



## **IRF WORLD ROAD MEETING 2017**

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### **Development of Pavement Maintenance Management System for High Speed Road Corridors Using State-Of-Art Technologies**

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# Objective of the Study

Development of a pavement maintenance management system involving network of high speed road corridors towards making logical decisions about the budget requirements and allocation of funds thereof for maintenance of pavements and bridges, based on optimal life cycle costs

- Both flexible as well as rigid pavements and bridges are included
- The system is capable of
  - Estimating the budget requirements and allocation of funds for pavement maintenance within constrained budget.
  - Deciding the optimal maintenance of road network within the given budget scenario.
  - Carrying out distress diagnostics, performance evaluation and rehabilitation and retrofitting of bridges.

# High Speed Corridors of National Highways (covered under the study)

- Golden Quadrilateral
- North South Corridor
- East West Corridor
- Port Connectivity
- Ahmedabad Vadodara Expressway
- Mumbai Pune Expressway
- Gurgaon Expressway
- Noida Greater Noida Expressway



# Location of Selected Road Sections

Six Climatic Zones Identified as per HDM-4 Classification



- A. Humid & Sub-tropical Hot
- B. Humid & Tropical
- C. Sub-humid & Sub-tropical Hot
- D. Sub-humid & Tropical
- E. Semi-arid & Sub-tropical Hot
- F. Semi-arid & Tropical

# Performance Observations on Selected Sections Selected under the Study

## Periodic Pavement Performance Data

(Three times with one year interval)

- Pavement Crust Thickness
- Pavement Structural Condition
- Pavement Functional Condition
- Pavement Surface Distress
- Road Inventory
- Pavement Maintenance History
- Vehicle Information Details
- Classified Traffic Volume Data
- Axle Load Spectrum
- Environmental Condition



**PERFORMANCE OBSERVATIONS ON SELECTED  
SECTIONS SELECTED UNDER THE STUDY  
(Typical Photographs)**

# Test Pit Evaluation



Density Measurement During  
Excavation

# Core Sampling of Bituminous and Cement Concrete Layers



(A) Core Extraction on Bituminous Pavement



(B) Core Extraction on CC Pavement



(C) Fresh Core Extracted from Bituminous Layers

# Structural Evaluation



**Deflection Measurements on a Test Section  
Using Benkelman Beam on NH-4B**



**Deflection Measurements on a Test Section  
Using Benkelman Beam**

# Surface Condition Survey on Flexible Pavements

**Good Surface Condition**



**Cracked Pavement Surface**



**Cracked Pavement Surface**



# Surface Condition Survey on Rigid Pavements

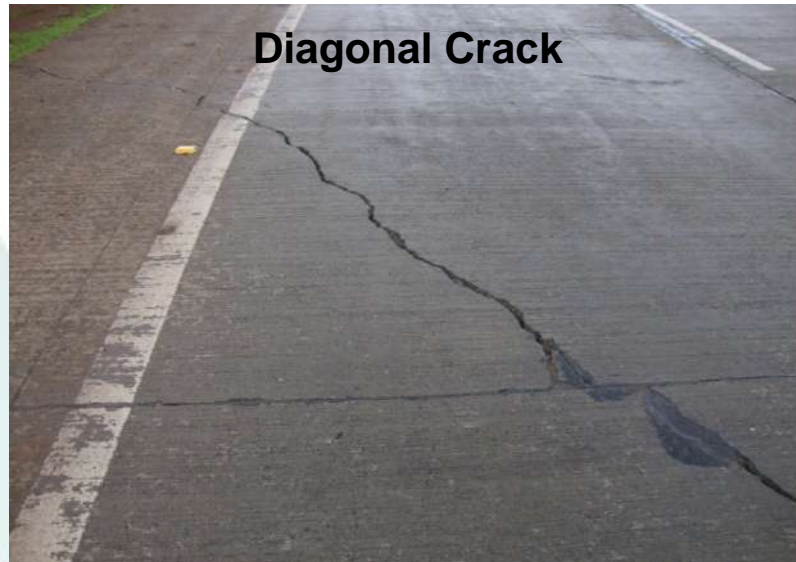
**Good Surface Condition**



**Abraded Surface**



**Diagonal Crack**



# Axle Load Survey Using Weigh-In-Motion (WIM) System



# Road Inventory and Pavement Condition Survey Using Automated Road Survey System



# Road Inventory and Pavement Condition Survey Using Automated Road Survey System



# ARSS-Rut Scanner



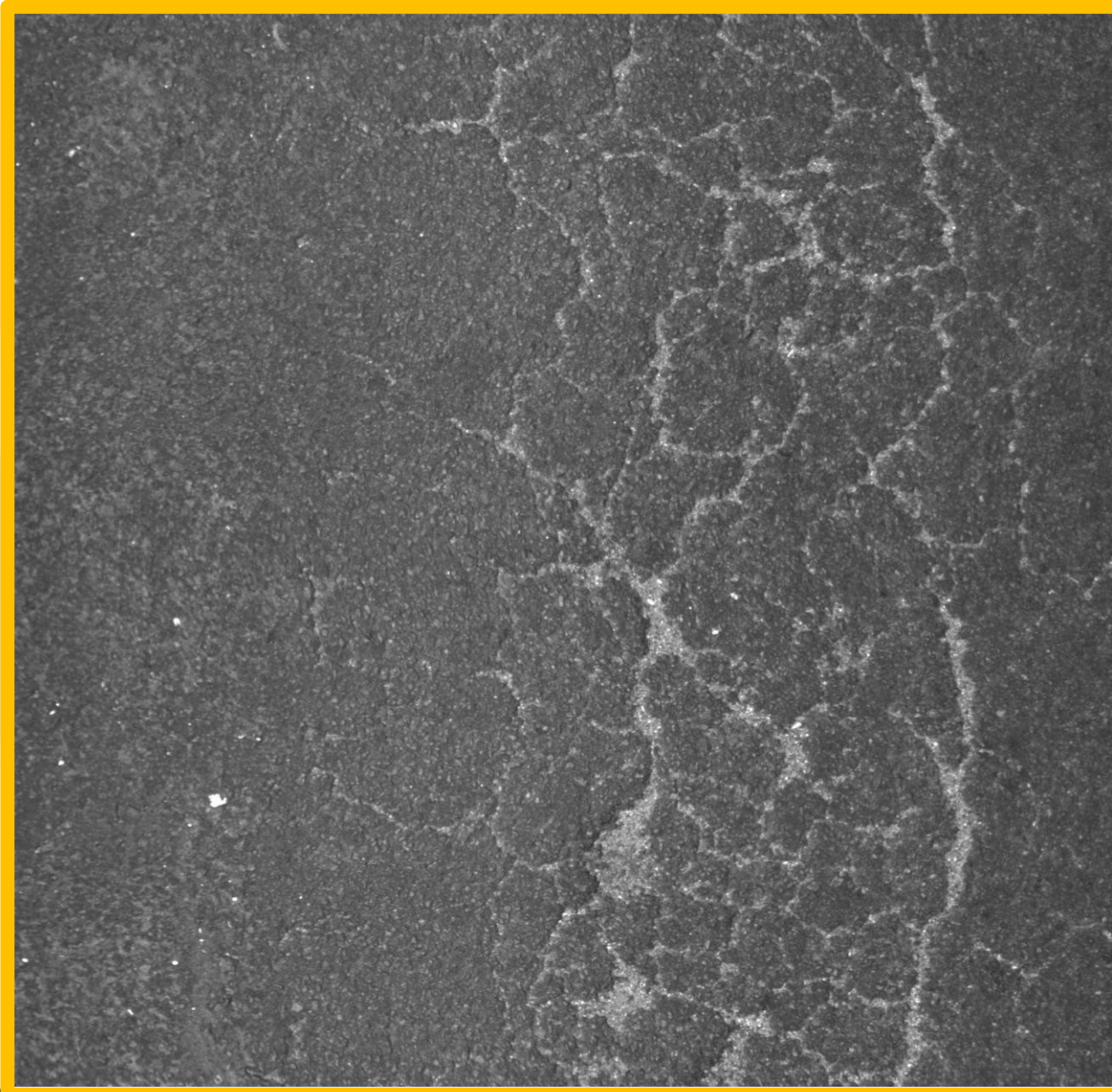
# Pavement Surface Imaging Technique



# Pavement Surface Imaging Technique



# Pavement Surface Image



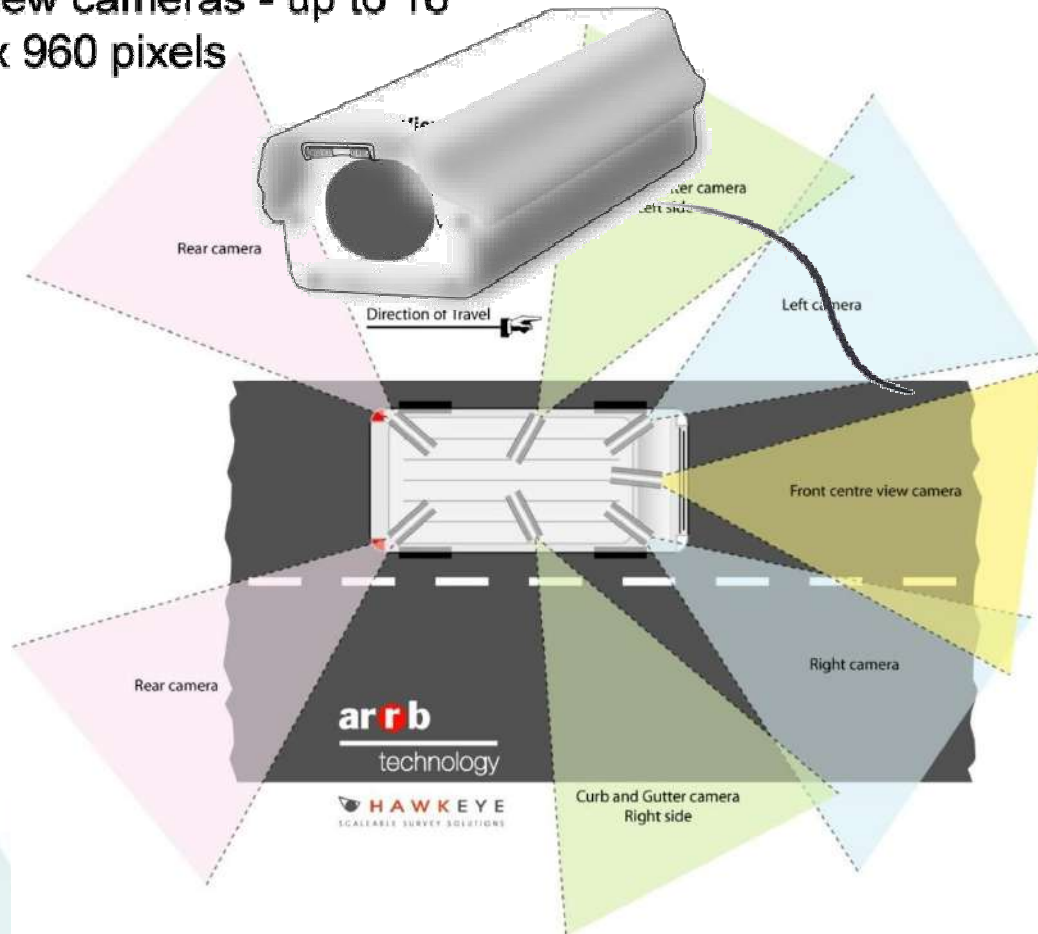
# Road Asset Camera

## Digital Cameras

Asset and Pavement View cameras - up to 16

High resolution - 1280 x 960 pixels

Fully Digital interface



# Asset Camera Measurements

The screenshot displays the ARRB-TEST - Hawkeye Processing Toolkit software interface. The main window shows a video feed of a road with a measurement overlay of 3.542 m. The interface includes a menu bar (File, View, Tools, Window, Help), a toolbar, and a sidebar with Toolkit Modules (GPS, Profiler, Reports, Scanner, Video) and Survey Position data.

**Survey Position Data:**

Chainage (km)	12.260
SubChain (km)	1.980
Speed (km/h)	49.0
Reference ID	5
Section Desc	more cracks
Road Name	Road name
Latitude (°)	28.46893800
Longitude (°)	77.30603900
Altitude (m)	194.1

**System Information:**

Server: localhost\HAWKEYE Database: ARSSODISSA Survey ID: 292058951159 Date and Time: 6/14/2012 10:53:18 AM Version 3.1 (Build: 16)

The Windows taskbar at the bottom shows the Start button, open applications (ARRB-TEST - Hawkeye..., Microsoft Office Pictu..., LANE WIDTH 1 - Paint), and system tray icons (9:47 PM).

# Road Parameters Measured Using Automated Road Survey System

- ✓ Longitudinal Profiling (International Roughness Index)
- ✓ Transverse profiling (Rut Depth)
- ✓ Pavement Texture (Mean Profile Depth)
- ✓ Cross Slope (%)
- ✓ Gradient (%)
- ✓ Rise+Fall (m/km)
- ✓ Rise +Fall (No. per km)
- ✓ Horizontal Curvature (degree/km)
- ✓ GPS coordinates (X, Y, Z) viz. longitude, latitude & altitude using Real Time-DGPS
- ✓ Pavement Surface Imaging for Distress Measurement
- ✓ Video imaging for Roadside furniture / Road asset



# **Development of PMMS**

- **Data Management and Information System on GIS based Software**
- **Management System for Maintenance Planning Using HDM-4**

# **Development of Data Management and Information System**

## **Creation of Database in SQL Server**

The database in respect of the following corridors has been created

– **Golden Quadrilateral Road Network**

- **Delhi-Mumbai and Mumbai-Delhi**
- **Mumbai-Chennai and Chennai-Mumbai**
- **Chennai-Kolkata and Kolkata-Chennai**
- **Kolkata-Delhi and Delhi-Kolkata**

– **North-South Corridor**

- **Jalandhar-Kanyakumari and Kanyakumari-Jalandhar**

– **East West Corridor**

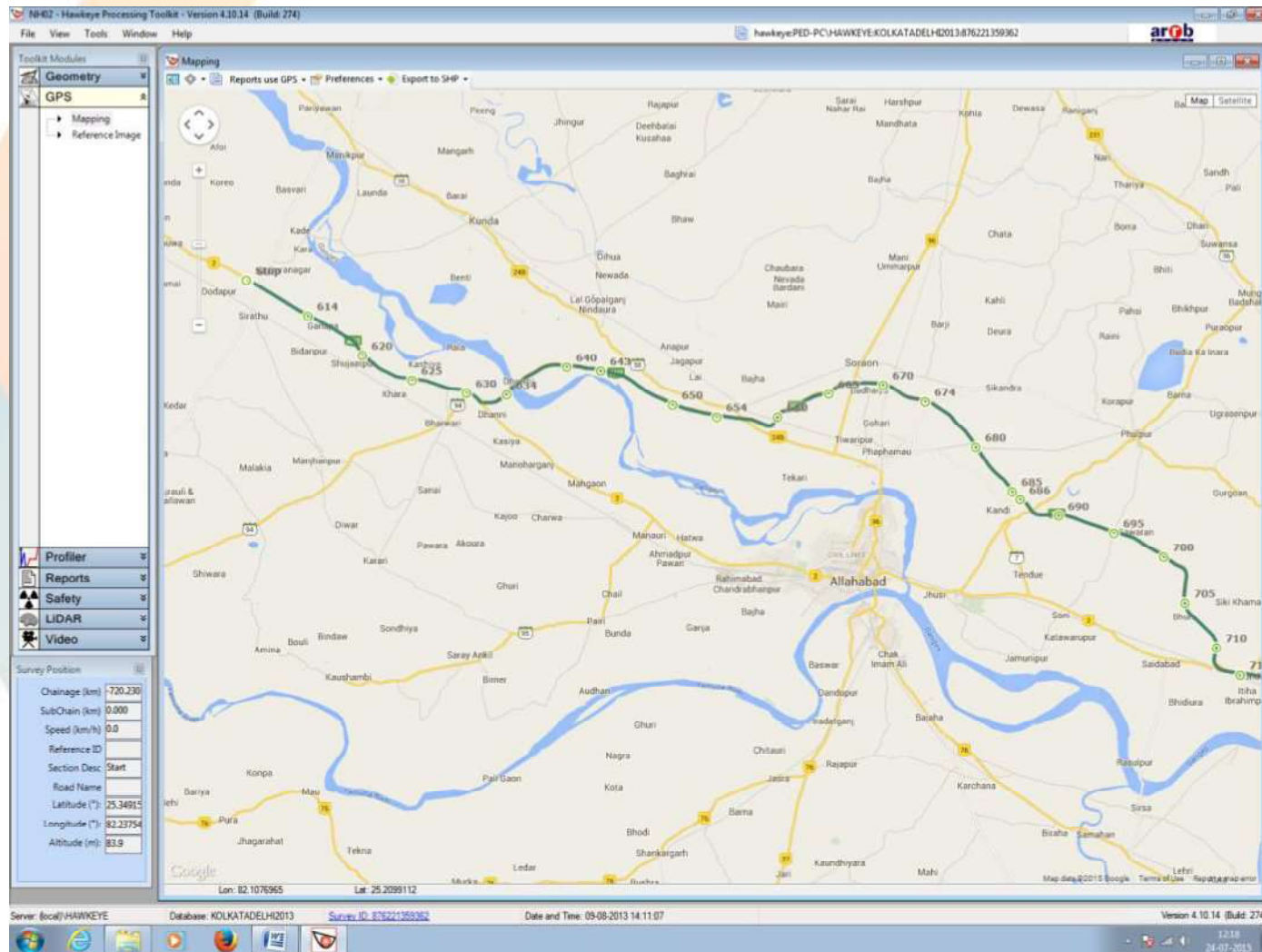
- **Silchar-Porbandar and Porbandar-Silchar**

## **.....Development of Data Management and Information System**

**Data Processing and Viewer Softwares has been used to manage and view the database and attribute information for each of the road corridor in GIS environment**

- Simultaneous viewing of all data (IRI, Rut Depth, Texture, Geometry, ROW Video, Pavement Surface Image, GPS Coordinates etc.)**
- Measurement of Carriageway Width, Lane Width, Shoulder Width etc. using ROW Video**
- Measurement of Pavement Surface Distress (Cracking, Ravelling, Pothole etc.) using Pavement Surface Images**
- Graphical View of data**
- Export to Excel File Format for Report Generation**
- Export to Shape File Format for GIS Compatibility**
- Export to HDM-4 File Format for HDM-4 Input**

# .....Development of Data Management and Information System



**A View of the GIS Map Generated for a Road Section (Kolkata-Delhi Corridor)**

# .....Development of Data Management and Information System



**A View of Road Information System showing all Data along with GIS Map and Right-of Way Images**

# .....Development of Data Management and Information System

The screenshot shows the HAWKEYE software interface. The 'Reports' menu is open, and 'HDM4 Export' is highlighted. A dialog box titled 'The Highway Development and Management System (HDM4) Reports' is displayed, showing a table of survey data and options to generate a report.

Survey ID	Survey Name	Description	Road Loc File	Survey Date/Time	Operator Name
<input checked="" type="checkbox"/>	853010624640	NH02	KOLKATA TO DHANBAD	07-08-2013 12:53:34	SUBHASH, SU...
<input type="checkbox"/>	853288721075	NH02	KOLKATA TO DHANBAD	07-08-2013 14:52:55	SUBHASH, SU...
<input type="checkbox"/>	853302877367	NH02	KOLKATA TO DHANBAD	07-08-2013 16:50:52	SUBHASH, SU...
<input type="checkbox"/>	857585781843	NH02	DHANBAD TO AURANGABAD	08-08-2013 08:43:01	SUBHASH, SU...
<input type="checkbox"/>	857585833603	NH02	DHANBAD TO VARANASI	08-08-2013 08:43:27	SUBHASH, SU...
<input type="checkbox"/>	871878751556	NH02	DHANBAD TO VARANASI	08-08-2013 12:41:05	SUBHASH, SU...
<input type="checkbox"/>	876173939868	NH02	AURANGABAD TO FATEHPUR	09-08-2013 07:36:02	SUBHASH, SU...
<input type="checkbox"/>	876173962224	NH02	AURANGABAD TO FATEHPUR	09-08-2013 07:36:23	SUBHASH, SU...
<input type="checkbox"/>	876202489806	NH02	VARANASI TO FATEHPUR	09-08-2013 11:33:54	SUBHASH, SU...

Output Folder: C:\Users\FED\Desktop

Report Type:  HDM4 Format Sections Report File

Description: Section or processing interval related data \*.csv file with the field structure corresponding to HDM4 (v.2)

Generate

A Typical View of HDM-4 Export Module



# Calibration and Validation of HDM 4 Deterioration Models For Indian Conditions

Six Climatic Zones Identified as per HDM-4 Classification



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- B. Humid & Tropical
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Calibration Factors for Flexible and Rigid Pavements Developed for Six Climatic Zones

# Road User Cost Study

## Traffic and Road Related

- Free Speed
- Speed – Flow
- Road Geometrics Data

## Vehicle Operating Cost Data

- Collection of real life data on vehicle operating costs from the actual vehicle owners / operators

## Travel Time Cost

- Passenger's Time Cost
- Goods Time Cost

- Delhi
- Mumbai
- Kolkata
- Chennai
- Hyderabad
- Ludhiana
- Vijayawada

# **Development Management System For Maintenance Planning**

**By using**

- **HDM-4 Calibration Factors**
- **Road Information System Data**  
(Performance and Inventory data)
- **Road User Cost Models**

**Pavement Maintenance Management System  
for High Speed Road Corridors using HDM-4  
has been Developed**

# Conclusion/Outcome

- **The PMMS developed under this study shall assist/enable engineers and decision/policy makers to pre-conceive the requirement of funds for maintenance of road network in order to bring them to a desired level of serviceability.**
- **The system developed will also assist in minimising wasteful losses occurring every year on account of poorly maintained roads.**
- **It will also provide powerful tool to the road authorities in allocating maintenance funds in a rational and judicious/manner and in prioritizing the maintenance tasks/ treatments in view of limited resources.**
- **The use of state-of-art technologies based on Global Positioning System, Geographical Information System, Laser, WIM, and image processing techniques is the key of success for accurate and timely collection of time series data on the huge road network as covered under this study.**



**Thankyou for your kind  
attention**

