Maintenance of Roads in Pakistan

NHA’s Perspective

BY

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Islamabad

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In the Name of Allah, the Most Gracious, the Most Merciful
ROAD NETWORK OF PAKISTAN AND ITS IMPORTANCE
PAKISTAN’S GEO-STRATEGIC LOCATION

PAKISTAN'S GEO-STRATEGIC LOCATION
## ROAD TRANSPORT DATA COMPARISON

<table>
<thead>
<tr>
<th></th>
<th>UNIT</th>
<th>1947</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL ROADS</td>
<td>KM</td>
<td>50,367</td>
<td>260,000 +</td>
</tr>
<tr>
<td>REGD VEHICLES</td>
<td>NO</td>
<td>30,577</td>
<td>5,000,000 +</td>
</tr>
<tr>
<td>REGD TRUCKS/TRAILERS</td>
<td>NO</td>
<td>800</td>
<td>184,000</td>
</tr>
<tr>
<td>NATIONAL HIGHWAYS &amp; Motorways</td>
<td>KM</td>
<td>NIL</td>
<td>11,485</td>
</tr>
<tr>
<td>ROAD DENSITY</td>
<td>KM/KM²</td>
<td>0.06</td>
<td>0.32</td>
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</tbody>
</table>
MODAL SHARE
PAKISTAN TRANSPORTATION MODE

95% 90%

% 100

Freight Traffic
Passenger Traffic

ROAD
RAIL
AIR

5% 8% 0% 2%
IMPORTANCE OF
MAINTENANCE OF ROADS
The Costs, Involved during the Design Life of any Pavement, may be Broadly Categorised into Following Three Types.

- Construction Cost
- Maintenance Cost
- Road User Costs
Components of Total Road Transport Costs in the Economy

- Fuel Consumption
- Oil Consumption
- Tyres Wear & Tear
- Parts Replacement
- Vehicle Depreciation
- Travel Time
- Accidents
Key Statistics from Emerging Countries

- Transport sector is 5 to 10 percent of GDP.
- Every Rupee not spent on maintenance increases transport costs by Four Rupees.
- Transport fuels and machinery account for 40% of import bill.
Is This we want on our Roads

Definitely - Not
The effects of road maintenance can be assessed in terms of the various impacts:

- Level of service (road condition)
- Socio economic impacts
- Road user costs
- Accident levels and costs
- Road administration costs
BENEFITS OF MAINTENANCE INVESTMENTS

<table>
<thead>
<tr>
<th>Budget Scenario</th>
<th>Decrease in Vehicle Operating Cost (Year 1-5)</th>
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<tbody>
<tr>
<td>9 Bn Rs./Yr</td>
<td>140</td>
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<tr>
<td>8 Bn Rs./Yr</td>
<td>128</td>
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<td>7 Bn Rs./Yr</td>
<td>112</td>
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<td>6 Bn Rs./Yr</td>
<td>100</td>
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<tr>
<td>5 Bn Rs./Yr</td>
<td>85</td>
</tr>
<tr>
<td>4 Bn Rs./Yr</td>
<td>65</td>
</tr>
<tr>
<td>3 Bn Rs./Yr</td>
<td>54</td>
</tr>
<tr>
<td>2 Bn Rs./Yr</td>
<td>37</td>
</tr>
</tbody>
</table>
SOME CHALLENGES
PERCENTAGE OF FREIGHT VEHICLES BY COMPOSITION

OVERLOADED PERCENTAGE

TRUCKS
2 & 3 AXLES

Within Load Limits: 30%
Overloaded: 70%

TRUCKS
4, 5 & 6 AXLES

Within Load Limits: 60%
Overloaded: 40%
Pavements
Definition

- The structure of road Which actually carries the traffic loads is called *Pavement*. 
Pavement Purpose; A Broad Definition

- Load support
- Smoothness
- Drainage

DC to Richmond Road in 1919 – from the Asphalt Institute
Pavement Performance

• Functional Performance
  • Providing Users a safe and comfortable Ride
  • Consists of
    ➢ Ride Quality
    ➢ Surface Friction
    ➢ Other factors (Noise, Geometrics etc)

• Structural Performance
  • Ability to withstand traffic and environmental loadings
Pavement Types

- Flexible Pavement
  - Bituminous pavements
  - Called "flexible" since the total pavement structure bends (or flexes) to accommodate traffic loads

- Rigid Pavement
  - Portland cement concrete (PCC) pavements
  - Called “rigid” since PCC’s high modulus of elasticity does not allow them to flex appreciably

- Composite Pavements
  - Portland cement concrete (PCC) over HMA pavements
  - HMA Over PCC Pavements
Flexible Pavement

- Structure
  - Surface course
  - Base course
  - Subbase course
  - Subgrade
Types of Flexible Pavement

Dense-graded

Open-graded

Gap-graded
Flexible Pavement Types

- Flexible Pavement
  - Hot Mix Asphalt Surface
    - With Granular Unbound Base
    - With Stabilised (Bound) Base
    - Full Depth HMA
  - Bituminous Surface Treatment
    - With Granular Base
      - Single Surface Treatment
      - Double Surface Treatment
      - Triple Surface Treatment
Rigid Pavement

- Structure
  - Surface course
  - Base course
  - Subbase course
  - Subgrade
Types of Rigid Pavement

- Jointed Plain Concrete Pavement (JPCP)
Types of Rigid Pavement

- Jointed Reinforced Concrete Pavement (JRCP)
  - Steel Mesh 0.1 to 2.0% of Cross sectional Area
  - Joint Spacing 7.5 to 30 m
  - Slab Thickness: 150 to 400 mm
  - Granular stabilized base
Types of Rigid Pavement

- Continuously Reinforced Concrete Pavement (CRCP)

Photo from the Concrete Reinforcing Steel Institute

© 2003 Steve Muench
Design Parameters

- Subgrade
- Loads
- Environment
Maintenance Alternatives

- Routine Maintenance
- Resurfacing
- Recycling
- Restoration
- Reconstruction
Types of Distresses in Flexible Pavements

A. Cracking
   1. Fatigue Cracking
   2. Block Cracking
   3. Edge Cracking
   4. Longitudinal Cracking
   5. Reflection Cracking at Joints
   6. Transverse Cracking

B. Patching and Potholes
   7. Patch Deterioration
   8. Potholes
Types of Distresses in Flexible Pavements

C. Surface Deformation
   9. Rutting
   10. Shoving

D. Surface Defects
   11. Bleeding
   12. Polished Aggregate
   13. Raveling

E. Miscellaneous Distresses
   14. Lane-to-Shoulder Dropoff
   15. Water Bleeding and Pumping
FATIGUE CRACKING

- Occurs in areas subjected to repeated traffic loadings (wheel paths).
- Can be a series of interconnected cracks in early stages of development.
- Develops into many-sided, sharp-angled pieces, usually less than 0.3 meters (m) on the longest side, characteristically with a chicken wire/alligator pattern, in later stages.
- Must have a quantifiable area.
FATIGUE CRACKING; Severity Levels

- **LOW**
  An area of cracks with no or only a few connecting cracks; cracks are not spalled or sealed; pumping is not evident.

- **MODERATE**
  An area of interconnected cracks forming a complete pattern; cracks may be slightly spalled; cracks may be sealed; pumping is not evident.

- **HIGH**
  An area of moderately or severely spalled interconnected cracks forming a complete pattern; pieces may move when subjected to traffic; cracks may be sealed; pumping may be evident.
FATIGUE CRACKING
BLOCK CRACKING

- A pattern of cracks that divides the Pavement into approximately rectangular pieces.
- Rectangular blocks range in size from approximately 0.1 m² to 10 m².
BLOCK CRACKING
LONGITUDINAL CRACKING

- Cracks predominantly parallel to pavement centerline. Location within the lane (wheel path versus non-wheel path) is significant.
LONGITUDINAL CRACKING

Inner Wheel Path
Outer Wheel Path

4a - Wheel Path
4b - Non-Wheel Path
REFLECTION CRACKING (At Joints)

- Cracks in asphalt concrete overlay surfaces that occur over joints in concrete pavements.
REFLECTION CRACKING

Diagram showing the various types of cracks, including joint reflection cracks, transverse cracks, and longitudinal joint reflection cracks. The diagram illustrates how these cracks propagate through the layers of the pavement system.

Note: Uniform spacing of cracks reflects the spacing of underlying joints.
Cracks that are predominantly Perpendicular to pavement centerline.
TRANSVERSE CRACKING
POTHOLES

- Bowl-shaped holes of various sizes in the pavement surface. Minimum plan dimension is 150 mm.

Note: Two potholes, third defect is less than minimum dimension.
POTHOLES
A rut is a longitudinal surface depression in the wheel path. It may have associated transverse displacement.
RUTTING
Shoving is a longitudinal displacement of a localized area of the pavement surface. It is generally caused by braking or accelerating vehicles, and is usually located on hills or curves, or at intersections.

It also may have associated vertical displacement.
Wearing away of the pavement surface caused by the dislodging of aggregate particles and loss of asphalt binder. Raveling ranges from loss of fines to loss of some coarse aggregate and ultimately to a very rough and pitted surface with obvious loss of aggregate.
RAVELING
Maintenance Principles
Treatments, Triggers and Resets

Decay in Condition (DETERIORATION)

Condition Improvement (RESET)

Minimum Acceptable Standard (TRIGGER)

Treatment Applied

ROAD CONDITION

EXCELLENT

POOR

TIME
Deterioration Management

- ASSET CONDITION:
  - EXCELLENT
  - POOR

- ORIGINAL DECAY

- OPTIMAL RENEWAL STRATEGY

- OPTIMAL CONDITION BAND

- Maintenance Treatments

- TIME
Requirement - Optimization to Minimize Total Transportation Cost (TTC)

- Total Transport Costs
- Road User Costs
- Maintenance Costs
- Construction Costs

Optimum Maintenance
Means of Maintenance

- An ideal system for the maintenance should be based on some scientific basis and all the data required should be collected on some standards.

- For decision making process, many countries have developed Pavement Management System (PMS) according to their need.

- In Pakistan, Different agencies are using various PMS varying from excel sheets to state of art Models like HDM-4
Main components include:

- Forecasting of Revenue Generation/Investment Statement
- Road and Bridge Distress Survey
- Roughness Measurement Survey
- Strength Evaluation Survey
- Traffic Survey
- Historical Data
- Performance Standards
- Feedback from Stakeholders
- Treatment Rules
NHA RAMS DATABASE

GIS System

Regional Office Connectivity

Bridge Management System

Road Database

Pavement Management System

Contract Management System
Data Collection
PLEASE DOCUMENT YOUR EXPERIENCE
Data Collection

Following Data is collected each year

• Pavement Condition Data
• Traffic Data
• Falling Weight Deflecto-meter Data
• Roughness Data
• Profilo-graph Data
• Economic Data for Traffic Fleet
• Revenue Data From Toll Plazas
Information Quality Levels (IQL)

- **IQL-5**: System Performance Monitoring
  - Performance
  - Structure
  - Condition
  - Planning and Performance Evaluation
    - Programme Analysis or Detailed Planning
    - Project Level or Detailed Programme

- **IQL-4**: Ride Distress Friction
  - Project Detail or Research

- **IQL-3**: Monitoring and Performance Evaluation
  - Programme Analysis or Detailed Planning

- **IQL-2**: Monitoring and Performance Evaluation
  - Project Level or Detailed Programme

- **IQL-1**: Monitoring and Performance Evaluation
  - Project Level or Detailed Programme

**HIGH LEVEL DATA**

**LOW LEVEL DATA**
Pavement Condition Data

Pavement Distress type, Extent and Severity is recorded for EACH KM of the every Road. The Data is Collected by WINDSHIELD SURVEY.

Following Distresses with measuring units are identified for Data Collection

- Cracking (%age of length effected & Crack Width)
- Rutting (Length of Rutted Portion & Rut Depth)
- Potholes (Number of Potholes in KM)
- Ravelling (%age of length effected & Disintegration Type)
- Edge Step (%age length effected & Depth)
- Erosion from Original Edge (%age length effected & Depth)
- Drainage Condition (Performance Indicator)
## PAVEMENT CONDITION SURVEY FORM

**Route:** ________________________  **To:** ________________________

**Kilometer Info.**

<table>
<thead>
<tr>
<th>Depth mm</th>
<th>6-12</th>
<th>12-25</th>
<th>25-40</th>
<th>&gt; 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Wheel Track Rutting**

<table>
<thead>
<tr>
<th>Width mm</th>
<th>&lt; 5</th>
<th>5 - 10</th>
<th>10 - 25</th>
<th>25-50</th>
<th>50-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
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</table>

**Cracking**

<table>
<thead>
<tr>
<th>Depth mm</th>
<th>&lt; 2</th>
<th>2 - 6</th>
<th>6 - 10</th>
<th>&gt; 10</th>
</tr>
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<tbody>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Potholes**

<table>
<thead>
<tr>
<th>Depth mm</th>
<th>&lt; 2 SM</th>
<th>2-4 SM</th>
<th>4-6 SM</th>
<th>&gt; 8 SM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ravelling**

<table>
<thead>
<tr>
<th>Depth mm</th>
<th>&lt; 5</th>
<th>5 - 10</th>
<th>10 - 25</th>
<th>25-50</th>
<th>50-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Edge Step**

<table>
<thead>
<tr>
<th>Depth mm</th>
<th>&lt; 5</th>
<th>5 - 10</th>
<th>10 - 25</th>
<th>25-50</th>
<th>50-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Erosion from Original edge**

<table>
<thead>
<tr>
<th>Width mm</th>
<th>&lt; 100</th>
<th>100 - 200</th>
<th>200 - 250</th>
<th>&gt; 250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Drainage Condition**

- Good
- Fair
- Poor

Filled By: _______________________  **S.Type** - **Surface Type**  **R.W** - **Road Width**  **L.S** - **Left Shoulder Width**  **R.S** - **Right Shoulder Width**
24 Hours Classified Traffic Counts at Chosen Stations is Carried Out.

Traffic Data is also Retrieved from NTRC, NHA, NH&MP and Other Highway Consultants.

This Data is, then, Sorted for Different Analysis.

Axle Load Data is Collected from NH&MP and NHA Weigh Stations.

Axle Load Studies by NTRC, RAMD and JICA Japan are also consulted.
FWD Data

- FWD data is collected by NHA itself.
- KUAB Falling Weight Deflectometer is used to collect the data.
STIFFNESS CONCEPT

Wheel load

WEAK

Poor load spreading

Subgrade

Compressive stress on subgrade

STONG

Good load spreading
FWD Deflection Basin
Pavement Roughness Data

- Pavement Roughness Data is Collected by ROMDAS Bump Integrator Unit & Profilograph.

- The BI unit Gives the Number of Bumps, it received from the pavement, which were, then, converted to IRI values.

- IRI is a standard to measure the smoothness of the Pavement and measures Pavement Roughness in terms of the number of mm per Km that a vehicle receives during its operation.
Bump Integrator Unit

Once the software is started the screen on the right is displayed. This has four buttons which control the software setup:

- **File** properties. Defines the file name.
- **Setup**. Defines the Z-250 settings.
- **Connection**. The status of PC connection.
- **Plot**. Plot a Z-250 file and display the IRI.

The name of the current file is displayed in the window. This name defaults to yymmddnn.txt, where yy is the year, mm the month, dd the day and nn the survey number. The name below is from 31 January 2002, survey number 2.

The ROMDAS Bump Integrator (BI) is illustrated below. It is installed in the rear of the vehicle but is small enough to be relatively unobtrusive.
Front bar with 13 roughness lasers (16 kHz) and 2 texture lasers (64 kHz)
HDM-4 APPLICATION
PRIORITIZATION CYCLE

ANNUAL BUSINESS PLAN

APPLICATON OF HDM MODEL

Analysis Tools
- Project
- Program
- Strategy

Central Data Bank
- Road Network
- Vehicle Fleet
- Road Works
- HDM Config.
The Highway Design and Maintenance Standards Model (HDM-4), Developed by the World Bank, has been Used for over two Decades to Combine Technical and Economic Appraisals of Road Projects, to Prepare Road Investment Programmes and to Analyze Road Network Strategies.
Road Network

Section: M-2 Isb Link Road N

Definition | Geometry | Pavement | Condition
---|---|---|---

Surfacing:
- Material type: Asphaltic Concrete
- Most recent surfacing thickness: 130 mm
- Previous/old surfacing thickness: 0 mm

Previous works (HDM-4 Work Types):
- Last reconstruction or new construction: 1998 year
- Last rehabilitation (overlay): 1998 year
- Last resurfacing (resealing): 1998 year
- Last preventative treatment: 1998 year

Strength:
- Calculated Dry season model parameters:
  - SNP: 4.35
  - DEF: 0.62 mm

- Structural Number: 4.5
- Subgrade CBR:
- Day Season or Wet Season

Road base (for stabilised base only):
- Base thickness:
- Resilient modulus:

Traffic:
- Motorised: 9143 AADT
- NMI: 0
- Year: 2005
- Flow direction: One-way uphill

Name of section
Vehicle Fleet is Developed by Considering Different Types of Vehicles which are Using the Road Network in Pakistan. Following Data is Provided for 12 Type of Vehicles:

- Type & Class of Vehicle
- Physical Characteristics
- Utilisation of Vehicle
- Specifications of Tyres
- Axle Loading and Spacing
- Vehicular Resources
- Time Value
- Fuel & Lubrication Pricings
## Economic Costs of Motorcycles & Cars

### BASIC SPECIFICATIONS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>M.Cycle</th>
<th>Car</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engine (cc)</strong></td>
<td>Honda 70</td>
<td>Toyota Corrolla XE</td>
</tr>
<tr>
<td><strong>Gross Vehicle Weight (kg)</strong></td>
<td>Honda 125</td>
<td>1296</td>
</tr>
<tr>
<td><strong>Number of Axles</strong></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Types of Tyres</strong></td>
<td></td>
<td>270 - 18-4PR</td>
</tr>
<tr>
<td><strong>Seats</strong></td>
<td></td>
<td>2</td>
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</table>

### USAGE

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>M.Cycle</th>
<th>Car</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Life (years)</strong></td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td><strong>Hours Driven per year</strong></td>
<td>300</td>
<td>450</td>
</tr>
<tr>
<td><strong>Average Speed (km/hr)</strong></td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td><strong>Km Driven per year</strong></td>
<td>12000</td>
<td>22500</td>
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</table>

### COST (Rs)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>M.Cycle</th>
<th>Car</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vehicle Market Price</strong></td>
<td>59000</td>
<td>879000</td>
</tr>
<tr>
<td><strong>Market Price of Tyre</strong></td>
<td>1200</td>
<td>2500</td>
</tr>
<tr>
<td><strong>Market Price of Tyres in vehicle</strong></td>
<td>2400</td>
<td>2500</td>
</tr>
<tr>
<td><strong>Vehicle Market Price without Tyres</strong></td>
<td>56600</td>
<td>869000</td>
</tr>
<tr>
<td><strong>Duty / Tax Ratio</strong></td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td><strong>Economic Cost Ratio</strong></td>
<td>0.71</td>
<td>0.71</td>
</tr>
<tr>
<td><strong>Economic Cost Of Vehicle Minus Tyre</strong></td>
<td>40186</td>
<td>616990</td>
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</table>

### Tyre Cost (Rs)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>M.Cycle</th>
<th>Car</th>
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<tbody>
<tr>
<td><strong>Market Price of Tyre</strong></td>
<td>500</td>
<td>2500</td>
</tr>
<tr>
<td><strong>Tax Ratio on Tyre</strong></td>
<td>0.13</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>Economic Cost Ratio</strong></td>
<td>0.87</td>
<td>0.87</td>
</tr>
<tr>
<td><strong>Economic Cost per Tyre</strong></td>
<td>435</td>
<td>2175</td>
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</table>
Work Standards

24 Maintenance Standards are Developed and Costing of Each of Them is Carried out. These Standards are Then Imported to HDM-4 for Choosing Best Alternative for any Road Section: Following are Considered for the Formulation of These Standards:

- Desired Service Indicators
- Maximize the Net Present Value
- Maximize the Internal Rate of Return
- Minimize the IRI
- Minimum Cost for Maintaining a Road.

Rate Analysis for All the Maintenance Standard is Carried out in Excel Sheets
Each Maintenance Standard is Associated with Responsive Criteria. And it Triggers when That Criteria is Met. Like

- **Rehabilitation Triggers when** $\text{IRI} \geq 5 \& \text{Cracked Carriageway} \geq 35\%$

Similarly

- **120 mm Structural Overlay Triggers when** $4 \leq \text{IRI} \leq 5 \& \text{Cracked Carriageway} \geq 15\% \& < 35\%$
Work Standards
# UNCONSTRAINED WORK PROGRAM

**AS PER HDM-IV ANALYSIS - 2008**

## HDM-4

**HIGHWAY DEVELOPMENT & MANAGEMENT**

---

### Work Programme Unconstrained by Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Section</th>
<th>Road Class</th>
<th>Length (km)</th>
<th>AADT</th>
<th>Surface Class</th>
<th>Work Description</th>
<th>NPV/CAP</th>
<th>Financial Costs</th>
<th>Cum. Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>N25-01</td>
<td>Karachi - Hub (15-24)</td>
<td>Primary or trunk</td>
<td>10.00</td>
<td>13479 Bituminous</td>
<td>100 MM Overlay Single</td>
<td>19.29</td>
<td>84.65</td>
<td>84.65</td>
</tr>
<tr>
<td></td>
<td>M2 N 0 - 12KM</td>
<td>Primary or trunk</td>
<td>13.00</td>
<td>9362 Bituminous</td>
<td>Overlay Hot Recycle (M)</td>
<td>17.36</td>
<td>60.06</td>
<td>144.71</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N70-02</td>
<td>Muzaffargarh - D.G. Khan (16-30)</td>
<td>Primary or trunk</td>
<td>15.00</td>
<td>8060 Bituminous</td>
<td>100 MM Overlay Single</td>
<td>16.59</td>
<td>126.98</td>
<td>271.69</td>
</tr>
<tr>
<td></td>
<td>N70-02A</td>
<td>Muzaffargarh - D.G.Khan I (31-50)</td>
<td>Primary or trunk</td>
<td>20.00</td>
<td>8060 Bituminous</td>
<td>100 MM Overlay Single</td>
<td>16.59</td>
<td>169.30</td>
<td>441.00</td>
</tr>
<tr>
<td></td>
<td>N70-02B</td>
<td>Muzaffargarh - D.G.Khan II (61-80)</td>
<td>Primary or trunk</td>
<td>30.00</td>
<td>8060 Bituminous</td>
<td>100 MM Overlay Single</td>
<td>16.59</td>
<td>253.96</td>
<td>694.95</td>
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<td>Ghotki - Panuqai (535-525)</td>
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<td>Lahore Urban Area (1265-1246)</td>
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<td>157.86</td>
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<td>Jhelum T.P. - Kharian (1430-1410)</td>
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<td>12020 Bituminous</td>
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<td>11.44</td>
<td>104.76</td>
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<td>D.G. Khan - Sakhi Sanwar (81-122)</td>
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<td>Sara Gambia - Karak II (1053-1060)</td>
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Road Condition Survey 2008

REMAINING SERVICE LIFE (RSL)
Route: National Highway Network

Total Surveyed = 10648 Kms.
Underconstruction = 670 Kms.

RSL (Year)
Road Roughness Survey 2008

ROUGHNESS

Route: National Highway Network

<table>
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<th>Roughness (mm/km)</th>
<th>No. of Km</th>
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<tr>
<td>2000 &lt; =2000</td>
<td>2278</td>
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<tr>
<td>3000 &lt; =3000</td>
<td>706</td>
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<td>4000 &lt; =4000</td>
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<tr>
<td>&gt;7000</td>
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</tbody>
</table>

Total Surveyed = 10648 Kms.
Underconstruction = 670 Kms.
Road Condition Survey 2008

**RUTTING (depth)**

National Highway Network

- Un-rutted: 69%
- Rutting < 6 mm: 15%
- Rutting 6-12 mm: 13%
- Rutting >25 mm: 1%
- Rutting 12-25 mm: 2%

Total Surveyed = 10648 Kms.
Underconstruction = 670 Kms.
Road Condition Survey 2008

CRACKING (width)

Route: National Highway Network

- Cracking <2 mm: 13.77%
- Cracking 2-6 mm: 18.39%
- Cracking 6-10 mm: 7.00%
- Cracking >10 mm: 23.01%
- Un-cracked: 37.83%

Total Surveyed = 10648 Kms.
Underconstruction = 670 Kms.
End Note

*A Stitch in Time Saves Nine*
Thank You

Questions