 600 MPa, Other , 400 MPa	For UCS – 1.5-3.0 MPA, 600 MPa, Other , 400 MPa
Curing Period	7 Days	3 Days	-
Remarks	Post Construction In-situ UCS< Design UCS # Design Reviewed	100 % Soil is used, Geo-composite can be used. Check UCS before construction of Upper Layer No Check for Amount of Cement Post Construction	Degree of Pulverization >60% Temperature for Mixing>10°C

Requirements for CTSB

UCS, Durability, Gradation

Resilient Modulus, Gradation, Dry ITS, Wet ITS



FDR

STABILISATION

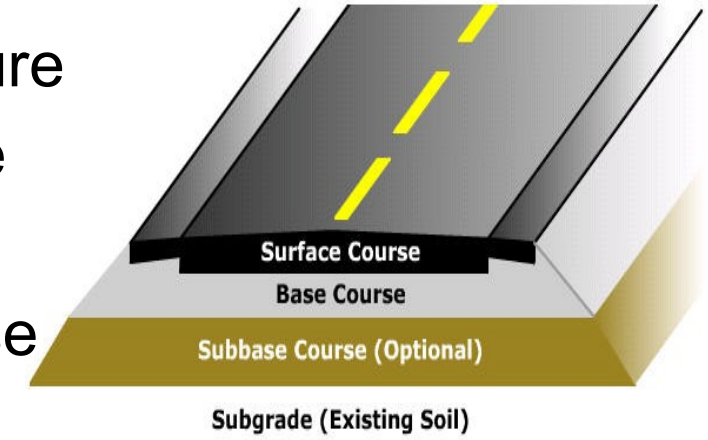
BSM

Parameter	IRC:SP-72	IRC:37	IRC:SP-89
Material	Gravel, Soil, Agg. or Soil-Agg. Mix	Gravel, Soil, Agg. or Soil-Agg. Mix	Gravel, Soil, Agg. or Soil-Agg. Mix
Recommended Aggregate Gradation	Table 400.5 of MORD LL<45, PI<20	Table 400-4 of MoRTH Indirectly Control	LL<45, PI<10 (Part-2)
Min Thickness	100 mm	100 mm	100 mm
Design UCS 7 Days	> 3.0 MPa	4.5-7.0 MPa	4.5-7.0 MPa
E-value 28 Days UCS	-	5000 MPa	1400 UCS 1700 Beam Method
Flexural Strength	-	20 % of UCS or 1.5*ITS	20 % of UCS
Curing Period	7 Days	7 Days	7 Days
Remarks	Post Construction UCS Durability	Post Construction UCS Durability ITS	Post Construction Permanent Deformation UCS Durability For Commercial Stabilizer FWD Evaluation for Two Years

Requirements for CTB

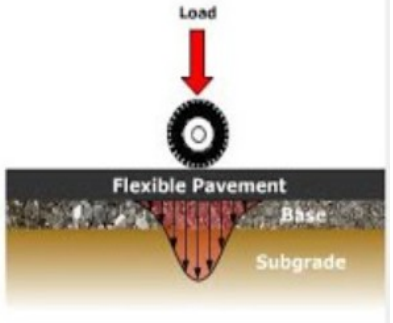
Failure/Concerns/Problems

- Multi-layer Structure
  - Surface course
  - Base course
  - Subbase course
  - Subgrade

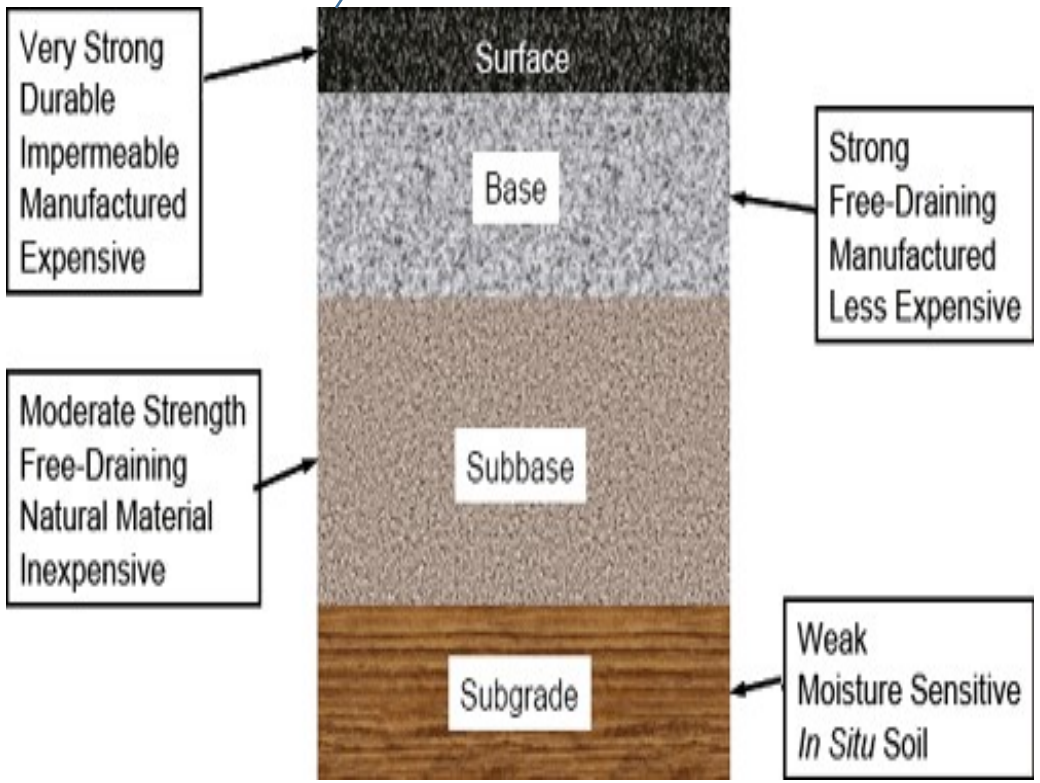


Pavement Failure

- Failure in Design
- Failure in Construction
- Failure in Materials
- Failure in Maintenance



Even the best technologies fail if ignored during material selection, design, testing, construction.



Bitumen Roads Are Material Sensitive

Cold Recycling Project

CONCERNS

- Influence of RAP temperature on CIPR mix
  if the RAP temperature is lower than 20C the air voids in the mix can be as high as 15-20% : There would be effect on ITS, compaction, rutting?
- Dosage of emulsion/foam bitumen/cement . Foaming Parameters: bitumen temp
- BSM mix should be compacted within 2 hours
- Regular Gradation Check
- Excessive fines are generated by milling and crushing, thus affecting further mix design.
- Work in wet weather should be avoided as moisture can become trapped in lower layers of pavement causing problems with compaction.
- Allowing traffic on the surface prior to primer sealing is not desirable, as the fines on the surface contain bitumen, which will in turn get stuck to cars-loss of fines.



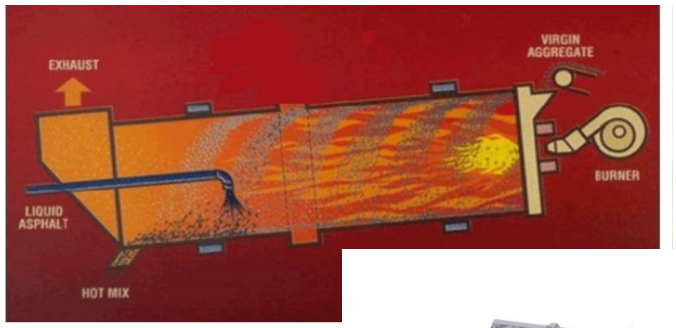

Concerns : FDR-stabilization
Construction of Stabilized Layer (Problems)

- Temperature cracking
- Traffic related cracks :only light traffic should be allowed before covering with surface layer
- Disintegration of stabilized layer
- Pre-cracking
- Provision of Stress relief layer
- Dosage of additive Cement/CCS
- Gradation
- Curing
- Should not be left open for long to rains and traffic
- **Anything & Everything is Troublesome**

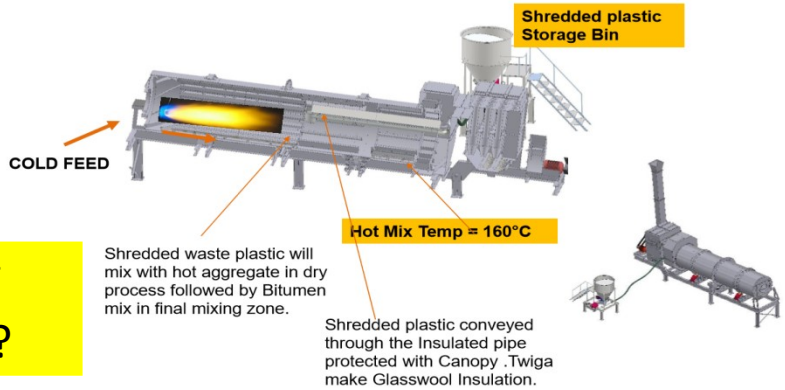
Choose your additive carefully, not all additives work for all type of soils and materials

Waste Plastic Type/ Quality : Concern for Roads

S.No	Description	Tm , °C	Tc , °C	Findings
1	MLP 1	158.5	117.7	PP & PE
2	MLP 2	253.9	196.3	PE & PET
3	PE-based	122.2	108.5	LLDPE/ LLDPE & LDPE



Plastic waste exposure to flame



Availability of Shredded WP?

WE STRIVE FOR : LONG LASTING & SUSTAINABLE PAVEMENTS