The Effect of Asphalt Concrete (AC) Pavement Distress on Road Traffic Accident: As Case Study

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Abstract:

Highway is an essential facility that led to both economic success and quality of life. Maintenance is necessary to ensure that highway will able to continue to carry out its functions. Pavement maintenance is essential to ensure good riding quality and avoid the happening of congestion, air pollution and especially traffic accident High level of pavement distress will lead to lower riding quality, vehicle damage, and more seriously traffic accident. Actually pavement distress has effects on road traffic accident, safety and time delay. According to the road and transport office there were a number of road traffic accident that were increasing from time to time Particularly from Alabaqulito to Shashemene road which is occurred on human, animal and properties on different section of road. Therefore the general objective of this research was to identify and analyze the effect of asphalt concrete pavement distress on road traffic accident from Alabaqulito to Shashemene road. Alabaqulito to Shashemene road is 65 km in length for the target area of the study. The road traffic accident data of all segments on this road are collected from September 2012 – June 2016 for the purpose of analysis. But the sample segment, those from the area that is very vulnerable by road traffic accident due to pavement distress, for the study are taken using purposive sampling method. These segments includes Alaba, Gedeba, Qufe, Ansha, Sherero, Guba, Yaye, Debaso, Aje town, Cibo, Awara, Fisa, Bura, Alamgebaya, Enbure, and Shashemene. The field survey was made to observe the type of distress, severity level and extent of the road. From the study conducted, it is concluded that there is an increase in the number of deaths, injury and property damage due to road traffic accident and coverage of road crashes and its effects as well. One of the reasons *for this road traffic accidents include high severity level of deterioration road that is bleeding, rutting, pothole and shoulder-scour. Finally the remedial measures for these problems are given.* These include *reconstruction of road or rehabilitation maintenance of pavement*.

Keywords: *AC pavement, distress type, extent & severity level, road traffic accident*

1. Introduction

In Ethiopia road infrastructure accounts for 90 to 95% of motorized inter urban freights and passenger movements. From this one can conclude that road transportation system is the core mode of transportation in boosting the economic growth of a country. Each year an estimated 1.24 million people are killed in road traffic accident and up to 50 million people injured worldwide. Third world countries bear the brunt of the fatalities from road traffic accidents, accounting for more than 85% of the world's road fatalities. Thus road traffic accident is the most dangerous health problem all over the world.

In our country Ethiopia this road traffic accident is one of the crucial health problem similar to the other sub Saharan regions. There are different causes for the occurrence of the accidents in Ethiopia, such as problems due to drivers. In the United States of America, for instance, 60% of the fatalities account to car drivers, while in Ethiopia, 5% account to drivers. This implies that in one crash the number of people killed or injured in Ethiopia is about 30 times higher than in the United States of America. Therefore in Ethiopia fatalities due to road traffic accident is the worst problem facing us in our day to day life.

Similar to the other sub Saharan regions road traffic accident in Ethiopia is increasing from time to time. A research was conducted in Addis Ababa from 2001 to 2008 it increased from 9.27% to 13.9% with atypical pick in 2006, 15.1%. This shows that similar to the other sub Saharan countries the road traffic accident in Ethiopia is increasing from time to time.

A number of road traffic accidents are increasing from Alabaqulito to Shashemene road which is happened on human, animal and properties on different section of road. Like fatal accident, heavy and minor accident and property damage. Drivers tend to slow down when driving on pavement distressed area in order to avoid accident; however, these will lead to traffic congestion and air pollution. Therefore, maintenance of pavement is essential to ensure good riding quality and avoid the happening of congestion, air pollution, and especially road traffic accident.

2. Research Questions

1. What the major types of distress their extent and level of severity that influence on road traffic accident?
2. What is the rate of road traffic accident due to AC pavement distress?
3. How does the road traffic accident occur from AC pavement distress?
4. What is an effective way to achieve the effect of AC pavement distress on road traffic accident?

3. Study Area

The study area for this research was located from Alabaqulito-Shashemene road. Alaba is liyu wereda which locate in SNNPR & Shashemene is zone which locates in Oromia region. This study covers 65 km length where asphalt concrete pavement is constructed with in Ethiopia regulated by Ethiopian road authority. From the statement of the problem point of view can understand that the issue is common in all part of the country. As a result, to make the research feasible the study area is on the effect of asphalt concrete pavement distress on road traffic accident from Alabaqulito-Shashemene road.

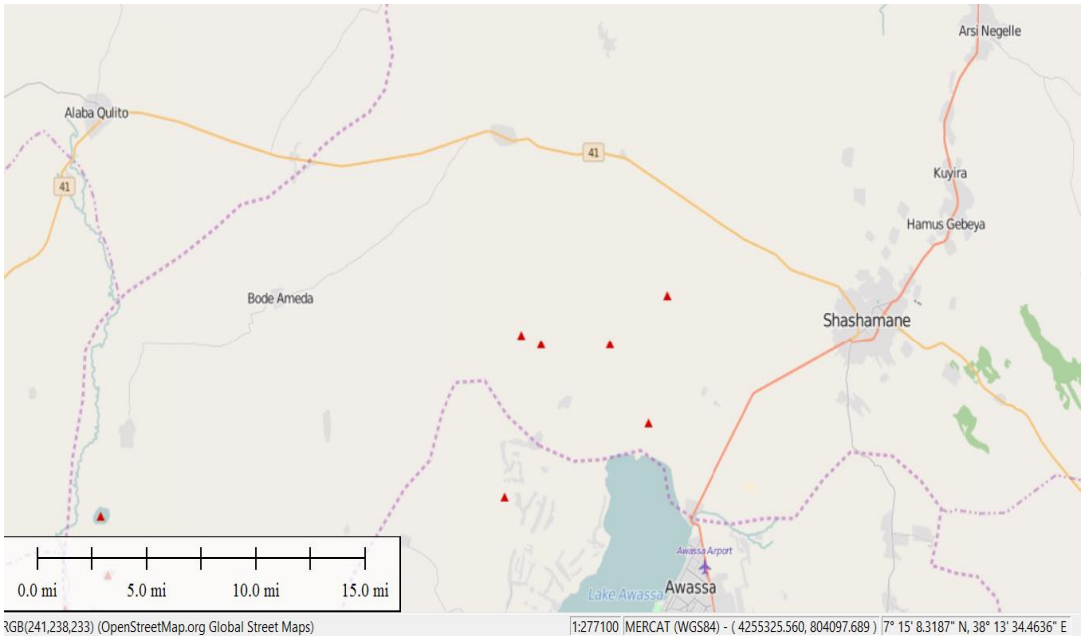


Figure 1. The route of road that connect Alabaqulito & Shashemene town

4. Research Design

4.1 Sampling Technique and Sample Population

The sample population was taken out from all segments which found Alabaqulito to Shashemene road and method of sampling used is purposive sampling technique. The areas to be sampled in this study are all segments located on the access road networks as they are suspected to high traffic volume. Thus the sample population includes all segments including Shashemene and Alabaqulito town located on access road network and having bad road condition (AC pavement). Based on this the sample population includes Alaba, Gedeba, Qufe, Ansha, Sherero, Guba, Yaye ,Debaso, Aje town, Cibo, Awara, Fisa, Bura,, Alamgebaya, Enbure, Shashemene segments for the study.

4.2 Data Collection Method

They are both primary and secondary data comprising of quantitative and qualitative types. These collected data includes,

- Road traffic accident data according to their severity i.e. fatal, injury and property damage with the number of crashes happened of all segments in the road.
- Listing out the road traffic accident areas of sample population (segments).
- Characteristics of road condition in sample population with high frequency of road traffic accident due to deterioration of road.
- Remedial measures taken to minimize the occurrence of road traffic accident due to deterioration of road.

The method used for the data collection was review by historical road accident data organized and during site survey the discussion with traffic officers about the crashes due to deterioration of road and how road accidents are happening at the locations. The data collected were all accidents happened from 2012 to 2016. For the Shashemene zone, a four years data was available from 2012/13-2015/16 and for Alaba liyu Werada an eight

years data's from 2007/8-2015/16 but for the analysis of data the last four year had been used**.**

4.3 Data Analysis

Data collected was analyzed according to their types as quantitative and qualitative. The raw data collected were organized and grouped to be easy for the conducted by both descriptive and analytical methods. The location of high influence of pavement distress for road traffic accident in a given 65 km length are identified by using accidental History Data (AHD) & site investigation. This study is evaluated from the rate of accident due to deterioration of road. the accident data is collected from existing AHD stored police station & identified which the accident is cause by pavement distress. Using the resent data through distress survey a place where accident is occurred, is verified the type of distress and measured the extent and severity level of the road. The samples of AHD are gathered and the data collected from each sample areas is organized according to their distress type, extent and severity level. The analysis of the effect of asphalt concrete pavement distress on road traffic accident is done statistically.

5. Results and Discussions

5.1 Characteristics of road traffic accident in Shashemene -Alabaqulito road

The data collected in Shashemene and Alabaqulito a total of 402 RTA were happened from 2012/13-2015/16. In this four year the maximum crashes were happened in 2015/16 as illustrated in figure below. In the recorded four year data there were 202 injuries (both major and simple) were occurred. When considering the number of road traffic accident in each year there is an increase in the number of occurrence of the accidents, fatality and injury from 2012/13-2015/16. The following graph shows the pattern of fatality, injury and total road traffic accident in Shashemene and Alabaqulito.

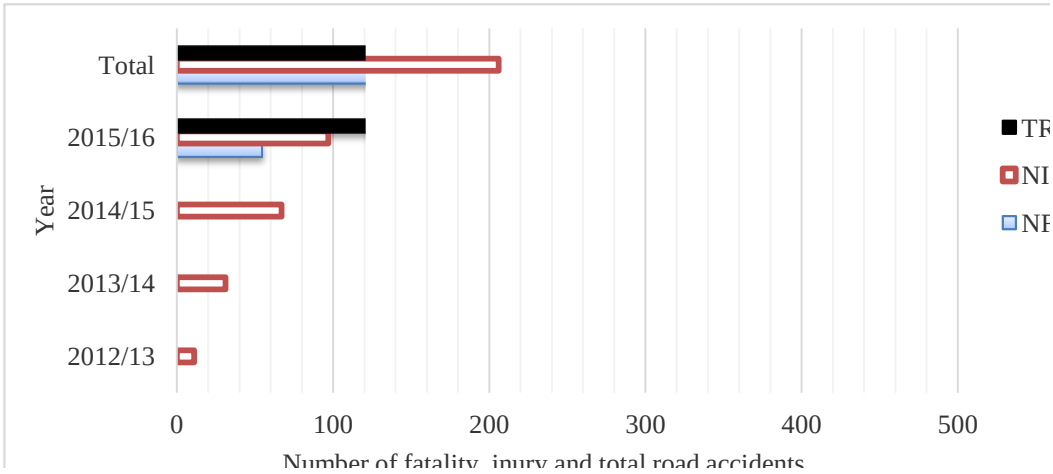


Figure 2. Total number of fatality (NF) injury (NI) and road traffic accident (TRTA) in Shashemene and Alabaqulito from 2012/13 – 2015/16

As it is explained in the below paragraph property damage is also another occurrence from the road accidents. Based on the collected data there was a large amount of damage recorded, estimated to 5,899,889 birr property from 2012/13 to 2015/16. In the first two year there is an increase on the amount of loss of property and a decrease in the third again increase in fourth year. Analyzing the loss of property damage in each year out of the total 32.22 % of loss occurred in 2015/16. Compared to the three previous

years this loss is greater which is about 21.57 % in the first year, 24.35% in the second year and 21.80% in third year.

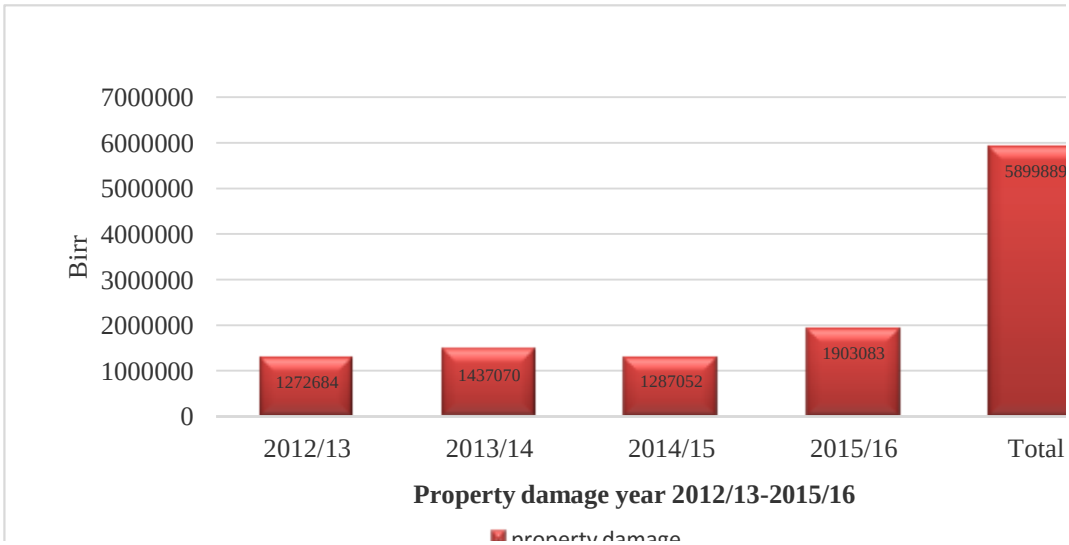
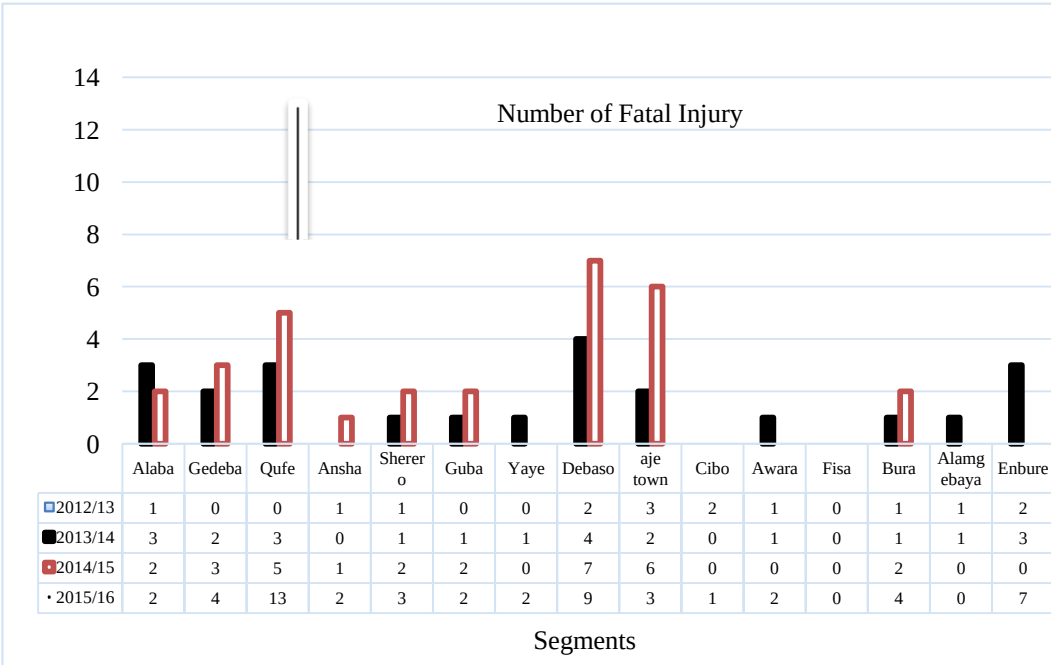


Figure 3. Property damage due to accident from 2012/13-2015/16

5.2 Analysis of Fatal Accidents

One of the negative impact of road traffic accident is the occurrence of fatal accidents during and after the existence of crashes. It is the most dangerous part of road traffic accident as it results in the loss of life of the road user's i.e. the driver, passengers, pedestrians or an individual around the incidence. Based on the collected data there was an increase of the fatality rate in each year. For instance there was an increase by 53.33% in 2013/14, 30.43% in 2014/15 and 80% in 2015/16.



	Alaba	Gedeba	Qufe	Ansha	Sherero	Guba	Yaye	Debaso	aje town	Cibo	Awara	Fisa	Bura	Alamgebaya	Enbure
2012/13	1	0	0	1	1	0	0	2	3	2	1	0	1	1	2
2013/14	3	2	3	0	1	1	1	4	2	0	1	0	1	1	3
2014/15	2	3	5	1	2	2	0	7	6	0	0	0	2	0	0
2015/16	2	4	13	2	3	2	2	9	3	1	2	0	4	0	7

Figure 4. Fatality of accident in segment of Shahemene-Alabaqulito road

In observing the detail rate of fatal accidents in each segments there was 3 fatal in Aje town segment the highest of 2012/13. This accounts about 20% of the total road accidents in the year. In the same year on average about 0.938 accidents happened in which 62.5% of the segments (Alaba, Ansha, Sherero, Debaso, and Aje town, Cibo, Awara, Bura, Alamgebeya and Enbure) has registered values greater than the average 37.5% (Gedeba, Qufe, Guba, Yaye, Fisa and Sheshamene area) have showed no fatal accidents.

Table 1. Percentage of fatality due to accident of each segment in Shashemene -Alabaqulito road

No.	District	Year								Total	%
		2012/13	%	2013/14	%	2014/15	%	2015/16	%		
1	Alaba	1	6.67	3	13.04	2	6.67	2	3.70	8	6.56
2	Gedeba	0	0.00	2	8.70	3	10.00	4	7.41	9	7.38
3	Qufe	0	0.00	3	13.04	5	16.67	13	24.07	21	17.21
4	Ansha	1	6.67	0	0.00	1	3.33	2	3.70	4	3.28
5	Sherero	1	6.67	1	4.35	2	6.67	3	5.56	7	5.74
6	Guba	0	0.00	1	4.35	2	6.67	2	3.70	5	4.10
7	Yaye	0	0.00	1	4.35	0	0.00	2	3.70	3	2.46
8	Debaso	2	13.33	4	17.39	7	23.33	9	16.67	22	18.03
9	Aje town	3	20.00	2	8.70	6	20.00	3	5.56	14	11.48
10	Cibo	2	13.33	0	0.00	0	0.00	1	1.85	3	2.46
11	Awara	1	6.67	1	4.35	0	0.00	2	3.70	4	3.28
12	Fisa	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
13	Bura	1	6.67	1	4.35	2	6.67	4	7.41	8	6.56
14	Alamgebaya	1	6.67	1	4.35	0	0.00	0	0.00	2	1.64
15	Enbure	2	13.33	3	13.04	0	0.00	7	12.96	12	9.84
16	Shashemene	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total		**15**	**100**	**23**	**100**	**30**	**100**	**54**	**100**	**122**	**100**
Average		**0.9375**		**1.4375**		**1.875**		**3.375**		**14.35294**	

The fatal accidents happened in 2013/14 was 4 in Debeso segments which is about 50% increase compared to the preceding year in the same location. Comparing this value with the former highest value there was an increase by 33.34% from Aje town segment in 2012/13. The maximum value was 7 which incorporate about 23.34% of the total records in 2014/15. This peak value was recorded in Debeso segment. The maximum value recording was 13 in Qufe segment which cover 24% of total records in 2015/16. The average value was increased to 3.375 in last year.

5.3 Analysis of Injury Accidents

Similar to the fatal accidents caused by road traffic accident there is the probability for the occurrence of injury on the road users. Both fatal and injury accidents has common behavior in that they are happening on humans. In this analysis section for this study both major and minor injury were compiled together. There was a total of 206 injuries happened from 2012/13-2015/16 as shown in table 2. Out of this about 47.08% happened in 2015/16 is the highest of all. Following this, there was an increase by 181% in 2013/14 from preceding year, an increase by 116% in 2014/15 from the preceding year and an increase in 44.78% in last year from preceding year.

Table 2: Percentage of injury (both minor and major) due to road traffic accident of each segment in Shashemene- Alabaqulito road

No.	District	Year								Total	%
		2012/13	%	2013/14	%	2014/15	%	2015/16	%		
1	Alaba	1	9.09	0	0.00	3	4.48	4	4.12	8	3.88
2	Gedeba	1	9.09	2	6.45	2	2.99	2	2.06	7	3.40
3	Qufe	2	18.18	1	3.23	15	22.39	26	26.80	44	21.36
4	Ansha	0	0.00	3	9.68	11	16.42	3	3.09	17	8.25
5	Sherero	0	0.00	0	0.00	3	4.48	1	1.03	4	1.94
6	Guba	1	9.09	2	6.45	0	0.00	2	2.06	5	2.43
7	Yaye	0	0.00	4	12.90	3	4.48	6	6.19	13	6.31
8	Debaso	0	0.00	3	9.68	2	2.99	4	4.12	9	4.37
9	Aje town	2	18.18	3	9.68	13	19.40	22	22.68	40	19.42
10	Cibo	0	0.00	4	12.90	7	10.45	9	9.28	20	9.71
11	Awara	1	9.09	3	9.68	2	2.99	5	5.15	11	5.34
12	Fisa	0	0.00	0	0.00	1	1.49	1	1.03	2	0.97
13	Bura	2	18.18	0	0.00	1	1.49	3	3.09	6	2.91
14	Alamgebaya	0	0.00	0	0.00	3	4.48	6	6.19	9	4.37
15	Enbure	1	9.09	5	16.13	0	0.00	3	3.09	9	4.37
16	Shashemene	0	0.00	1	3.23	1	1.49	0	0.00	2	0.97
	Total	**11**	100	**31**	100	**67**	100	**97**	100	**206**	**100.00**
	AVERAGE	**0.6875**		**1.9375**		**4.1875**		**6.0625**			

The average values of 0.68, 1.937, 4.18, and 6.06 in each year were observed. The number of segments having injury below the average values is 50% in 2012/13, 2013/14 is about 43.75%, 2014/15 is about 75% and 81.25% in last year. The following figure 6 shows the number of injury for each of the segment Shashemene- Alabaqulito from 2012/13– 2014/15.

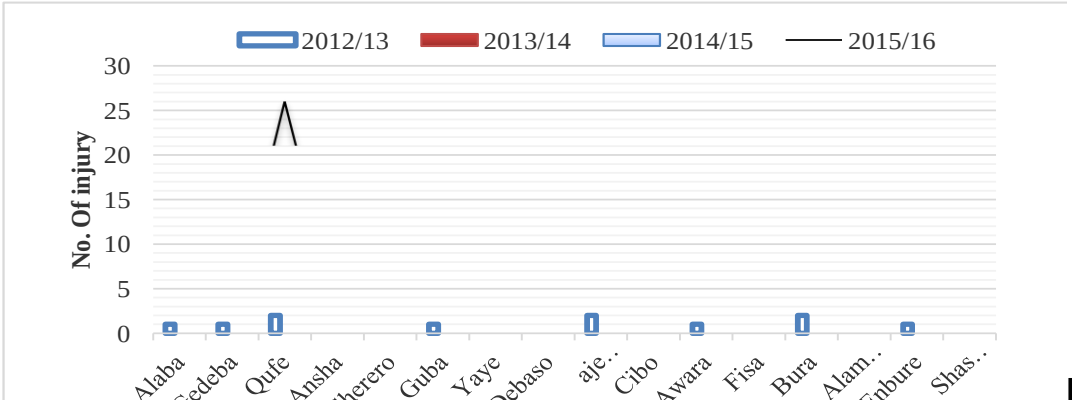


Figure 5. Injury accidents in Shashemene- Alaba from 2012/13-2015/16

5.4 Analysis of Property Damage

This is not the only side effect of road traffic accident; it is also the cause for the loss of property which includes destruction of vehicles, goods or freights. The amount of loss of property in the study area for each segment is shown in the following table 3.

Based on the data collected for the study (2012/13-2015/16), there was a total damage of property estimated to 5899889 birr. Comparing the estimated loss of property the highest amount was recorded in 2015/16 about 1903083 birr, 1437070 birr in

2013/14 and 1287052 birr in 2014/15. The least damage was in 2012/13 about 1272684 birr.

5.5 Pavement Distress Survey in Shashemene-Alabaqulito Road

The Shashemene ERA district provided roadway data concerning distress characteristics of pavement sections for Shashemene-Alaba routes. This road connects the Oromia region and SPNNR region. The road is a major transport facility for trucks and buses that transport goods and passengers from Shashemene to Alaba southern region. A portion of this road 65 km length had been plagued by significant distresses. This particular road section recently had received a 30mm overlay.

However, currently the overlay construction was badly cracked, potholes, bleeding and rutting. It was observed that there improper shoulder off and edge of pavement off and very bad condition located. These conditions of pavement prompted the urgent need for a detailed inspection of failures. This road has been experiencing considerable pavement failures. The road narrows to one lane in each direction. It was observed that the majority of the damage is large potholes. Most of potholes are considered high severity and located along the road carriageway.

In this road, no shoulder or bad shoulder conditions which cause difficulty in operating vehicles in certain circumstances, and potentially lead to increase in accident severity. Shashemene zone has 5 entrance of alignment which is through Awasa, Ziway, Bale robe, Medewelabu and Alabaqulito liyu wereda. In addition Alabaqulito liyu wereda has 4 entrance of alignment which is through welayita zone, hadiya zone, silite zone and Shashemene zone.

Even though from all this alignment of the route, the road traffic accident from Shashemene zone to Alabaqulito liyu wereda is alarming rather than the other routes due to deterioration of road and the highest severity level and extent of bleeding and rut depth, pot holes, shoulder scour. Especially accident is increase during market days (Thursday and Saturday) because the number of cart and car which flows on the carriageway is crowded. The most commonly found pavement distresses were pot holes, rutting, bleeding and shoulder scour.

Table 3. Cost of property damage from 2012 - 2016 (the amount in birr)

No.	District	Year								Total
		2012/13	%	2013/14	%	2014/15	%	2015/16	%	
1	Alaba	27500	2.16079	0	0	14600	1.13438	15300	0.80396	57400
2	Gedeba	331000	26.008	390500	27.1733	194570	15.1175	0	0	916070
3	Qufe	11584	0.9102	98870	6.87997	0	0	98960	5.19998	209414
4	Ansha	0	0	3600	0.25051	54900	4.26556	56600	2.97412	115100
5	Sherero	78000	6.12878	15300	1.06467	0	0	0	0	93300
6	Guba	0	0	0	0	62000	4.81721	68000	3.57315	130000
7	Yaye	191000	15.0077	95000	6.61067	0	0	286000	15.0282	572000
8	Debaso	0	0	268000	18.6491	160500	12.4704	0	0	428500
9	aje town	293500	23.0615	0	0	117000	9.09054	68650	3.6073	479150
10	Cibo	79100	6.21521	22100	1.53785	14500	1.12661	21000	1.10347	136700
11	Awara	0	0	0	0	80000	6.21576	83920	4.40969	163920
12	Fisa	40000	3.14296	94000	6.54109	0	0	112000	5.88519	246000
13	Bura	0	0	36700	2.55381	458982	35.6615	502653	26.4126	998335
14	Alamgebaya	196000	15.4005	381000	26.5123	130000	10.1006	0	0	707000
15	Enbure	0	0	10000	0.69586	0	0	0	0	10000
16	Shashemene	25000	1.96435	22000	1.53089	0	0	590000	31.0023	637000
	Total	1272684		1437070		1287052		1903083		5899889
	Average	79542.8		89816.9		80440.8		118943		

Table 4. Road condition survey from Alabaqulito to Shashemene road

No	Segment	Distress Type	Direction	No	Length (mm)	Width (mm)	Avg. Depth (mm)	Severity	Extent
1	Alaba	Potholes		10	473	2010	75	2	2
		bleeding			90000	7000		2	2
2	Gedeba	Potholes		34	1320	1515	153	3	3
3	Qufe	bleeding			87000	6500		3	3
		shoulder scour	Left		60000	1120		3	3
			Right		45789	1000		3	3
4	Ansha	potholes		8	3012	266	73	2	2
		shoulder scour	Left		32000	600		2	2
			Right		20000	125		2	2
5	Sherero	potholes		23	2506	478	160	3	3
		rutting			4500		120	3	2
		shoulder scour	Left			1500		3	2
			Right		60000	1236		3	2

6	Guba	potholes		15	2650	1132	151	3	3
		rutting			7000		90	3	2
		shoulder scour	Left		34000	789		3	2
			Right		50000	1600		3	2
No	Segment	Distress Type	Direction	No	Length (mm)	Width (mm)	Avg. Depth (mm)	Severity	Extent
7	Yaye	potholes		19	2345	896	180	3	3
		rutting			15000		100	3	3
		shoulder scour	Left		90345	1320		3	2
			Right		67000	1450		3	2
8	Debaso	potholes		31	2358	1060	220	3	3
		rutting			5000		230	3	3
		shoulder scour	Left		10000	340		3	3
			Right		89000	850		3	3
9	Aje town	potholes		15	1000	1500	153	3	3
		rutting			25000		150	3	3
		shoulder scour	Left		5000	950		3	3
			Right		15000	1200		3	3
10	Cibo	shoulder scour	Left		9000	980		3	2
			Right		45000	1320		3	2
		potholes		35	1235	1000	164	3	3
11	Awara	potholes		29	2500	2012	154	3	3
		shoulder scour	Left		43000	300		3	3
			Right		32000	700		3	3
12	Fisa	rutting			19000		50	2	2
13	Bura	potholes		17	2000	800	200	3	3
14	Alamgebaya	potholes		13	1000	3000	190	3	3
15	Enbure	potholes		11	1234	3457	150	3	3
16	Shashemene	rutting			20000		48	2	2

The above pavement distress survey has been done using ERA road condition survey manual. From the sample segments, those from the area that is very vulnerable by road traffic accident due to pavement distress are shoulder scour, bleeding, pot holes, rut depth. The standard limit for each distress is shows as following.

Table 5. Shoulder-scour from ERA road condition survey manual

Severity	Extent
1. Shoulder profile less than design 5 % drainage becoming impaired. 2. Shoulder slightly scoured, some erosion channels, drainage impaired, Shoulder sloping towards carriageway. 3. Shoulder heavily scoured, water not getting of ditch shoulder sloping markedly towards the carriageways.	1. Less than 20 % of the section affected. 2. Between 20 % and 50 % of section affected. 3. Greater than 50 % of the section affected

The deformations specific to flexible pavements almost always lead to rutting or subsidence. Their degree of severity is determined by the depth (h) measured on a straight edge 1.5 m long placed crosswise on the pavement and wedge to make task simple and faster.

Table 6. Rutting from ERA road condition survey manual

Severity	Extent
1. Max rut depth between 10 mm and 20 mm 2. Max rut depth between 20 mm and 50 mm 3. Max rut depth greater than 50 mm	1. Less than 20 % of the section affected 2 .Between 20 % and 50 % of section affected 3. Greater than 50 % of the section affected

Note: The rut depth is to be measured at selected areas in the sections and the maximum reading recorded.

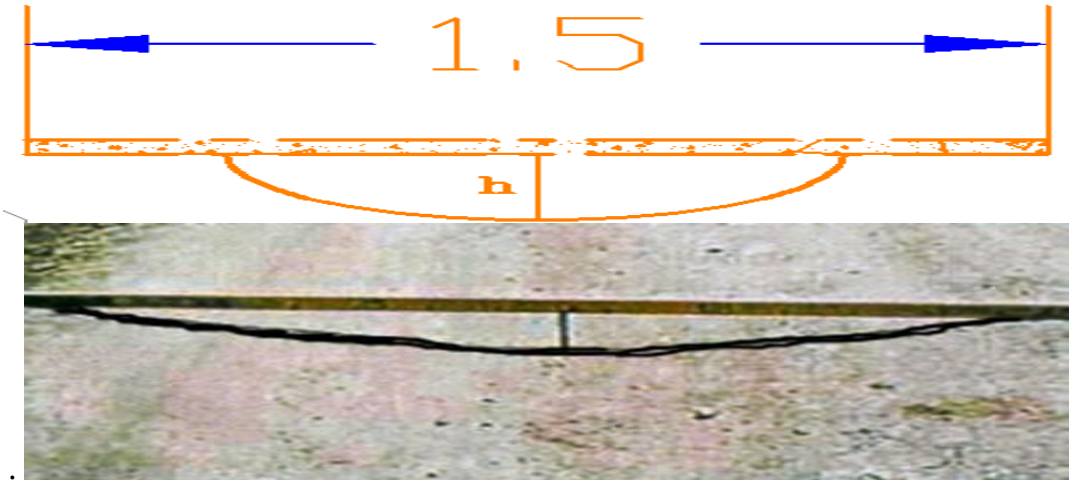


Figure 6. Shows the measurement of rutting depth

Potholes in the carriage way surface should be recorded by measuring the affected area in each 500 m section. Where the potholes are very large, greater than one meter, the inspector should ensure that the pothole can be repaired using a pothole repair activity. For very large potholes the damage to the road base may be extensive and a deep base repair may be required. If this is the case then the defect should be recorded as a failure. Depending on the degree of severity of these potholes, it may be necessary to rebuild part of the wearing course or, if they have become too deep, of the wearing course and road base. In some cases, it may even be necessary to rebuild the whole pavement. If there are too many potholes, it may be necessary to rebuild a considerable length of pavement.

Table 7. Pot holes from ERA road condition survey manual

Severity	Extent
1. Pothole depth only in the surfacing. 2. 2 or more potholes greater than 0.5 m^2 in surface area or depth of into base course. 3. 2 or more potholes greater than 1 m^2 in surface area or depth of into sub base course.	1. Less than 1 pothole in the section. 2.Between 2 and 10 potholes in the section. 3. More than 10 pothole in the section.

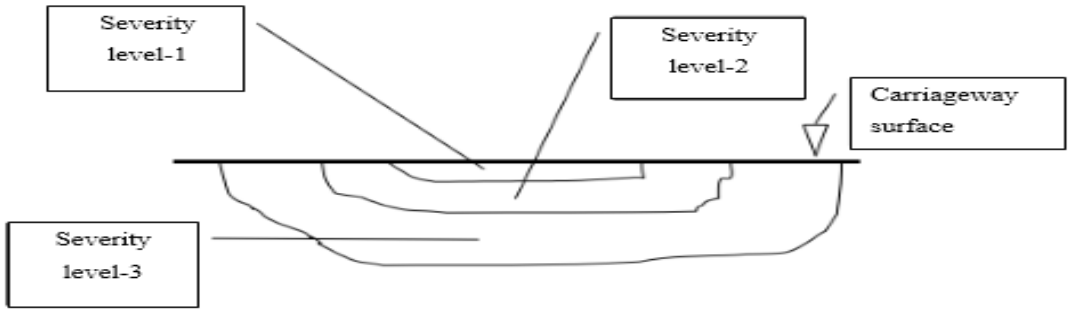


Figure 7. Shows the severity level of pot hole

5.6 Relationship between Number of Traffic Crashes and Pavement Distress

From the results is along the road, there are some notable location or segment like Qufe has the highest accident rate from the entire 16 segment in 2016. It could have contributed to such a high traffic crashes are occurred due to the effect of bleeding, potholes and rut depth. In addition the deterioration of pavement road with the existence of vegetation which limits the visibility of drivers. From out of 16 sample segment Alaba, Ansha, Fisa, Shasemene are severity level 2 but the rest of segment like Gedeba, Qufe, Sherero, Guba, Yaye, Debeso, Aje town, Cibo, Awara, Bura, Alemgebeya, Enbure are severity level 3 of road distress.

Table 8. Severity level of road and traffic crashes

Location	Level of severity			Total No of crashes in 2016	Total No injured in 2016	Total No killed in 2016	Total No injury/Total No crashes	Total No killed/Total No crashes
	1	2	3					
Alaba		2		7	4	2	0.571	0.286
Gedeba			3	11	2	4	0.182	0.364
Qufe			3	13	26	13	2.000	1.000
Ansha		2		7	3	2	0.429	0.286
Sherero			3	10	1	3	0.100	0.300
Guba			3	9	2	2	0.222	0.222
Yaye			3	11	6	2	0.545	0.182
Debaso			3	8	4	9	0.500	1.125
Aje town			3	12	22	3	1.833	0.250
Cibo			3	13	9	1	0.692	0.077
Awara			3	10	5	2	0.500	0.200
Fisa		2		5	1	0	0.200	0.000
Bura			3	11	3	4	0.273	0.364
Alamgebaya			3	10	6	0	0.600	0.000
Enbure			3	11	3	7	0.273	0.636
Shashemene		2		5	0	0	0.000	0.000

Percentage of the extent of distress type is pothole 32%, bleeding 5%, shoulder scour 45% and rutting 18%. The extent of distress throughout study is 42.5% extent 2 (medium) and 57.5% extent 3 (high). Additionally Percentage coverage of the severity level 2(medium) is 17.5% and severity level 3(high) 82.5% of road distress.

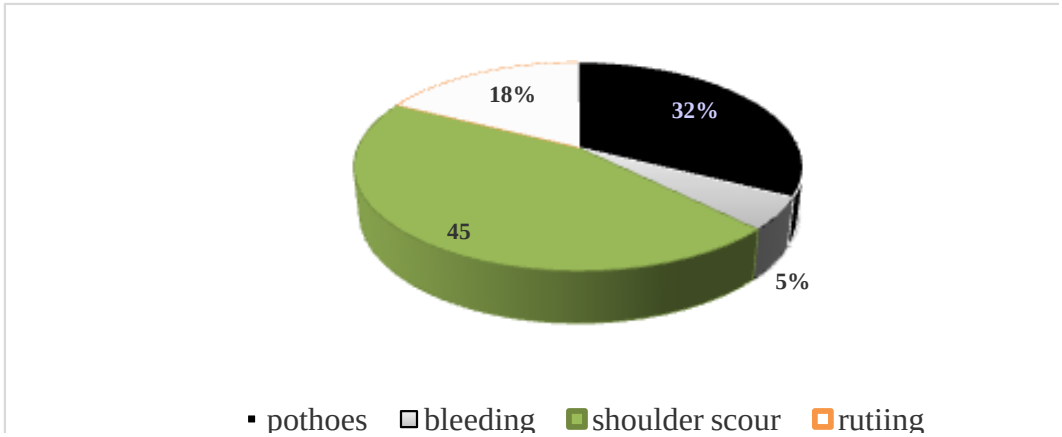


Figure 8. Type of distress in %

6. Conclusion and Recommendation

6.1 Conclusion

- The road traffic accident from Shashemene zone to Alabaqulito liyu wereda is increasing time to time due to deterioration of road. Especially the major distress type which contributed for traffic crashes are bleeding, rutting, potholes and shoulder scour rather than the other type of distress.
- Percentage of the distress type that influences for crashes are pothole 32%, bleeding 5%, shoulder scour 45% and rutting 18%. The extent of distress throughout study is 42.5% extent 2(medium) and 57.5% extent 3 (high). Additionally Percentage coverage of the severity level 2(medium) is 17.5% and severity level 3(high) 82.5% of road distress.
- In the year 2016 the severity index from the number of crashes shows that the 1st highest fatality rate is 1.125 (Debaso segment) and the 2nd fatality rate is 1(Qufe segment) while the lowest rate of 0.07(Cibo segment) people killed per crash.
- The severity index from the number of crashes shows that the highest injury rate is 2(Qufe segment) and the second injury rate is 1.833(Aje town segment) while the lowest rate is 0.100 (Sherero segment) people injured per crash.
- Bleeding, rut depth, pothole, shoulder scour has more dominate effects for accident at Qufe, Yaye, Gedeba, Sherero respectively.

6.2 Recommendation

- The frequency and interval of this pavement distresses is too much and well exceeded from the ERA road condition standard, therefore ERA will immediate repair and maintenance is required either rehabilitation or reconstruction.
- Near to Alabqulito the bleeding is minor, coarse sand can be applied to the pavement in order to absorb the excess asphalt binder. At Qufe segment much of the pavement surface is affected by bleeding, the surface may need to be removed (i.e., milled) and the surface wearing course replaced.
- Posting Sign boards will be made for the drivers in order to reduce their speed from the standard limits till the road maintain.
- During the market days (Thursday and Saturday) the traffic flow of animal transportation is greater than the vehicle, the carriageway of the road is crowded both by vehicles and carts or animals transportation therefore in order to reduce the accident, just providing the diversion road for the animals or carts.

- The road surveying data will be collected and redesigned properly by the consultant.
- The quality of road construction will be made based on the design by the contractor.

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