Health Monitoring Of Road Using Network Survey Vehicle

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Abstract— Road completion is examined followed by the audits. The NSV deals with the Quality of the pavement constructed. The Network Survey Vehicle analyses the level of deterioration of pavement, identifies maintenance and reconstruction needs, and determine maintenance costs both routine as well as periodic. In past, the road deterioration survey is done by simply walking through entire road. This old method takes time to analyze the site and make a report, to overcome this Network Survey Vehicle (NSV) is the next Generation State of the Art technology being developed for assessment of road health using laser- based technology. The NSV is vehicle which is a combination of laser profilometer, laser crack measurement system, transverse profile logger, GPS, camera, and odometer. In this research the study intended to carry out road condition survey using NSV on Nanded-Jalkot Section of NH-50. This project stretch lies between Ch. 0+000 to Ch. 65+865 in the state of Maharashtra. The total length of project stretch is 63.334 km. The project corridor comprises of Two& Four lane carriageway passing through various settlements in Maharashtra

Index Terms— Network Survey Vehicle (NSV), Laser Based Technology, Laser Profilometer, GPS, Pavement Maintainance, Road Safety Audit.

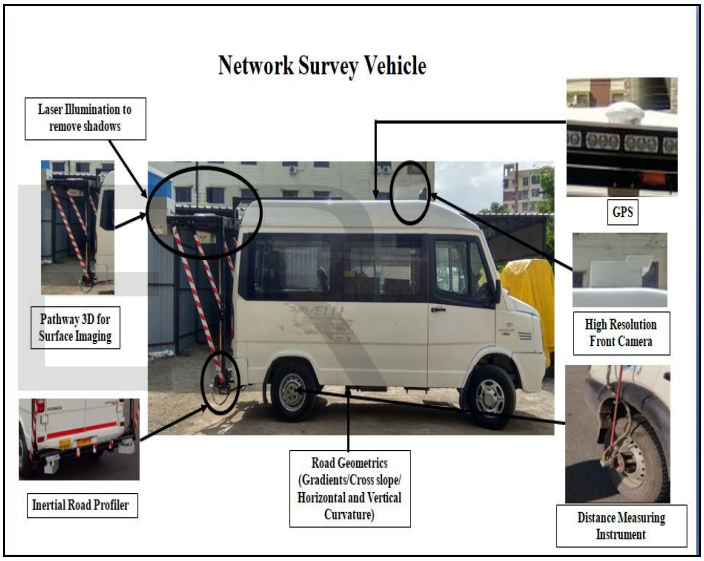
1 INTRODUCTION

Road health Condition is important so that passengers, drivers, vehicles, pedestrians stay safe while driving. They are of vital importance in order to make a nation grow and develop. In addition, providing access to employment, social, health and education services makes a road network crucial in fighting against poverty. Roads open up more areas and stimulate economic and social development. Well maintained roads are safer. The implications of a sustained road maintenance schedule have wide and real benefits which cut across all areas of a society.

1.1 Network Survey Vehicle (NSV)

The Network Survey Vehicle is based on the latest survey techniques utilizing Laser, Global Positioning System and Video image processing tools etc. The Survey Vehicle is used for automatic collection of road inventory and pavement condition related data required for Road Asset Management, Pavement Maintenance Management System and Road Safety Audit Related Studies. The system is capable of collecting the following information at Highway Speeds:

- Longitudinal profiling (International Roughness Index)
- Transverse profiling (Rut Depth)
- Pavement Texture in terms of Mean Profile Depth
- Road Geometry Data (cross slope, gradient, curvature)
- GPS coordinates (X, Y, Z) viz. longitude, latitude & altitude
- Video imaging for Roadside furniture / Road Assets
- Video imaging for Pavement Surface Distresses



1.2 Data Collection

The following data can be collected by performing a normal single lane one-time travel of NSV vehicle.

- High Resolution Right-of-Way
- Asset Inventory and Management
- High Resolution Surface Imaging
- Roughness Data
- Shoulder and Edge Dropoff
- Rutting Data and Transverse Profile
- GPS
- Road Geometrics
- Macro Texture
- Faulting Data
- Pavement Condition Rating
- 3D Pavement Surface Depths

1.3 Advantages

- Proactive assessment of structural or underlying damage to road or pavements
- High degree of portability enables adaption to different vehicle types for road safety appraisal
- High degree of precision in location and measurement of road condition issues
- Gives a push to good maintenance policies for roads and highways with cadastral survey
- Non-destructive assessment enables smooth flow of traffic without any jam
- The Road Safety Equipment facilitates all-round road safety audit

2 METHODOLOGY

The Network Survey Vehicle is used for automatic collection of road inventory and pavement condition related data required for Road Asset Management, Pavement Maintenance Management System and Road Safety Audit Related Studies. The methodology adopted for survey and analysis of Nanded-Jalkot (NH-50) road is described in detail in following section.

Table -1: Salient Features of this project Stretch

Sr. No.	Description /Item	No's/ Length
1	Rigid Pavement (PQC)	60.260 Km
2	Four lanes Over laying	5.032 Km
3	Major Bridge	1 No's
4	Minor Bridge	16 No's
5	Minor Bridge (widening)	1 No's
6	Box culvert	54 No's
7	RCC Box at cross road Junction	27 No's
8	Slab Culvert (widening)	2 No's
9	Pipe Culvert	43 No's
10	CUP	6 No's
11	Drain	7.245 Km (B/S)
12	Major Junction	7 No's
13	Minor Junction	27 No's
14	Bus lay by/Shelter	8 No's
15	Truck lay by	2 No's
16	Toll Plaza	1 No's
17	Realignment / New construction	2.925 Km
18	Slip Road	0.400 Km
19	Service Road	5.91 Km
20	Built up Area	10.942 Km
21	Retaining wall/Breast wall/Toe wall	6.215 Km
22	W-Beam Crash Barrier	3.927
23	Rainwater harvesting	As per site condition

2.1 Attribute Location and Assessment

Since the Network Survey vehicle is an integrated system, the roadside inventory information can be collected from the images in conjunction with the pavement distress types. Attributes such as bridges, land use, topography, hydrological characteristics, public transport arrangements, etc. are assessed in accordance with the relevant sections including the accurate assessment of the location and condition. The system utilizes the latest in digital camera technology and produces crisp high-resolution video frames to ensure a continuous digital record of the roadway.

2.2 Outputs Road Dimension Confirmation

All Digital Image System data is calibrated prior to the commencement of the survey.

2.3 Visual Assessment of Road Inventory Assets

From the digital images, a host of information is extracted. This information is linearly (chainage) and spatially (GPS) referenced.

2.4 Defect Assessment

The collected images / videos are rated using the Pathways Processing Toolkit. The processing toolkit is fully customizable and allows rating criteria to be set to produce project specific outputs linked to its spatial (GPS) and linear (chainage) position. The Pathways Processing Toolkit is an integrated graphical user interface (GUI) that compiles the collected survey data and allows the user to 'virtually drive down the road' and record rating information as needed. With each frame, a customized set of rating fields are attached, where the rater records set decisions about various parameters of the road at that point. These include areas, widths, heights, text fields, lists or numerical counts, this means that all ratings are automatically linked to its GPS and road-chainage position.
The images are rated using standard guidelines, the extent of which are measured using the toolkit's area and width measurement facilities. The area calculations are stored against the relevant defect field in the toolkit's data file, which is stored in the required format and referenced to the road location.

2.5 Distance and Speed measurement

Each road inventory and condition parameter are referenced to the road running distance via a highly accurate distance transducer attached to a rear wheel of the NSV. The transducer is calibrated using a distance calibration site. The Distance and speed measurement performed by the distance-measuring instrument, which are a distance transducer and highly accurate equipment. GPS distance and speed are also calculated.

3 LIMITATIONS OF THE SURVEY

The limitations of technology and the implications of the inappropriate use of technology to collect condition data are listed below with additional comments, which need to be kept in mind while on site collecting data.

- Imaging technology requires appropriate lighting: Images are collected only when lighting conditions are conducive to recording images.
- Heavily wet pavements & stagnated water on pavements can mask defects and affect laser readings.
- Images do not capture extremely fine cracking: cracking less than 2.5 mm can be difficult to observe even with high resolution images. Cracking of this severity can also be difficult to observe from a manual footpath-based assessment and impossible from a windscreen-based assessment.
- Road conditions, which affect the body roll of the vehicle such as excessive gradient, tight corners, traffic calming may affect the results of the laser profilometer.
- Inherent road attributes such as joints on flyover & bridges, speed humps and service covers may represent high roughness and rutting readings on roads. These may or may not affect the accuracy of the equipment but recognizes that such issues will naturally increase the reported roughness reading.
- Due to the mechanism of data capture and rating, being from digital images instead of real environment conditions, limitations exist in the rating. Some of the possible rating limitations are that it cannot identify cracking < 2.5 mm due to image resolution.

However, even taking these limitations into account, it remains possible to capture meaningful and useable data and information from the digital imaging survey, such that when applied in asset management procedures it can assist an asset manager to effectively maintain the network.

4 RESULTS

Annexure for data collected through NSV

LRMS Data Template Nanded-Jalkot.
BIS Data Template Nanded-Jalkot.
RIS Data Template Nanded-Jalkot.

4.1 International Roughness Index (IRI)

The accepted world standard for Roughness is the International Roughness Index (IRI). The equipment is included with software to calculate and print various profile statistics including the IRI as well as the individual point elevation and local surface curvatures.
Length wise summarized Roughness condition details for both the directions are given in Table -.

Table -2: Direction wise Roughness distribution (Asphalt)

Pavement Type	Condition	Roughness Range (m/km)	Length (km)			
			L1	L2	R1	R2
Asphalt	Good	< 2.55	5.239	4.934	5.239	4.934
	Fair	2.55 – 3.30	0.000	0.1	0.000	0.1
	Poor	> 3.30	0.000	0.000	0.000	0.000
		Total	5.239	5.034	5.239	5.034

Table -3: Direction wise Roughness distribution (Cement Concrete)

Pavement Type	Condition	Roughness Range (m/km)	Length (km)			
			L1	L2	R1	R2
Cement Concrete	Good	< 2.81	56.987	0.000	57.234	0.000
	Fair	2.81 – 3.30	0.000	0.000	0.000	0.000
	Poor	> 3.30	0.000	0.000	0.000	0.000
		Total	56.987	0.000	57.234	0.000

The Roughness in conformance to the MORTH specifications for entire project stretch has been tabulated in Annexure– "RIS Data Template Nanded-Jalkot".

IRI values for the project stretch were found to be on the lower side. According to Cl. 3.2 of IRC SP: 16-2019, it is recommended that all the newly constructed roads shall meet the criteria of roughness values as per "Good" category. The roughness values under "Fair" and "Poor "surface condition of roads have been indicated for purposes of timely maintenance planning and interventions.

4.2 Rutting

Rutting is one of the important factors which determine the functional performance of pavement. Rutting is characterized by permanent deformation of the pavement in wheel path due to heavy load vehicles. It is one of the main modes of failure in asphalt mixes.
Length wise summary of Rut Depth condition details for both the directions is given in table below: -

Table -4: Direction wise Rut Depth Distribution

Pavement Type	Condition	Rut Depth Range (mm)			Length (km)	
			L1	L2	R1	R2
Asphalt	Good	< 5	5.23	5.03	4.73	5.03
	Fair	5 - 10	0	0	0.5	0
	Poor	> 10	0	0	0	0
		Total	5.239	5.034	5.239	5.034

4.3 Highway Inventory

The detailed asset inventory report in which each highway asset provided with georeferenced positions along the project stretch is submitted in the form of be Annexure and is tabulated below for clarity –

Table -5: Summary of Inventory of Project Stretch

Sr.	Description		Details
1	Project Stretch		As per Table 3-1
2	Length of Project Stretch (in km)		68.368 (LHS) &68.368 (RHS)
3	Road Type (2/4-lanes length in km)	BT	10.273 (LHS) and 10.273 (RHS)
		CC	58.095 (LHS) and 58.095 (RHS
4	No. of Intersections		24 (LHS) &39 (RHS) &08 (BHS)
5	No. of Major Bridges*		00
6	No. of Minor Bridges*		16
7	No. of Flyover*		00
8	No. of Underpass*		00
9	No. of Overpass*		00
10	No. of ROB*		00
11	No. of Culverts*		87
12	No. of Toilet Blocks		00
13	No. of Single Arm Street Lights		00
	No. of Double Arm Street Lights		103 (Median)
	No. of High Mast		1 (RHS)
	No. of Mid Mast		3 (LHS)
	No. of Solar Blinker		00
	No. of Traffic Signal		00
14	W-Beam Safety Barrier (length in km) **		1.991 (LHS) &1.439 (RHS)
15	Concrete Barrier (length in km) **		1.793 (LHS), 1.363 (RHS)
16	Railing (length in km) **		0.00 (LHS) &0.00 (RHS)
17	No. of Signboards		520 (LHS) &524 (RHS)
18	No. of Pedestrian Crossing		22 (LHS),24 (RHS)& 70 (BHS)
19	No. of Bus Shelters		03 (LHS) &04 RHS)
20	No. of Overhead Gantry		00
	No. of Cantilever Gantry		00 (LHS) & 00 (RHS)
21	No. of Petrol Pumps		01 (LHS) &05 (RHS)
22	No. of Telephone Booth		00
23	No. of Toll Plaza		00

5 Conclusion

Health Monitoring of Road Using NSV is automatic collection of pavement condition and road inventory and based on which the following conclusion are drawn from this study:

1. India has the second-largest road network in the world & health monitoring of such huge road length by conventional method is very tedious & time consuming which will possible through NSV surveys.
2. Road Infrastructure is assets of country & regular monitoring of this asset is possible through NSV surveys.
3. The Data Collected through NSV surveys is useful for Pavement Maintenance Management System, Road Asset Management and Road Safety Audit Related Studies
4. The data collected through NSV surveys will highlight deficiencies in road conditions which prompting concerns officials to take corrective steps to bring the road condition to the desired level.
5. Health Monitoring of Road Using NSV gives a push to good maintenance policies for roads and highways.
6. Health Monitoring of Road Using NSV gives high degree of precision in location & measurement of road condition issues.
7. Health Monitoring of Road Using NSV plays predominant role in BOT project to to take corrective steps.
8. Proactive assessment of structural or underlying damage to road or pavement.
9. Non-destructive assessment enables smooth flow of traffic without any jam
10. Longitudinal road surface profiling to check alignment
11. Road Geometry data like gradient, cross slope and curvature can be determined
12. Assessing GPS coordinates (x, y, z) of a particular road section.
13. Contractor work quality control assessment can possible

6 Future Scope

The total road network in India is 6.4 million km comprising of national & state highways and urban & rural roads. India has the second-largest road network in the world& to upkeep this road network in good condition health monitoring of road using NSV is better option in future. NHAI to make network survey vehicle use mandatory for road condition survey. The deployment will help in enhancing the overall quality of the highways. The provision has also been included as a part of the standard bidding document of consultancy ser-

vices. The deployment will help in enhancing the overall quality of the highways as NSV uses the latest survey techniques such as high-resolution digital camera for 3600 imagery, Record images/videos at regular intervals, Laser Road Profilometer and other related technology for measurement of distresses in road surface. The data collected through NSV survey shall be uploaded on NHAI's AI based portal Data Lake, where it will be analyzed by Road Asset Management Cell (RAMS Cell) to assess the condition / roughness of the road to prioritize for the maintenance. The data will help in maintaining up to date asset inventory and road assets condition status. Apart from delivering vital information on road network planning, providing relevant information on other aspects such as development of road safety measures, etc. it will also assist in developing highway maintenance strategies, analysis of maintenance and selection of optimal maintenance regime. The data collected through NSV surveys will highlight deficiencies in road conditions, prompting BOT operators/NHAI officials to take corrective steps to bring the road condition to the desired level. This will further result in better upkeep of national highways, leading to more comfort and better travel experience for highways users.

7 REFERENCES

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3. IRC: SP 16-2019 Code for Guidelines on Measuring Road Roughness and Norms.
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