New Technology Initiatives in Rural Roads and Use of Marginal Materials

Technology Initiatives under PMGSY

National Rural Infrastructure Development Agency

Ministry of Rural Development

National Institute of Technology

Warangal, Hyderabad

Lecture 1

New Technology Initiatives under PMGSY

Outline of Course

- ❖ Rural Roads – Need for New Technologies & Issues
- ❖ Major Proven Technologies Useful for Rural Roads
- ❖ Guidelines on Technology Initiatives under PMGSY, 2013
- ❖ New Technology Vision 2022: Guidelines
- ❖ New Technology Vision 2022: New Materials/Technologies
- ❖ Guidelines for Adoption of New Technology
- ❖ Technology Driven Demonstration Projects
- ❖ Technology Development
- ❖ Preparation of Manuals & Others
- ❖ MoRT&H Advisory on New/Alternate Materials & Technologies
- ❖ NewTechnology Status (March 2022

Rural Roads – Need for New Technologies & Issues

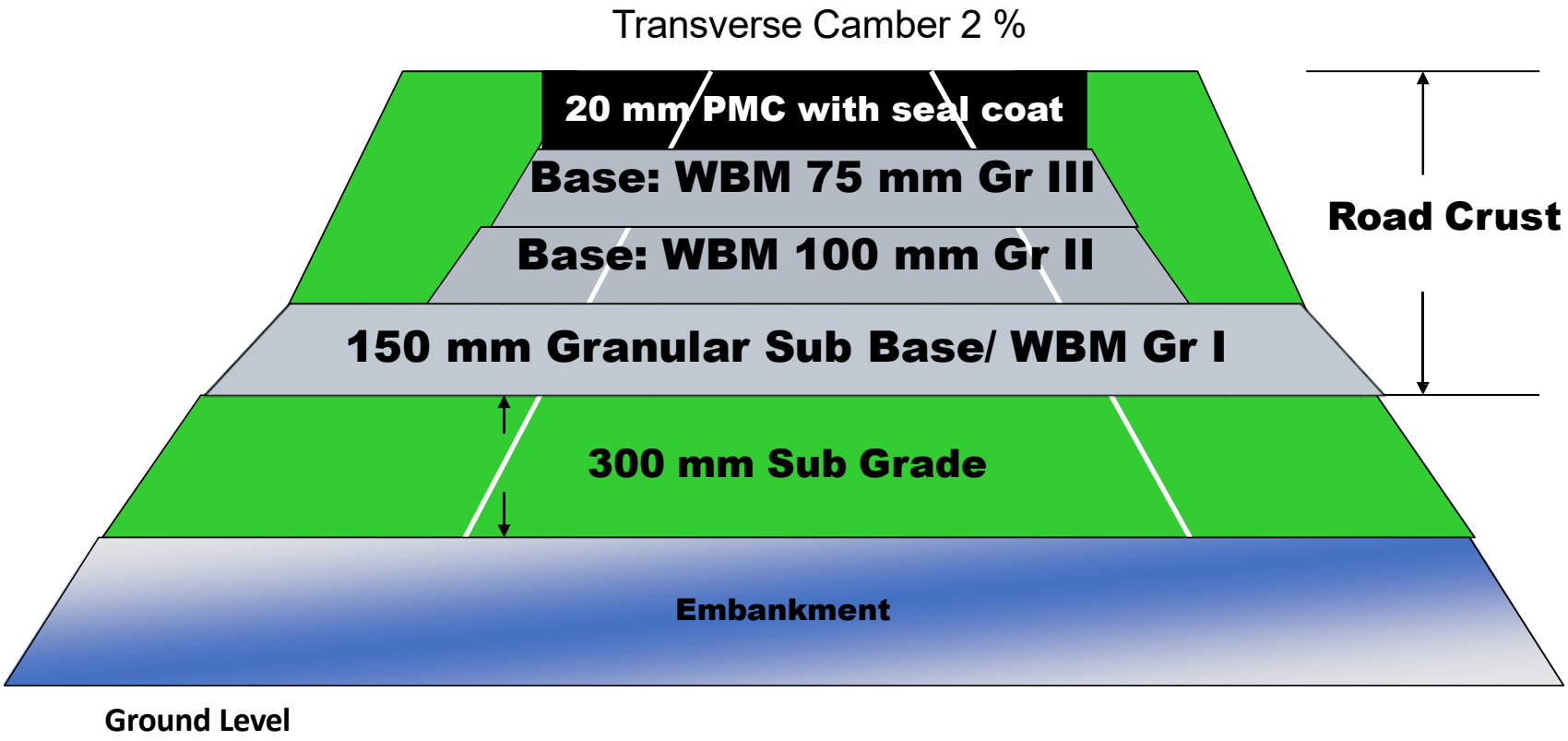
Rural Roads - PMGSY

- Rural roads – key component of rural development
  - Access to economic and social infrastructure
  - Access to services
  - Increased agricultural incomes
  - Enhance productive employment opportunities
- To accelerate rural connectivity – PMGSY was launched by the Central Govt. in Dec. 2000

Rural Roads - PMGSY

- Required to be constructed to proper engineering standards
- Stress is laid on quality and durability of assets being created
- Investments in PMGSY Programme
  - Initially investments: Rs. 2,500 to Rs. 3,000 crore per year
  - Current investments: Rs. 20,000 crore per year (Approximately)

Rural Roads – Pavement Cross Section



Need for Technology Initiatives

- To promote cost-effective and fast construction technologies
- To mitigate the problem of depleting Natural Resources
- To mainstream the technologies already developed through R & D in the past
- To undertake further research and technology initiatives duly taking into account the environment, terrain, accessibility and other constraints
- For Protection of Environment.

FIGURE 1: Destroying our valuable mountains for the quarrying of aggregate

Issues in Use of New Technologies (1/2)

- Fear of failure of New Technology & accountability
- Apprehensions among the officers about rate analysis.
- In-adequate technical know-how about various technologies
- Fear of strict Quality Control and Additional Work burden of reporting performance evaluation
- In-adequate information about life cycle cost analysis
- In-adequate knowledge about design requirements for different technologies.
- Reluctance of the States in coming forward with New Technologies and reduction in cost.

Issues in Use of New Technologies (2/2)

- Non-availability of standards and specifications for construction
- Lack of awareness by contractors
- Non-availability of indigenous equipment
- Lack of information on performance of roads constructed with new technologies in India
- Pro- active Role of States / STAs not seen.
- When compelled, efforts to make higher provisions and prove that the technology is not cost effective or even lead is higher.
- Identifying some most ignorant junior most officer and deputing to NRIDA for discussion.

Immediate focus should be on promoting

- Use of locally available marginal materials.
- Industrial wastes.
- New materials accredited by IRC and
- Environment friendly new technologies., e.g. Cold Mix Technology, Jute/Coir Geo-textiles, Waste Plastic in Surfacing.

Need for Locally Available Materials

- Inadequate availability of quality aggregates is becoming a serious bottleneck probably due to
  - Quantum Jump in Road Development Programs.
  - Closing of quarry's by State Governments.
- Improving properties of locally available materials and marginal materials, soft aggregates, brick aggregates etc. – IRC :63- 1976
- locally available marginal materials and soft aggregates can be used by suitably modifying them with addition of lime or cement or an additive other than cement/lime or even through mechanical stabilization without compromising on :
  - Strength and quality standards.
  - Cost reduction
  - Environment protection with reduced carbon footprint

Reduced time of construction

Waste Materials Available in Different Parts of the Country

- **Construction Waste**
- **Marble Dust and Slurry**
- **Plastic Waste**
- **Quarry Waste Materials**
- **Blast Furnace Slag, Steel Slag, Zinc Slag**
- **Rice Husk Ash**
- **Paper Mill Sludge, etc.**

Use of these materials has already been demonstrated in various components of construction of roads

However, systematic records of their performance have not been maintained. Use of such waste materials should be encouraged for converting waste to wealth and avoiding environmental pollution.

Broad classification of Alternate Materials

- Manufactured materials: cement, fibers, etc.
- Natural materials: coir, jute, etc.
- Waste materials: crumb rubber, waste plastic, etc.
- By-products from industry: fly ash, slag, etc.

Major Proven Technologies Useful for Rural Roads

Proven Technologies with IRC Codes/Specifications (1/3)

- Soil Stabilization Technologies (IRC SP89-2010; SP89 (Part-II)-2018
  - Lime stabilization – IRC :SP- 89-2010
  - Cement stabilization- IRC: 50-1973
  - Bitumen stabilization – IRC :55-1974
  - Mechanical stabilization – IRC : SP : 20-2002

Proven Technologies with IRC Codes/Specifications (2/3)

- Use of Fly Ash/Pond Ash (MoRD Specifications-2014)
  - Use of Fly ash in Road Embankment – IRC : SP : 58-2001
  - Use of fly ash in cement for concrete structures (culverts, bridges)/ use of blended cement- IRC : 112 – 2020
- Locally available /Marginal materials, Brick aggregate, etc. IRC:63- 1976 (MoRD Specifications-2014)
- Use of bio-engineering measures – MoRD Specifications-2014
- Jute Geo-Textiles – IRC SP126-2019
- Geo Synthetics – IRC SP59-2019
- Gravel Roads (IRC:SP:77:2008)/Gravel Sealed Roads

Proven Technologies with IRC Codes/Specifications (3/3)

- Construction & Demolition Waste – IRC 121-2017
- Recycling of Bituminous Pavement – IRC120-2015
- Iron, Steel & Copper Slag – IRC SP121-2018
- Roller Compacted Concrete Pavements IRC : SP: 68-2005
- Interlocking concrete block pavement – IRC : SP : 63-2018
- White Topping IRC SP76-2015
- ✓ Cold Mix Technology – IRC:SP:100-2014 & MoRD Specifications-2014
- ✓ Waste Plastic Utilization – IRC SP98-2013

Guidelines on Technology Initiatives under PMGSY, 2013

Technology Initiatives, PMGSY 2013

- A target of 15 percent length of annual proposals by the State is to be proposed with use of new technologies/materials.
  - This includes 10 percent length for mainstreaming of existing technologies for which relevant IRC codes and specifications are available.
  - The other 5 per cent length is for technologies/materials where accreditation has been accorded by IRC or where although IRC has not accorded accreditation, however NRIDA has approved use of such technologies/materials on a trial basis.
- During the last three years i.e., 2019-20, 2020-21 and 2021-22, the road length completed using new materials/technologies is 8870, 11235 and 16038 kms respectively.
- An assessment conducted by NITI Ayog has also recommended substantially increased use of new/green technologies in PMGSY roads.

New Technology Vision 2022: Guidelines

New Technology Vision 2022 Guidelines for Surface Course

1. Compulsory use of waste plastic in at least 70% length out of the eligible proposed length involving Hot Mix process.
2. Universal use of Mechanized Surface Dressing (MSD) in T-1 to T-5 category of roads. From T-6 to T-8 category of roads, minimum 50% of length shall be taken under MSD. Surface Dressing can also be done with cold mix technology.
3. Cold Mix Technology shall be used in minimum 25% of the total eligible proposed length. The use of cold mix technology shall be prioritised in climatically suitable areas.

NT Vision 2022 Guidelines for Base Course, Sub-base Course and Subgrade

a) At least 50% of length of the proposal shall be constructed utilizing new/green technologies/materials.

b) Each state shall promote two new innovations.

c) 100% proposed length under Cement Concrete shall be constructed using thin White topping (Paneled cement concrete) or Cell Filled Concrete. Only in exceptional cases Pavement Quality Concrete (PQC) shall be used.

d) In cases where pavement cost is high due to factors, such as non-availability of aggregate, leading to high transportation cost or unacceptable quality parameters of aggregate, FDR shall be preferred as methodology of construction with advanced equipment and machineries by using stabilization technology so as to attain cost economy, better compaction, quality and durability.

NT Vision 2022 Guidelines for Base Course, Sub-base Course and Subgrade

e) In areas near thermal power plants, fly ash shall be used in Cement Treated Base (CTB) and embankments in adequate quantity.

f) In areas near steel plants, slag shall be used in subbase course, base course and embankments in adequate quantity.

g) Construction and demolition (C&D) waste, duly processed, shall be used in subbase/base course in at least 10% of the proposals.

h) Jute -Geo textile/Coir and similar such locally available materials shall be used for slope protection in hilly areas and other areas, where improvement of characteristics of sub-grade, embankments, shoulders etc. may be required.

New Technology Vision 2022: New Materials/Technologies

New Technology Vision: New Materials/Technologies

- Soil Stabilization
- Full Depth Reclamation (FDR)
- Mechanized Surface Dressing (MSD)
- White topping (paneled Concrete)
- Cold Mix Technology
- Waste Plastic in the Bituminous Layer
- Cell-Filled Concrete

New Technology Vision: New Materials/Technologies

- Fly Ash
- Slag
- Warm Mix Technology
- Coir Geosynthetics
- Geosynthetics
- Bio-Engineering Techniques
- Cement Grouted Bituminous Macadam (CGBM)
- Gabions
- Industrial Waste
- Gravel Roads

Guidelines for Adoption of New Technology

Measures Proposed (1/3)

- One Nodal officer at State level for New Technologies
- Pre DPR meetings to identify the Technology and roads
- Special care would be required by the PIUs / Consultants in preparation of DPRs and by STAs/ PTAs in scrutiny of DPRs using such materials/technologies.
- The traffic survey for such roads is to be carried out with greater reliability and design traffic to be projected.
- The State governments should also ensure that the traffic plying on such roads after construction is not higher than the design traffic.
- DPRs of New Materials / technology to be prepared after site inspection jointly by the DPR consultant, officer of PIU and the STA.
- Special care would be required by the contractors for execution of works with such materials/technologies

Measures Proposed (2/3)

- Only experienced firms with competence shall be allowed to offer the bids.
- No Sub Contracting for such works.
- Stage passing shall be mandatory,
- Defects Liability Period shall be only six months after issue of Take Over Certificate. Thereafter, neither the Employer nor the Contractor will be held responsible. The supervision engineer / project implementation unit and the STA concerned would also not be held responsible for any defect appearing after the said period.

Measures Proposed (3/3)

- Necessary modifications in Bidding Documents and Procurement process to be made taking care of special equipment and technical personnel.
- During execution of works, documentation of procedures observed, quality control tests conducted and operation of equipment, etc. through videography of various activities.
- Concept of Durability and Life Cycle Cost analysis including social and environmental costs should always be carried out.

Technology Driven Demonstration Projects

Technology Driven Demonstration Projects

- The PTA/STA/Technology provider may guide the PIU in preparation of analysis of rates.
- To create a control section with conventional materials side by side. The control section should have the overall specifications (thickness and materials) as per IRC standards for rural roads.
- For all the technology demonstration projects, the control section may be of about 25 percent of road length.
- The DPRs for R&D and technology demonstration road projects shall include a section on ‘Reduction in Carbon Footprint’ as against the conventional method.

Technology Driven Demonstration Projects: Roles & Responsibilities

A. NRIDA

(i) Bear the cost of construction of the trial section as per PMGSY guidelines.

(ii) Consider and approve, the locations identified by SRRDAs for demonstration of technology in consultation with the SRRDA/STAs/PTAs/Technology Providers.

(iii) Obtain and negotiate warranty from the industry/technology providers.

(iv) Enter into agreement with the STA, as a partner in technology development process including post-construction periodic monitoring and performance evaluation.

(v) As facilitator, arbiter and dispute resolver amongst various stakeholders.

Technology Driven Demonstration Projects: Roles & Responsibilities

B. Industry/Technology Provider

(i) Provide value for money analysis of the product and warranty of performance to the NRIDA, SRRDA, PIU and contractors.

(ii) Technical backstopping of SRRDA/PIU and STA/PTA.

(iii) Training to be imparted to site engineers, equipment operators and construction workers of the contractors. Also provide stipend, if necessary, to workers and equipment operators for the period they are off site during training as per laid down rules and regulations.

(iv) Support the STAs/Technical Institution in supervision of the work being executed by the contractors.

(v) Assist the SRRDA in installation of performance monitoring instruments/equipment required, if any, at the time of execution of the work.

(vi) Join the STA and PIU in periodic monitoring and evaluation of performance, say every six months, after the road is open to traffic. Performance would be monitored for a period of two years.

Technology Driven Demonstration Projects: Roles & Responsibilities

C. SRRDA and PIU

(i) Bear the cost of construction of trial section as per PMGSY Guidelines.

(ii) Assist the NRIDA in finalizing the location of the demonstration project.

(iii) Enter into agreement with the STA, in preparation of project estimate, engage consultants for preparation of DPR, supervision during execution and periodic monitoring.

(iv) Enter into agreement with Technology provider/material supplier in preparation of project estimate, supervision during execution and rendering logistical support in periodic monitoring of performance of the road when it is open to the traffic.

(v) Oversight on the work of the STA and the contractors in this aspect.

(vi) Ensure installation of performance monitoring instruments, if any, during execution of demonstration projects.

(vii) Join the team of technology provider and STA in periodic monitoring of performance.

(viii) Ensure that such roads are properly designed for the traffic expected on them.

Technology Driven Demonstration Projects: Roles & Responsibilities

D. STA/PTA

(i) Enter into agreement with the NRIDA, as a turnkey partner in technology development process including preparation of project estimate, supervision and quality control during construction, and post-construction periodic monitoring of performance for a period of two years.

(ii) Expose its personnel to training by the industry/technology provider and experts.

(iii) Support the industry/technology provider in training of contractors' personnel (site engineers, equipment operators and construction workers).

(iv) Documentation of the procedures observed, methodology of construction, quality control tests conducted, operation of equipment and post-construction performance monitoring.

(v) Preparation of handouts/booklets for wider use of the technology and dissemination in consultation with NRIDA.

(vi) Development of specifications for the technology on successful trials for inclusion in codes, book of specifications by IRC in consultation with NRIDA.

Technology Development

HRB-IRC: Thrust Areas

- Promoting recycling of pavements for up-gradation/rehabilitation projects – evolving guidelines and warrants for recycling.
- Evolving environmentally optimized and climate resilient design for rural roads.
- Evolving pavement performance prediction models for determining rate of deterioration of pavements with time, traffic and weather.
- Scope for composite construction technology in rural roads.
- Bridge construction technologies to achieve faster construction such as pre-casting technologies, steel superstructures etc. Also evolve standard designs for bridges on rural roads, along with standard drawings.

HRB-IRC: Thrust Areas

- Pre-cast technologies for small CD structures (culverts) and similarly pre-cast side drain system, along with standard drawings.
- Evolving cost-effective cross drainage structure designs by adopting precast components.
- Evolving low-cost erosion control and drainage measures.
- Evolving bio-engineering measures for improving slope stability in hilly areas.
- Evolving simple models for Asset Management System of rural roads.
- Evolving simple methods/technologies for maintenance of rural roads.
- Practical measures for enhancing safety on rural roads. Evolve typical design and layout of intersections.

HRB-IRC: Thrust Areas

- There is a need for a Pan India GIS database of location and strength characteristics of locally available road construction materials.
- The NRIDA had sponsored a pilot study in this direction wherein the CSIR Central Road Research Institute (CRRI) had carried out a project on preparation of database of locally available materials for four districts (two districts each in Bihar and Madhya Pradesh).
- Under the New Technology Vision 2022 it is envisioned that this study will be extended to cover the entire country to locate potential locally available marginal material for their effective use.

Preparation of Manuals & Others

Methodology for Technology Development

- Preparation of Manuals/Handouts and Dissemination
- Workshops with STAs and PTAs
- Training and Awareness
- Visits of PIUs/SRRDAs/STAs/PTAs within and outside India
- Colloquium of Contractors
- Awards to recognize the efforts of-
  - NRIDA
  - STAs/PTAs/ IITs etc
  - SRRDA
  - PIUs
  - Contractors

In main streaming and up-scaling the innovative technologies in construction and maintenance of rural roads.

Additional Information Required in DPRs

- Introduction of Technology
- Choice of Technology and Advantage of Technology in Particular Case.
- Design of Pavement Component Using Technology.
- Rate Analysis of Items
- Cost comparison of corresponding layers.
- Results of Trials if carried out in advance or Proposed Methodology of Trial tests.
- Certification by the Technical Agency.

MoRT&H Advisory on New/Alternate Materials & Technologies

S. No.	Material/ Technology	Applications	IRC Code/Guidelines/IS Code	MoRT&H Circular
1.	Waste Plastic	Wearing Coat	**IRC:SP-98** "Guidelines for the use of Waste Plastic in Hot Bituminous Mixes (Dry Process) in Wearing Courses".	i. Circular No. RW/NH 33044/24/2015-S&R (R) dated **26.11.2019** "Use of Waste Plastic in hot bituminous mixes in wearing courses (dry process) for construction of National Highways";

S. No.	Material/ Technology	Applications	IRC Code/Guidelines/IS Code	MoRT&H Circular
3.	Geo-Synthetics	i. Reinforcement in pavement ii. Slope-Protection iii. Separation, Filtration, Drainage and erosion control iv. Impermeable barrier/capillary cut off in waterlogged areas v. Stress relieving membranes and crack retarding layer.	i. **IRC:SP:59** "Guidelines for Use of Geo-synthetics in Road Pavements and Associated Works"; ii. **IRC:113** "Guidelines for the Design and Construction of Geo-synthetic Reinforced Embankments on Soft Subsoils". iii. **IRC:SP:48** "Hill Road Manual" iv. **IRC:56** "Recommended Practices for Treatment of Embankment and Roadside Slopes for Erosion control"	Circular No. 33044/64/2018-S&R (P&B) dated **16.07.2018** "Geo-Synthetics and their use in road construction".

New Technology Status (March 2022)

Length (in km)

State	Road Length Sanctioned till March 2022	Road Length Completed
Andaman and Nicobar	118	25
Andhra Pradesh	1544	862
Arunachal Pradesh	2677	924
Assam	7680	6366
Bihar	7060	5459
Chhattisgarh	8089	4722
Gujarat	1532	592
Haryana	3232	2265
Himachal Pradesh	2176	1422
Jammu and Kashmir	1140	599
Jharkhand	5128	4949
Karnataka	1647	957
Kerala	1064	528
Ladakh	111	84
Madhya Pradesh	13671	9851
Maharashtra	2797	928
Manipur	1111	492
Meghalaya	2210	1086
Mizoram	729	264
Nagaland	675	355
Odisha	13438	7728

State	Road Length Sanctioned till March 2022	Road Length Completed
Pondicherry	50	–
Punjab	1010	453
Rajasthan	6376	5209
Sikkim	1132	444
Tamilnadu	3383	2334
Telangana	1801	795
Tripura	474	302
Uttar Pradesh	11835	3552
Uttarakhand	5261	2334
West Bengal	3778	3362
Grand Total	**112930**	**69243**

Length (in km)

Technology	Road Length Sanctioned till March 2022	Road Length Completed
Waste Plastic	40130	25904
Cold Mix	25977	16955
Cell filled	3068	2218
Panelled CC	4831	2513
Terrazyme	1654	993
Nanotechnolgy/Nanotac	7777	3580
Coir/Jute/Geo- Textiles	1539	1061
RCCP (Roller Compacted Concrete Pavement)	1055	983
Cement Stabilization	10384	5887
Surface dressing	2816	949
Others	13699	8200
Total	**112930**	**69243**