NEW AND INNOVATIVE MATERIALS FOR LONG LASTING ROAD INFRASTRUCTURE
MODIFIED BINDERS FOR IMPROVED PERFORMANCE OF HIGHWAYS
TYPES OF POLYMERS

- Plastomers
  - High stiffness - low ductility
  - Typical kinds - LDPE, polyolefin,

- Elastomers
  - Low initial stiffness - high ductility
  - Typical kinds - SB, SBS, SBR
TECHNICAL REASONS FOR USE OF POLYMERS

- Stiffer mixtures at higher temperatures
- Softer mixtures at low service temperatures
- Improved fatigue resistance of HMA mixtures
- Reduced life cycle costs of HMA pavements
POLYMERS - CONSTRUCTION CONCERNS

- Separation
- Higher construction temperatures
- Difficult to handle
<table>
<thead>
<tr>
<th>Types of Modifiers</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plastomeric Thermoplastics</strong></td>
<td>Polyethylene (PE), Ethylene Vinyl Acetate (EVA), Ethylene Butyl Acrylate (EBA) and Ethylene Ter Polymer (ETP), etc.</td>
</tr>
<tr>
<td><strong>Elastomeric Thermoplastics</strong></td>
<td>Styrene Isoprene Styrene (SIS), Styrene-Butadiene – Styrene (SBS) block copolymer, etc.</td>
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<tr>
<td><strong>Synthetic Rubber Latex</strong></td>
<td>Styrene Butadine Rubber (SBR) latex and any other suitable synthetic rubber</td>
</tr>
<tr>
<td><strong>Natural Rubber</strong></td>
<td>Latex or Rubber power</td>
</tr>
<tr>
<td><strong>Crumb Rubber</strong></td>
<td>Crumb Rubber powder from discarded truck tyres further improved by additives, viz., gilstones resin, etc.</td>
</tr>
</tbody>
</table>
APPLICATIONS OF RUBBER AND POLYMER MODIFIED BITUMEN

- Modified Bitumen – High Stiffness Modulus
  - Enhanced Fatigue Life
  - Better Resistance to Creep
  - High Indirect Tensile Strength
  - Quite Suitable as Renewal Course and Overlay Material
  - Used as Stress Absorbing Membrane (SAM) for Sealing of Cracks
  - Used as Interim Overlay for Preventive Maintenance
  - Stress Absorbing Membrane Interlayer to Delay Reflection Cracking
PERMANENT DEFORMATION

- Heavy Wheel Loads
- High Service Temperature
- Slow Speed
- Channelised Traffic
- High Tyre Pressure
- Stiffness of the Asphalt Mixture
- Stiffness of Asphalt Binder
- Degree of Compaction
SOLUTIONS

- Use Stiffer Mix
- Stiffer Binder with High Softening Point, High Temperature Behaviour without Loss of Low Temperature Properties
- Stiffer Binder has a Risk of Low Temperature Cracking !!
- Use Polymer Modifier Without Risk of Low Temperature Cracking – High Softening Point and Low Breaking Point
What Is SMA?
STONE MATRIX ASPHALT (SMA)

- SMA is a gap graded aggregate asphalt hotmix that maximises the asphalt cement content and coarse aggregate fraction.
- SMA provides a stable stone on stone skeleton that is held together by a rich mixture or asphalt cement, filler and stabilising additive.
COMPARISON OF SMA AND DENSE GRADED MIXES

Dense Graded Mix

SMA Mix
Stone Matrix Asphalt

Components

Stone Aggregate

Asphalt Mastic

Stone on Stone Contact
WARM MIX ASPHALT

- Technological improvements to enhance material performance
- Increase construction efficiency
- Conserve resources
- Advance environmental stewardship

- Methods to reduce material production temperature
WHAT IS WARM MIX ASPHALT (WMA)?

WMA is asphalt mix technology suitable for use with:

- conventional hot mix aggregates & binders;
- continuous & batch mix production plants;
- common hauling, paving, & compaction equipment; and
- standard HMA mix design & testing methods.
WHAT IS WARM MIX ASPHALT (WMA)?

WMA is asphalt mix technology that:

- allows asphalt mix production at temperatures 85 to 100 F (30 to 50 C) below HMA production & construction temperatures,
- while delivering the same or better performance properties as conventional hot mix asphalt (HMA)
TEMPERATURE

- Crucial for aggregate coating
- Matrix stability during production and transport
- Ease of placement and compaction
- Temperature high enough to ensure workability of the mix, but below the temperature at which drain-down and excessive binder hardening occur
<table>
<thead>
<tr>
<th>Grade</th>
<th>Bitumen</th>
<th>Agg.</th>
<th>Mix</th>
<th>Laying</th>
<th>Rolling</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>150 - 165</td>
<td>150 - 170</td>
<td>165 Max</td>
<td>125 Min</td>
<td>90 Min</td>
</tr>
<tr>
<td>90</td>
<td>140 - 160</td>
<td>140 - 165</td>
<td>155 Max</td>
<td>115 Min</td>
<td>80 Min</td>
</tr>
</tbody>
</table>
FIELD PROBLEMS

- Modern performance requirements dictate use of PMB, more angular aggregates, higher in-place density
- Insurance against permanent deformation at high temperature
- PMB mixes-difficult to work than mixes with unmodified binders
- Tendency to raise production and placement temperature ➔ increased plant emissions and fumes
- Reduce temperature of the plant mix ➔ reduced emission, energy savings
PERFORMANCE IMPACT

Reduction in production temperature:
- Reduced rate of cooling
- Improved compaction
- Reduced mixture aging
- Improved crack resistance
- More time for compaction – extended time
LOWER PRODUCTION AND PAVING TEMPERATURE

- Enhance compaction characteristics by lowering the viscosity of the binder at low temperature
- Reduction in short term aging; loss of stability resulting in increased rutting
- Use of foam bitumen/emulsion ➔ moisture effect viz., stripping
Late Season Paving

HMA Time = 14 min.

WMA Time = 29 min.

For $\Delta T = 125^\circ F$
Binder Hardening

- Virgin AC
- Recovered AC
- 2 years

Pen

- Hot Mix
- Evotherm
Geosynthetics

- Geosynthetics in civil engineering
  - Geotextiles – Woven and Non woven
  - Geogrids – Flexible and Rigid
  - Geonets
  - Geoties
  - Geomembranes
  - Band drains

- Polymer based – Polypropylene, Polyester, PVC, Polyamide, Polyethylene
Geotextile Usage

- About 3 billion square m of geotextiles estimated to have been used worldwide last year – China using about 50 per cent of this quantity
- About 5 to 10 million square m of geosynthetics used in India last year, worth Rs.100 Crores
- Huge potential for usage of geosynthetics in on-going road development projects
Geosynthetic Usage – Potential Areas

- Black Cotton Soil Areas – Geotextile application
- Coastal and Delta Regions – Band drains
- Hilly Terrain – Erosion control with the use of Geotextiles – Synthetic and Natural
- Reinforced soil structures using polymeric geosynthetics
Roads on soft subgrade.
Truck on Sub-Base without Geogrid.
Truck on_sub-base with_grid.
SOIL SQUEEZES

Base Failure / Bearing Capacity Failure / Failure by Lateral Spreading
Multi-layer Reinforcement / Geocell mattress
Use of Geotextile as Separator in NHDP Work
(Four-laning work on NH-6, Dankuni to Kolaghat, Km 17 to 72, West Bengal)
Use of Geosynthetics in Black Topped Pavement
Use of Geosynthetics in Concrete Pavement
Ground Improvement Using Geosynthetic Band Drains

- Project – Visakhapatnam Port Connectivity Road
- Distinguishing feature – Ground improvement using band drains for a length of 4 km
- Spacing of band drains – 1.15 m centre to centre and waiting period – 350 days
Installation of band drains

Stitcher for installing band drains

Close up view of mandrel for installing band drain
Band Drains After Installation
THANK YOU