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Pavement Distress: A case study of Kota-Anta road Rajasthan

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Abstract: ***Pavement design, the process of developing the most economical combination of pavement layers, mainly deals with the design of material mixtures and thickness of different pavement layers. Even if highway pavements are well designed and constructed, they may require proper maintenance; and if not, different distresses like fatigue cracking, bleeding, rutting, potholes etc occur in the pavement which is considered to be complex phenomenon because of several factors involved. This paper in 40 km length of NH-27 was selected, starting from Kota to Anta, to carry out survey of pavement distress. 200 m intervals in the highway were selected for the study. In this study, the observation showed that the most commonly found pavement distresses in the highway were pot holes, cracks, patch and rutting. All the distresses found have values exceeding maximum limits. The most required probable treatments for surveyed distresses are overlay, patching. It was also observed that the side drainages were not maintained, cleaned and even absent in some places of the NH-27.***

Keywords: Pavement design, Distress, Pavement maintenance, Crack, Rutting, Pothole identification

I. INTRODUCTION

Pavement distresses are visible imperfections on pavement surface. They are symptoms of the deterioration of pavement structures. Most, if not all, agencies that have implemented a Pavement Maintenance Management System (PMMS) collect periodic surface distress information on their pavements through distress surveys. Distress evaluation, or condition survey, includes detailed identification of pavement distress type, severity, extent, and location. To combine these details, an index is assigned to each pavement which is transferred to a general rating. Every highway agency either develops pavement distress evaluation procedure or selects a developed one for its pavement condition survey. Not considering of the size of the highway network or the sophistication of the PMS procedure, most PMS strategies can offer assistance at two levels: the network level and the project level. Network level information provides management with broad-based data about the entire system. Information for planning purposes and financial analysis is often provided by the network data. On the other hand, project level information can include specific details about engineering design, construction and cost accounting. Obviously the data required for each level differs significantly. Network level required disaggregate data that reflects the general pavement condition. However, project level needs detailed and specific data on expected distresses.

In general, distress density starts its transmission process very slowly, but it accelerates more at a later stage. There are factors that affect rate of transmission. These factors may include pavement condition, traffic levels and distress severity. The distress density transmission on a new or recently overlaid pavement sections having excellent condition is expected to be slower than on pavement sections with poor condition. A distress is expected to behave differently on pavement sections subjected to different traffic levels. Also, the distress severity levels have an effect on behavior and propagation of distress density.

A flexible pavement failure is defined by formation of pot holes, ruts, cracks, localized depressions, settlements, etc. The localized depression normally is followed with heaving in the surrounding area. The sequence develops a wavy pavement surface. The failure of any one or more components of the pavement structure develops the waves and corrugations on the pavement surface or longitudinal ruts and shoving. Pavement unevenness may itself be considered as a failure when it is excessive. The subject of pavement failure/distress is considered to be complex as several factors contribute to its deterioration and failure. The aging and oxidation of bituminous films lead to the deterioration of flexible pavement. Detrimental actions in pavement are rapidly increased when excess water is retained in the void spaces of the pavements.

1.1 Types of failures in flexible pavement

As stated above, the localized settlement of any one component layer of the flexible pavement structure could be enough to cause pavement failure. This demands that each one of the layers should be carefully designed and laid. Thus to maintain the stability of the pavement structure as a whole, each layer should be stable within itself and thereby making the total pavement continue its stability. One of the major challenges facing pavement engineers is how to select the most favorable repair strategy for a flexible pavement that is aging and exhibiting distress. This selection process can

be relatively straightforward if the cause of the pavement distress is known. Unfortunately, finding the cause of the distress is often compound. The different types of distress/failure in flexible pavement are tabulated in Table 1.

Table 1: Types of Distresses in Flexible Pavement

No.	Type of failure	Description
1	Alligator cracking	Series of interconnected cracks caused by fatigue failure under repeated traffic loading
2	Bleeding	Film of asphalt binder on the pavement surface
3	Block cracking	Interconnected cracks that divide the pavement up into rectangular blocks (approx. 0.1 m2 to 9 m2)
4	Corrugation and Shoving	A form of plastic movement typified by ripples(corrugation) or an abrupt wave (shoving) across the pavement surface
5	Depression	Localized pavement surface areas with slightly lower elevations than the surrounding pavement
6	Joint reflection Cracking	Cracks in a flexible overlay of a rigid pavement which occur directly over the underlying rigid pavement joints
7	Longitudinal cracking	Cracks parallel to the pavement's centerline or laydown direction (a type of fatigue cracking)
8	Patching	An area of pavement that has been replaced with new material to repair the existing pavement
9	Potholes	Small, bowl-shaped depressions in the pavement surface that penetrate all the way through the HMA layer down to the base course
10	Raveling	The progressive disintegration of an HMA layer from the surface downward as a result of the dislodgement of aggregate particles
11	Rutting	Surface depression in the wheel path
12	Slippage cracking	Crescent or half-moon shaped cracks generally having two ends pointed into the direction of traffic
13	Transverse (thermal) cracking	Cracks perpendicular to the pavement's centerline or lay down direction is usually a type of thermal cracking
14	Water bleeding And pumping	Water bleeding occurs when water seeps out of joints or cracks or through an excessively porous HMA layer. Pumping occurs when water and fine material is ejected from underlying layers through cracks in the HMA layer under moving loads

II. OBJECTIVES OF THE STUDY

The main objective of the present study was to carry out a survey on pavement distresses present in National Highway 27 of Kota-Anta road. The specific objectives of this study were:

1. To identify the different locations of pavement distress in the highway.
2. The frequency of pavement distress present on this highway stretch.
3. To study possible causes of these distresses and at meantime suggesting remedies and solutions for these distresses.

III. SCOPE OF STUDY

1. It gives us the most accurate reason for the pavement distress/failure which makes the repairing work easy.
2. The knowledge about pavement distress enables us able to make more efficient and high performance pavement.
3. Moreover, the study of pavement distress in an area helps in the improvement in design of the pavement, which may be so more effective in the area.

IV. METHODOLOGY

The study area stretch from Kota-Anta Toll road along the National Highway- 27 is of 40 Km for chain age 1080+263 to 1121+00. National Highway No.27 is a part of East-West Corridor. Survey was carried out visual inspection/investigation of the different pavement distresses found in NH-27.The length, size and depth of the distresses found in the highway were measured. The total study was divided into 5 days; in each day, approx. of 8 km of survey

was carried out, starting from Kota. The survey of pavement distress was done after dividing the selected length (40 km) of the highway into 200 m stretch interval. Some of the photographs of the study done on NH-27 are shown in figures.

Figure-*1 Pothole*

Figure-2 Patch

Figure-3 longitudinal crack

Figure-4 Alligator crack

V. DATA COLLECION & ANALYSIS

5.1Data collection

The study area stretch from Kota-Anta Toll road along the National Highway- 27 is of 40 Km for chain age 1080+263 to 1121+00. Survey was carried out visual inspection/investigation of the different pavement distresses found in NH-27.The length, size and depth of the distresses found in the highway were measured. The data have collected by manual survey and Patch, Pothole, Rutting, Alligator crack, Longitudinal crack are found which are given in following table:

Table 2 Pavement distress Data

Chainage			Patch(m^2)	Pothole (No. of)	Rutting(m^2)	Crack A(m^2)	Crack L(m^2)
1080.263	to	1081	0	3	0	80.92	11.4
1081	to	1082	80.85	0	36	108.56	16.74
1082	to	1083	63.75	3	0	193.86	35
1083	to	1084	89.5	3	299.5	230.5	5.4
1084	to	1085	250	3	36	181.5	3
1085	to	1086	401.5	0	321	88.59	7
1086	to	1087	53.4	3	619	50.67	9.4
1087	to	1088	670.5	1	94	10.3	0
1088	to	1089	254	4	207.5	75.76	1.8
1089	to	1090	70	2	108	140.5	14
1090	to	1091	0	2	0	261.5	5.6
1091	to	1092	120	11	0	187.87	10.4
1092	to	1093	83	5	96	166.44	3
1093	to	1094	0	7	33	77.89	5.4
1094	to	1095	0	1	0	210.15	0
1095	to	1096	0	0	0	39.56	13.56
1096	to	1097	0	3	0	78.78	4.5
1097	to	1098	0	3	154.5	111.78	23.45
1098	to	1099	174.5	3	89	80.12	6.8
1099	to	1100	56	6	15	63	0
1100	to	1101	108	2	20	56.2	35.5
1101	to	1102	11.64	0	0	225.56	0
1102	to	1103	58.5	1	64	10.8	0
1103	to	1104	0	1	100	29.8	0
1104	to	1105	3	0	0	9.5	4.5
1105	to	1106	0	1	0	0	0
1106	to	1107	0	0	0	0	0
1107	to	1108	0	0	0	0	0
1108	to	1109	0	0	0	0	0
1109	to	1110	0	0	0	0	0
1110	to	1111	0	1	0	4	0
1111	to	1112	133	5	87.5	4	0
1112	to	1113	0	2	0		0
1113	to	1114	353	0	174		6.9
1114	to	1115	0	8	0		10.56
1115	to	1116	15	4	0		1.2
1116	to	1117	0	6	0	18	10.8
1117	to	1118	0	5	0		38.9
1118	to	1119	0	1	24		4.6
1119	to	1120	0	1	0		2
1120	to	1121	7.5	1	0	42	5.7

5.2Pothole

Potholes are measure by measure tap and Numbers of potholes per 200 m interval for LHS as well as RHS are as depicted in graph. Some locations have more number of potholes while some location shows good surface and having

less number of potholes. No. of potholes in LHS are more than RHS Most of potholes having area of 1sq m to 2sq m. maximum pothole is 4 and minimum pothole is 1.

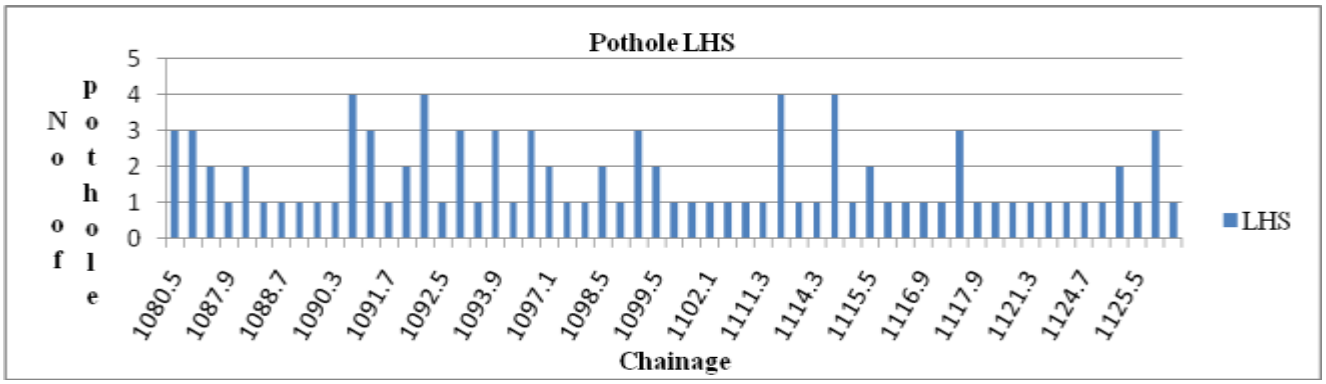

Figure-5 No. of pothole LHS

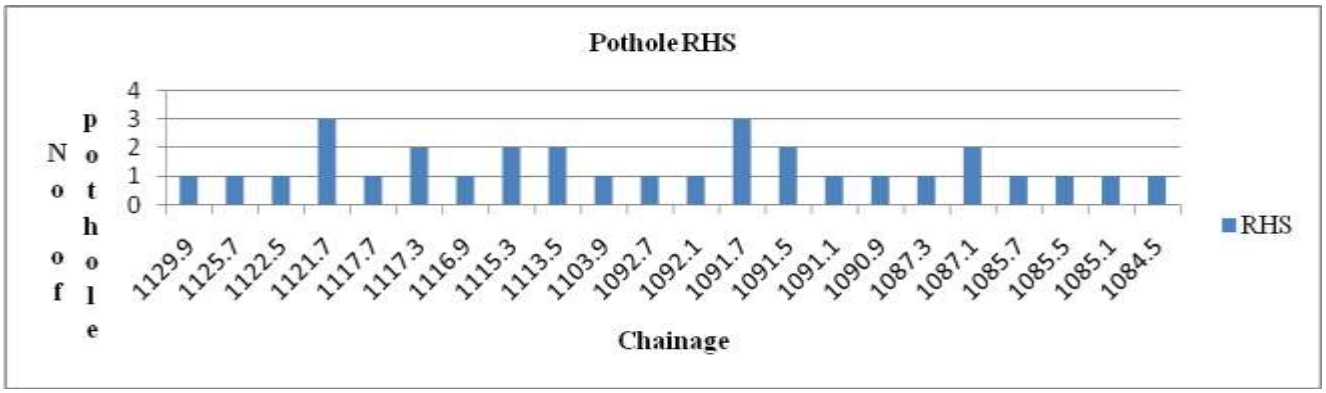

Figure-6 No. of pothole RHS

5.3 Crack

Observed cracking in study are of two types

1. Alligator Cracks
2. Longitudinal Cracks

Length and width of Alligator cracks are measured Area of cracks are found as % of Carriage way Study are shows excessive number of alligator cracking compare to longitudinal cracks Maximum, minimum cracking is show in graph .

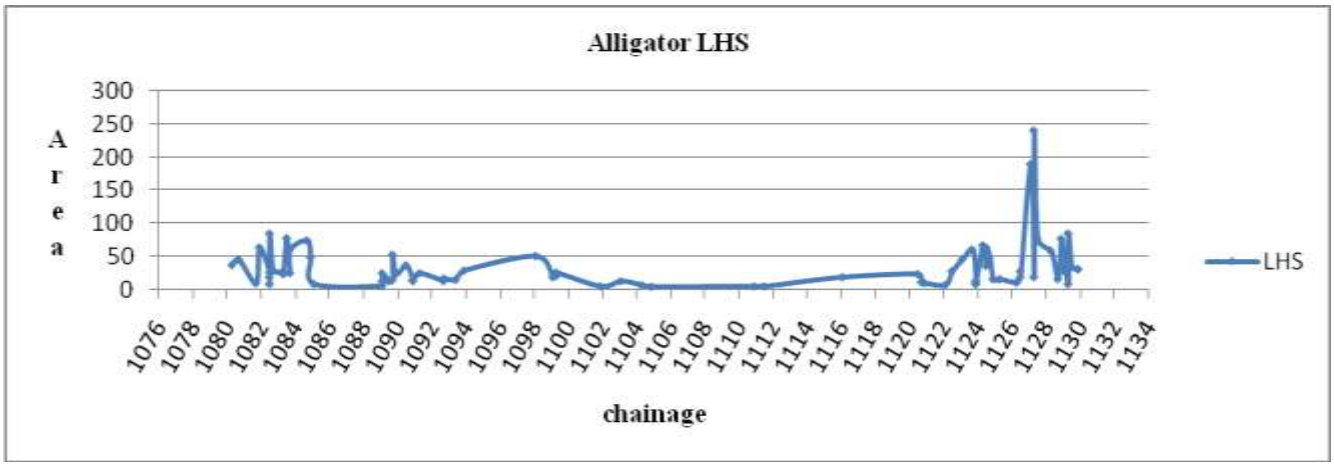

Figure-7 Area of Alligator crack LHS

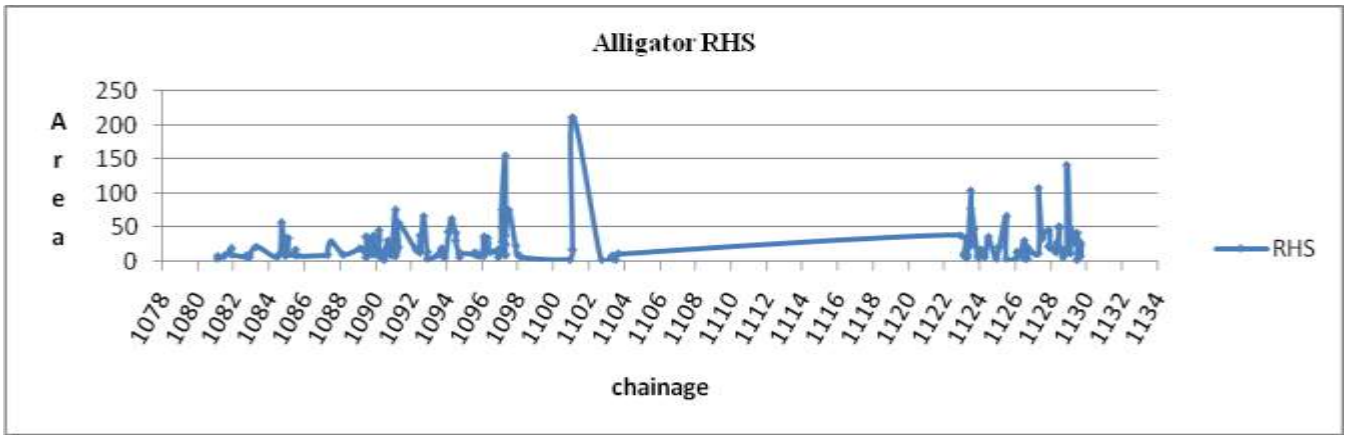

Figure-8 Area of Alligator crack RHS

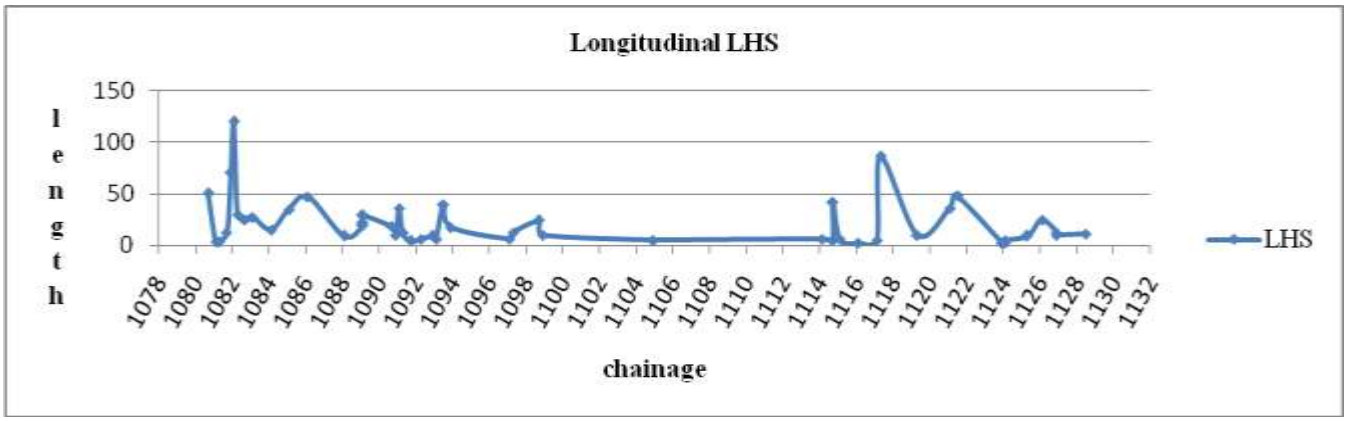

Figure-9 Area of longitudinal crack LHS

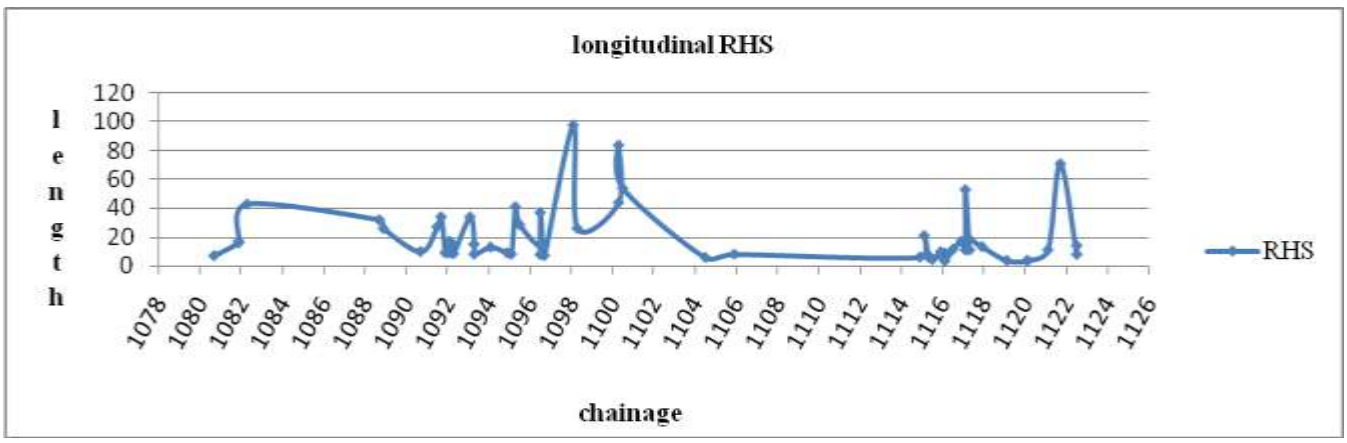

Figure-10 longitudinal crack RHS

5.4 Rutting

From the observation data collected by pavement condition survey from CH. 1080.263 to CH. 1130.000 and found the total rutting area is 3453.2 the maximum rutting is 34 at ch. 1123.6 and minimum rutting is 4 at ch. 1086.8.

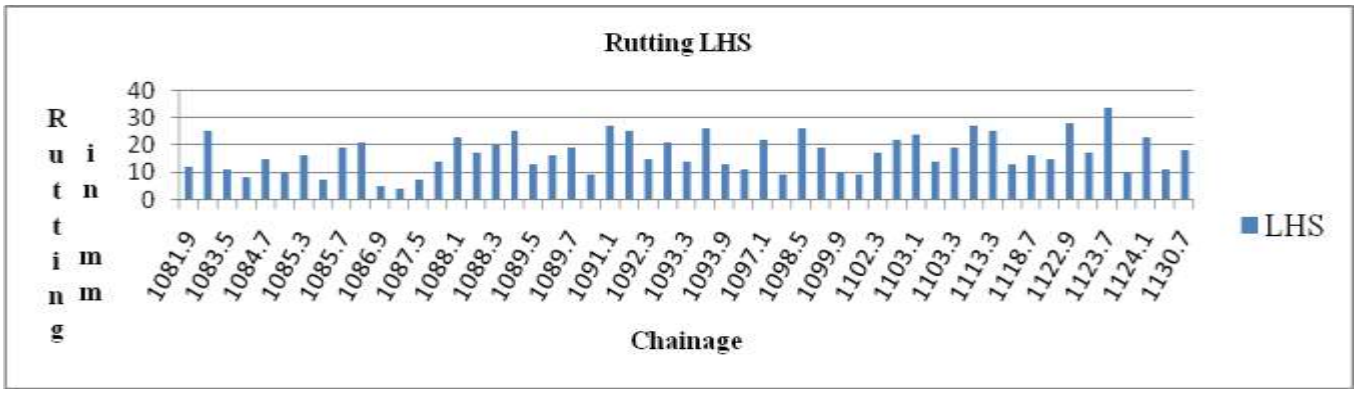

Figure-11 Rutting LHS

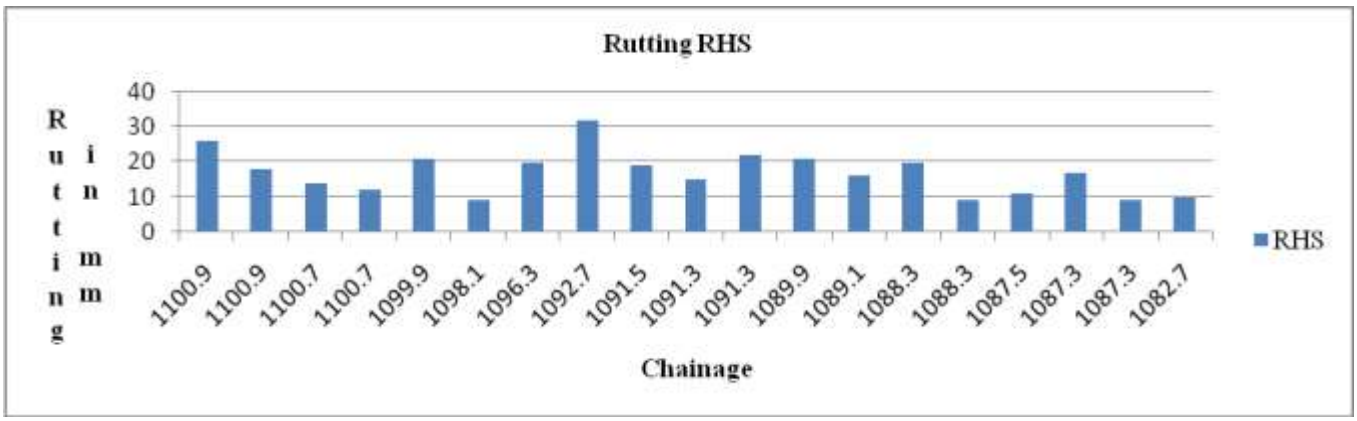

Figure-12 Rutting RHS

5.5 Patch

Patches are measured in sq. meters and relevant & area of carriageway is to determined. Patchwork in LHS is more than RHS. Survey depicts that some area are extensively good with no deterioration but some area shows higher number of deterioration.

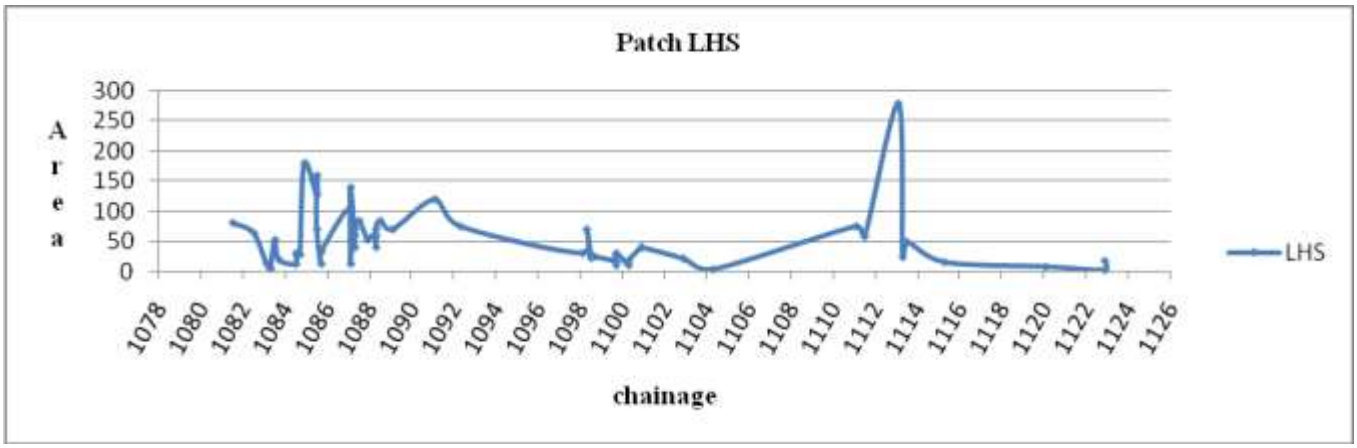

Figure-13 Patch LHS

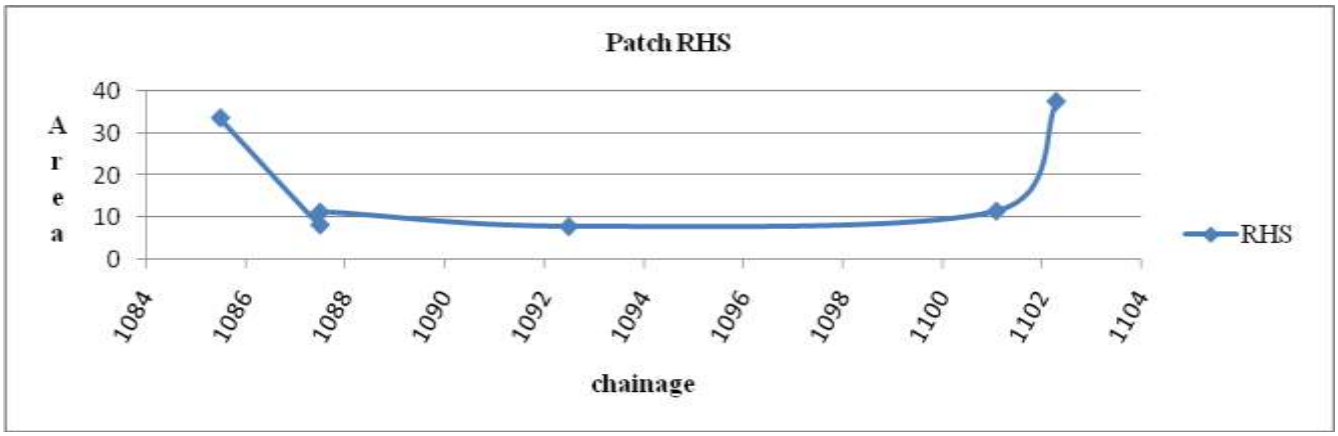

Figure-14 Patch RHS

VI. RESULTS AND DISCUSSIONS

The basic reason for pavement distresses along the Highway and flexible pavement in general is a resultant of poor implementation of mix design and poor workmanship followed by lack of timely maintenance. Interestingly, It was observed that the side drainages of the NH-27 were not maintained, cleaned and even absent in some places. The most commonly found pavement distresses were pot holes, alligator cracks and longitudinal crack. The relative scale for measuring the severity of pot holes with respect to depth is: Low < 25mm deep; Moderate 25mm to 50mm, High >50mm deep. The average depth of pot holes found in NH-27 is 70-90 mm deep and the deepest pot hole found being 100 mm. It was observed that bleeding was almost absent along this highway which may indicate that overall use of binder content is very much below the required amount. Stripping phenomenon due to heavy rainfall and implementation of poor mix design of bituminous mix may also be the factors for this. It was also observed that most of the cracks were top-down cracks starting with the bitumen-aggregate binding failure which indicates poor mix design. Rutting and patch are also there at site but comparative less than crack and pothole. The maximum percentage of Alligator Crack is 60% at CH. 1101.2 and minimum percentage of Alligator Crack is 1% at CH. 1102.8. The maximum percentage of Longitudinal Crack is 46% at CH. 1082.00.00 and minimum percentage of Longitudinal Crack is 1% at CH. 1116.00. From the observation data collected by pavement condition survey from CH. 1080.263 to CH. 1130.000 and found the total patch area is 3321.39m^2 .The maximum percentage of patch is 40% at CH. 1113.00 and minimum percentage of patch is 0.10% at CH. 1124.4.

The possible causes and probable treatments of the surveyed distresses are below. For repairing Alligator crack treatment are Strengthen the pavement or reconstruction, Base recycling or reconstruction, Replace or treat wearing course. For repairing longitudinal crack in treatment are Cut and patch, replace bituminous surfacing, Reconstruction of joints, Crushed aggregate overlay or reconstruction of joints. For repairing pothole treatment are Patching, Cut and patch, Base reconstruction Base reconstruction. For repairing rutting treatment are Strengthening overlay or reconstruction, Replace or recycle bituminous surfacing or use the stiffer mix, Base or sub base strengthening.

VII. CONCLUSIONS

- All distresses found in the highway were exceeding their maximum limits.
- The interval of the pavement distresses found is too frequent and well exceeded the standard limits.
- The most required probable treatments for surveyed distresses are overlay, patching and local reconstruction of road.
- The bleeding distress was not found along this highway.
- For chain age 1080.263 to 1120.00, LHS is containing more pot hole, crack and rutting patch than RHS.
- The side drainages are not maintained, cleaned and even absent in some places of the road.
- Interval of the pavement distresses found is too frequent and well exceeded the standard limits.

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