

**Technical Lecture 3**

**Full Depth Reclamation (FDR)  
Using Portland Cement**

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# Road Pavement Distress

- Pavement Types – Flexible (Granular Base or Bound Base) and Rigid
- Causes for Distress – Traffic Loads, Environment, Ageing
- Pavement rehabilitation – Thick structural overlay, Removal and replacement, Full depth reclamation (FDR)
- FDR – Recycling distressed flexible pavement and its underlying pavement layer(s) into a new base layer
- Advantages – Sustainable technology, low cost alternative, thinner surface course, moisture resistant, higher strength of new pavement which provides stronger, consistent base

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# Full Depth Recycling (FDR)

- Process – Excavating and pulverising in-situ pavement, blending with a binder (Portland cement), water, corrective or additional aggregates (if needed) as per mix design, compaction followed by curing to produce a bound base, laying surface courses (**Subgrade inclusion?**)
- **FDR using OPC saves 30 to 60 per cent in costs (PCA)**

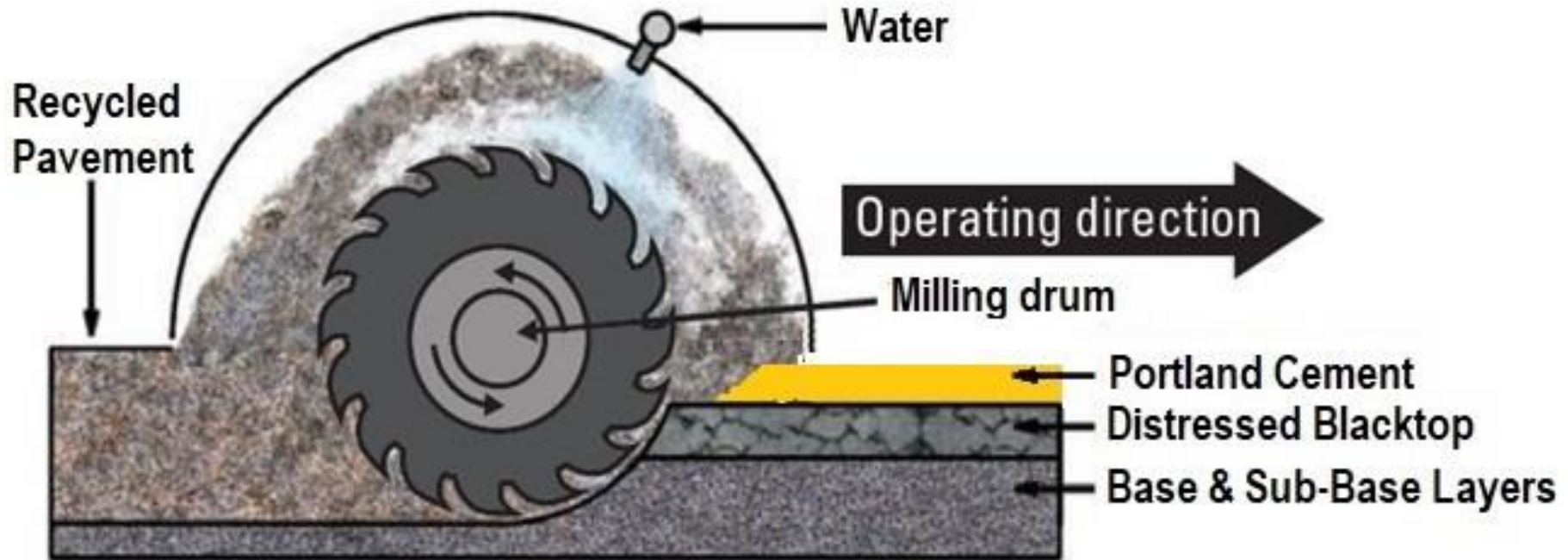
## **Soil Stabilisation Using Cement & FDR**

- Both have similar methodologies, Creating bound pavement layer using an additive to increase the strength
- However, soil is a natural material, pavement is man made, differences in gradation, compaction and strength

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# Road Reclaimer

- **Road Reclaimer or Road Recycler** – Machine for excavation, pulverisation and mixing stabiliser and water



**Schematic View of FDR Process**

- **‘Recycling’ and ‘Reclamation’ usage as synonyms**
- **Suitable Road Reclaimer machine – Must for FDR**



# Limitations of FDR

- Not for improving roads which fail due to poor drainage – Saturated subgrade or inadequate pavement drainage
- Not if ground water table within 0.6 m from subgrade top, Not for cement concrete pavement
- Not when failure is due to poor quality subgrade soil
- Before taking up FDR, ‘Drainage and Poor subgrade condition’ if encountered, must be treated appropriately
- Crack relief layer required above FDR layer
- Traffic not to be allowed over FDR layer during curing
- Impact of FDR layer on pavement drainage.....?

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# Rural Roads Suitable for FDR

- Upgradation projects under PMGSY III –After completing 10 years of design life
- When existing pavement has more than 50% area distressed – Deep rutting, Shoving, Slippage, Extensive potholes and patching, Excessive cracks (Longitudinal, Transverse, Alligator) Worn out pavement, Ravelling, Base or sub-base failure
- Road pavement made of low grade materials – Brickbats, Soft aggregates, Gravel, etc., which need to be replaced
- Pavement Condition Survey to identify principal modes of distress, Ground water table depth,
- Identify road sections having distress due to poor subgrade or inadequate drainage for separate treatment

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# Distresses Which Can be Rectified



Extensively Worn out Pavement



Rutting



Raveling



Potholes and Cracking





# Material Testing – Subgrade & Reclaimed Pavement

- Subgrade – Index Properties and CBR
- Reclaimed Pavement – Particle size analysis, Liquid limit and Plastic limit, Heavy Compaction test
- Cube compressive strength test (IS 516)
  - 15 cm cube moulds, Needle Plate Compactor use
- Durability Test as per IRC SP:89
- Tests on Cement and Water (IS 456) – Potable water

Replacing aggregates more than 38 mm size by equal weight of particles between 4.75 to 37.5 mm

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# Mix Design for FDR Process

- Determining suitable percentage of cement and water to be admixed before compaction – Mix design
- Sample LL to be less than 45%, PI to be less than 20
- Pulversied pavement sample to meet gradation limits or adopt mechanical stabilisation
- At different cement contents – Modified Proctor test and cube compressive strength test (7 days curing)
- Using graph decide cement content required for 4.5 MPa compressive strength
- Additional cube specimens for durability test

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# Gradation of Pulverised Pavement

## Changes required for cement stabilised material gradation

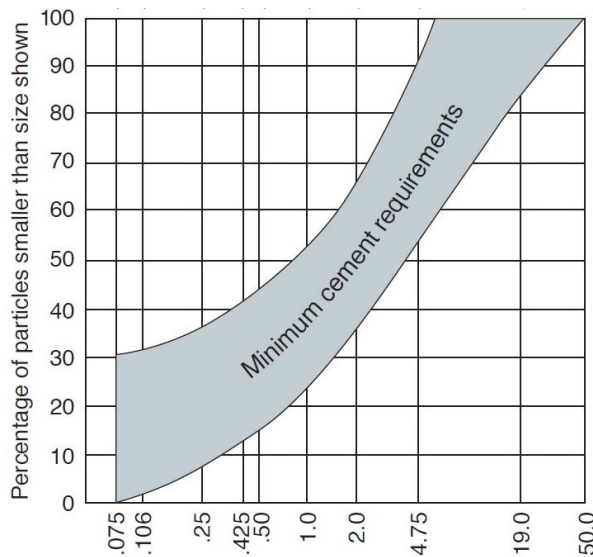
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IS Sieve	% passing
53 mm	100
37.5 mm	95 – 100
19 mm	45 – 100
9.5 mm	35 – 100
4.75 mm	25 – 100
600 micron	8 – 65
300 micron	5 – 40
75 micron	0 – 10

**NOT APPLICABLE**

Gradation Limits for Cement Stabilisation

MORD Specifications for Rural Roads



Particle Size

PCA, Cement Treated Base, 2006

## Proposed Gradation

IS Sieve	% passing (Max)
75 mm	100
53 mm	65 – 100
4.75 mm	55 – 85
75 micron	0 – 20

Optimum Cement Content Should meet both compressive strength and durability test criteria



# Pavement Design

- Pavement design to be as per IRC SP:72 – Cement treated bases & sub-bases, thinner pavement due to high modulus
- Design traffic above 0.3MSA – Crack relief layer required
- Aggregate crack relief layer (Modified gradation of WMM) or Stress Absorbing Membrane Interlayer (SAMI)
- Pavement drainage – Permeable Crack Relief Layer
- Aggregate crack relief layer in view of Cost consideration and Thinner bituminous wearing course of rural roads
- FDR to be used as bound base for flexible pavement



# Construction & Specifications

- FDR work – Machinery intensive operation, similar to cement stabilisation
- In-situ operations – Excavate and pulverise existing pavement, Mix it with cement and water, Compact it
- Equipment – Road Reclaimer (Recycler), Water tanker, Motor grader, Various types of road rollers, Dumpers, Loaders, Machineries for WMM and bituminous mix preparation and laying
- **Manual spreading of cement for FDR in Rural roads**
- Simultaneously during excavation and pulverisation, water is mixed, Water tanker to be tagged with reclaimer

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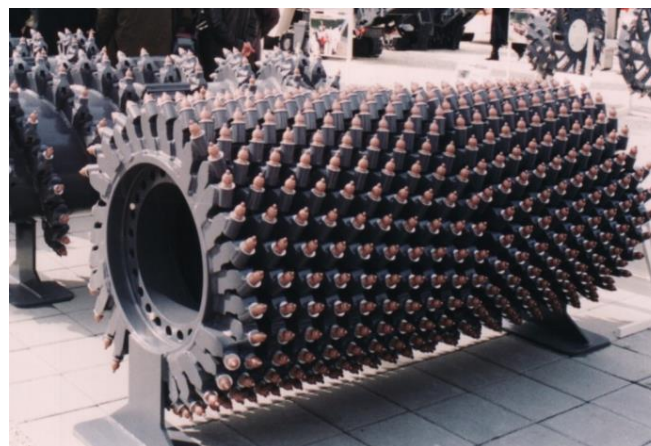
# Construction & Specifications..Contd

- Spotting bags, opening and spreading cement



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- Must equipment for FDR – Road Reclaimer (Recycler)



Cutting Drum of Road Reclaimer



# Road Reclaimers



Wirtgen



XCMG



Roadtec

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Caterpillar



Roadhog



Sakai



# Construction & Specifications..Contd



- Output– 500 cubic m per day (Single lane, 0.3 m thick FDR layer – 450 m length)
- Reclaimers can be operated in single pass – Excavation, pulverisation and stabiliser additive mixing in one pass
- Reclaimers can be used for Two Pass operations also
- Drum rotates backwards when machine moves forward
- Pulverisation depends on speed of reclaimer, drum rotation speed, door opening size for the drum, breaker bar setting, pavement composition and its condition, etc
- FDR layer to be compacted in one lift, hence high thickness of compacted FDR layer

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# Construction & Specifications..Contd



- Different types of Rollers – Tamping foot / vibratory foot roller for break down rolling, Smooth wheeled single drum vibratory roller or pneumatic roller for intermediate rolling, Tandem roller for finishing rolling
- Roller passes to have 50% overlap
- Grader – Camber for material laid for compaction, aeration
- Compaction to be completed within **TWO hours** after mixing water and cement
- Utilities to be identified & protected – Manual operations
- Curing for 7 days by sprinkling water over hessian/ straw
- **Trial stretch (min 50 m) construction to finalise operations**

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# FDR Process for Rural Roads



1



1



2



3



4



5

Andhra Pradesh  
Maharashtra  
Tripura  
Kerala





# Quality Control

## Before Construction - During DPR Preparation

- Existing Pavement Subgrade, and other pavement layers
  - Gradation, Plasticity, in-situ density and in-situ moisture content – 3 Samples per km
  - CBR at in-situ density – One set of tests (3 moulds) for each type of soil
  - Pavement layers – One sample per km for gradation and plasticity
- Mix design to be adopted for FDR
- Cement type to be reported, Same type of cement to be for both laboratory tests and field application
- Cement (One set of tests for each lot) water (One set of tests) and additives if any (**Before taking up works**)



# Quality Control

## During Construction

- Pulverisation of pavement layers
- Placement Moisture content
- Quantity of cement spread on pavement
- Uniformity of cement Mixing
- Layer thickness after compaction
- In-situ compacted density
- Compressive strength of cement admixed mix – Cube moulds
- Compressive Strength of field compacted FDR layer after 7 days (By taking cores)

# Cores Extracted from FDR Layer



Full Depth Cores – Extracted After 28 Days



Broken Core  
Extracted After  
7 Days Curing

*Listen to your heart,  
Not to the Crowd  
Thank you*

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