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Probable Causes and Proposed Alternatives of Rutting on BRT Route (Phase-1), Ahmedabad

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Abstract:
Pavement rutting is one of the peculiar and far impacting pavement distresses which being observed in flexible pavements. At present, the pavement surface at the bus shelter area appears to be challenging problem and requires maximum attention due to its severe distress, categorized as higher severity rutting. In order to ponder upon such high severity distress, some of the alternative solutions could stand as: Mastic Asphalt (MA), Use of Modified Bitumen, Stone Matrix Asphalt (SMA), White-topping, Glass Fiber Grid, Rigid Pavements and paver-blocks. Thus the overall objective of this study is to explore various alternatives of similar environments and arrive at optimum kind of alternative for BRTS Bus Shelters.

Key words: *Flexible Pavement, Mastic Asphalt, Rutting, Stone Matrix Asphalt, White topping*

1. Introduction

Pavement rutting is the accumulation of permanent deformation in all or a portion of the layers in a pavement structure that results in a distorted pavement surface. Progression of rutting can lead to cracking and eventually complete disintegration and shoveling of the surface pavement occur which produce uncomforting for vehicle riders. Rutting is calculated as the maximum depth measured from the deepest point in the deformed wheel path to the top of the surface beside the wheel path, using a reference length of 3.0 m. This depth is expressed in millimeter. The maximum permissible rutting depth as per IRC 37-2012 (for design traffic up to 30 **msa** (million standard axles) is 20mm. Repetitive applications of with increasingly high pressure tires drives rut formation in high quality bitumen asphalt layers. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favorable light reflecting characteristics, and low noise pollution. The ultimate aim is to ensure that the transmitted stresses due to wheel load are sufficiently reduced, so that they will not exceed bearing capacity of the sub grade. Transportation is the backbone to the development of urban areas. It enables functioning of urban areas efficiently by providing access and mobility. Passenger transport has an overriding influence on the functioning of the city.

Figure 1: Distresses on the BRTS Bus Shelter; (A) Bhavasar Hostel (B) Valinath Chowk

2. History of BRT and Rutting

BRT is a high performance public transport bus service which aims to combine bus lanes with high-quality bus 'stations', vehicles, amenities and branding to achieve the performance and quality of a light rail or metro system, with the flexibility, cost and simplicity of a bus system.

The first BRT system was the Rede Integrada de Transporte in Curitiba, Brazil (translated as 'Integrated Transportation Network') which entered service in 1974, which inspired the Trans Milenio in Bogotá, Colombia (opened 2000) and subsequently many other systems around the world. Ahmedabad BRTS is a bus rapid transit system developed by Gujarat Infrastructure Development Board (GIDB) and Ahmedabad Municipal Corporation (AMC) for the city of Ahmedabad. The project has total of 126.5 km of BRT corridors which is divided into three phases:

- Phase-1 covering distance of 58kms.
- Phase-2 covering distance of 30.5 kms.
- Phase-3 covering distance of 38 kms.

The features of BRT system are it is closed system –trunk and feeder services and aesthetically designed, accessible Bus stations, Level Boarding and provides External ticketing, Smart cards.

After the completion of phase-1, the pavement was found to breaking up fast, leading to bumpy rides for the commuters. The pavement was pavement was uneven near the bus shelters where repeated application of brakes resulted the distress. The overall cost has spurred as the risen cost of bitumen is a petroleum product. Maintenance of BRTS route is also a problem because maintenance works requires the regular traffic to be stopped and the regular maintenance work is very inadequate.

3. Field Investigation

In order to understand the impact of distress the first rut depth was measured and pavement condition survey, Benkelman beam test analysis. In order to define the structural and functional needs of a roadway and specific pavement engineering design methods, evaluations were carried out on the existing pavement of project corridors. The data was collected was on two different stretch covering four bus shelters and length of 4 kms.

- Stretch -1: Bhavsar Hostel to Shastrinagar.
- Stretch -2: Jaymangal to Memnagar.

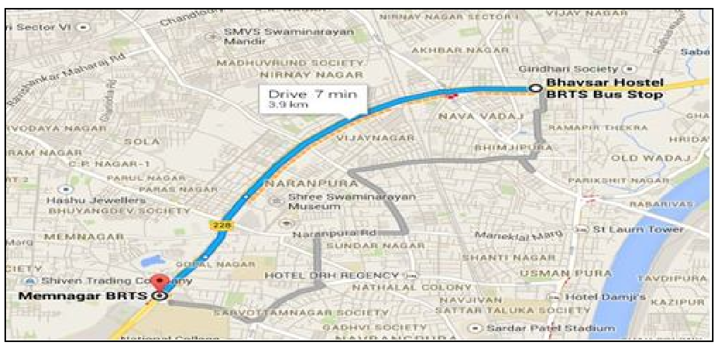

Figure 2: location Map of the Stretch

4. Data Analysis

The rutting is generally measured in depth. As per IRC: 37-2012, permissible rutting depth is 20 mm. Looking at the case study rutting depth is found as high as 90 mm (at Bhavsar hostel Shelter). The average rutting depth over the entire stretch comes out to be 65 mm. This means that the pavement has failed completely.

5 .Causes Of Rutting

The probable causes of rutting may be:

- Repetitive application of brakes leading to acceleration and deceleration on the bus shelters.
- Inadequate mix design.
- Improper material characterization and its properties.

6. Proposed Alternatives

After the investigation, a set of proposed alternatives for mitigating the rutting distress along the wheel path of the BRTS bus shelter was evaluated**.** With respect to the above problem, suggesting the following alternatives are:

- Flexible Pavement
- Flexible Pavement with Mastic Asphalt
- Flexible Pavement reinforced with Glass Fibre Grid
- Paver Blocks
- Rigid Pavement (PQC), and Geogrid.

7. Conclusion

From the visual observations and data collected it can be concluded that different alternative can be feasible and also economical in nature. Distress type is good in the location stretch 2 compared to stretch 1 and rutting depth though decreases initially but later on varies abruptly with the no of observations. A fundamental and research work can be carried out to improve quality of BRT system as a whole by taking various case studies. The phase -1 of the BRTS is an important route to connect to the other bus corridors and the other phase. Continuation of rutting can lead to the more aggressive failure of the pavement.

8. Acknowledgement

The authors are thankful to the various stakeholders for their valuable suggestion and the reports provided by the BRTS and CEPT, and LEA associates.

9. Appendix

Sl. no.	Bus Shelter	Rutting Measurements(in mm)			Side
		Length	Breadth	Depth	
1.	BHAVSAR HOSTEL	1950	980	90	L.H.S.
2.	AKHBARNAGAR	1490	790	65	L.H.S
3.	PRAGATINAGAR	1620	650	80	R.H.S.
4.	SHASTRINAGAR	890	490	55	L.H.S.
5.	JAYMANGAL	1340	745	30	L.H.S.
6.	SOLACROSSROAD	1780	690	45	R.H.S.
7.	VALINATH CHOWK	1580	560	85	R.H.S.
8.	MEMNAGAR	1350	740	70	L.H.S.

Table 1: Rut Measurement Data (Stretch: 1&2)
(The Highest Value Is Tabulated Based On the Cumulative Measurements

Sl. no	Distress type	Severity			Extent			Remark
		Light	Moderate	Heavy	Low	Medium	High	
1.	Cracking	✓	------	-------	------	✓	------	Edge cracking
2.	Potholes	✓	-----	-----	----	✓	----	100–300 mm in width(bowl is shape)
3.	Raveling	✓	-------	------	-----	-------	✓	More in Akbarnagar area
4.	Rutting	✓	--------	------	-----	✓	------	NA
5.	Patch deterioration.	-----	✓	------	----	------	✓	NA

Table 2: (Pavement Condition Survey)
Location: Stretch-1 Bhavsar Hostel to Shastrinagar

Sl. no	Distress type	Severity			Extent			Remark
		Light	Moderate	Heavy	Low	Medium	High	
1	Cracking	✓	-----	------	✓	------	-----	Transverse cracking (5%- 10%)
2	Potholes	-------	✓	------	-----	✓	----	NA
3	Raveling	✓	------	-----	✓	-------	-----	NA
4	Rutting	✓	------	-----	✓	-----	-----	Depth less than 15 mm
5	Patch deterioration.	✓	------	-----	✓	-------	------	NA

Table 3: (Pavement Condition Survey)
Location: Stretch -2 Jaymangal to Memnagar

- Name of the road: 132ft ring road
- Section: 0-3 km, Temperature: 30ºc, Pavemen: 30℃

Location of test Pt.	Offset from Pavement Median(m)	Dial gauge reading			Measured rebound deflection (4)-(2)x0.02	Pavement Temperature	Correction for temperature in mm	Temp. corrected deflection in mm (5) ± (6)	Seasonal correction factor	Corrected deflection in mm (7) x (8)	Mean deflection in mm X	Max	Min
		initial	intermediate	Final									
IN THE STRETCH OF 0 to 3 kms (R.T.O-VASANA)													
0	3	1.20	0.96	0.94	0.52	30.00	0.05	0.57	1.02	0.579	0.60	0.79	0.40
+10	3	1.78	1.56	1.55	0.46	30.00	0.05	0.51	1.02	0.518	0.60	0.79	0.40
+10	3	1.73	1.45	1.42	0.62	30.00	0.05	0.67	1.02	0.678	0.60	0.79	0.40
+10	3	3.79	3.56	3.55	0.48	30.00	0.05	0.53	1.02	0.538	0.60	0.79	0.40
+10	3	1.40	1.12	1.10	0.60	30.00	0.05	0.65	1.02	0.660	0.60	0.79	0.40
+10	3	1.20	0.96	0.95	0.50	30.00	0.05	0.55	1.02	0.558	0.60	0.79	0.40
+10	3	1.43	1.17	1.10	0.66	30.00	0.05	0.71	1.02	0.721	0.60	0.79	0.40
+10	3	1.29	1.00	0.98	0.62	30.00	0.05	0.67	1.02	0.680	0.60	0.79	0.40
+10	3	2.06	1.82	1.80	0.52	30.00	0.05	0.57	1.02	0.579	0.60	0.79	0.40
+10	3	2.22	2.05	2.02	0.40	30.00	0.05	0.45	1.02	0.457	0.60	0.79	0.40
		IN THE STRETCH OF 0 to 3 kms (VASANA-R.T.O)											
0	3	1.53	0.91	0.90	1.26	30.00	0.05	1.31	1.02	1.330	1.13	1.50	0.75
+10	3	1.41	0.96	0.95	0.92	30.00	0.05	0.97	1.02	0.985	1.13	1.50	0.75
+10	3	2.35	1.66	1.65	1.40	30.00	0.05	1.45	1.02	1.472	1.13	1.50	0.75
+10	3	2.70	2.30	2.29	0.82	30.00	0.05	0.87	1.02	0.883	1.13	1.50	0.75
+10	3	2.48	1.93	1.92	1.12	30.00	0.05	1.17	1.02	1.188	1.13	1.50	0.75
+10	3	2.08	1.59	1.58	1.00	30.00	0.05	1.05	1.02	1.066	1.13	1.50	0.75
+10	3	1.99	1.59	1.57	0.84	30.00	0.05	0.89	1.02	0.903	1.13	1.50	0.75
+10	3	1.12	0.59	0.58	1.08	30.00	0.05	1.13	1.02	1.147	1.13	1.50	0.75

Table 4: Benkelman Beam Test Analysis

- The Standard and characteristics deflection measured was (mm):
- R.T.O-VASANA: 0.08, 0.77
- VASANA-R.T.O:0.18, 1.49

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