

## A Review on Effect of Pavement Surface Failure on Road Traffic Accident

Debela Deme

Department of Civil Engineering, University of Gondar, Gondar, Ethiopia

\*Corresponding author: Debela Deme, Phone: +251913834664 E-mail: [Debela.Deme@gmail.com](mailto:Debela.Deme@gmail.com)

Received: February 4, 2020, Accepted: April 16, 2020, Published: April 16, 2020.

### ABSTRACT

Pavement surface condition was parameter used to define quality of road traffic system. In this review pavement surface condition inspected were pavement friction, roughness and rutting. In order to analysis the study considers all previous paper done by researcher in specified and related title. Due to data constraints and other related issues to signify the outcome this review randomly selects forty-five researches paper. As per the examination most researchers argue that affinity of pavement surface condition for the occurrence of road traffic accident was irrelevant in respect to other related factor (Vehicle speed, Road geometry, Wet pavement surface, Pavement edge and etc.). Even though; the impact was insignificant the number of people dies and injured kin with other accident triggering factor was significant. As a result; stakeholder must play substantial role to overcome road traffic accident due to lack of proper maintenance and management of pavement surface condition.

**Keywords:** *Effect; Friction; Pavement Failure; Skid Resistance; Rutting; Road Traffic Accident*

### INTRODUCTION

Effect of pavement surface failure on road traffic accident was the concern of our globe. Researchers define road pavement structure in different approaches. Jorge et al. (2019) define road pavement structure was made of multiple layer processed and compacted material in different thicknesses; primarily supports vehicle loads as well as providing a smooth riding quality (1). Other researcher supports (1) pavement was hard and high strength surface that separates the underlying well-compacted foundation of road from the weight of vehicles (2). Even if, pavement layers was well compacted and highly qualified to bear traffic load, due to that and other related factor pavement may be under risk of failure. Pavement failure occurs as soon as pavement surface no longer holds its original shape and develops material stress (3). When pavement reaches its terminal life the pavement surface suffers from distresses which unable to provide smooth surface for users (4). Categorically; pavement failure includes cracking, potholes, depressions, rutting, shoving, upheavals and raveling. That caused by a number of factors like: water intrusion, stress from heavy vehicles load, enlargement and shrinkage from seasonal temperature changes, and sun exposure (3).

Pavement failure was a process by which weakness developed on pavement under the combined effects of traffic load and environmental condition (5). Due to the presence of pavement failure; particularly, surface condition in line with other factors road traffic accident happen immensely. Most pavement failures primarily reflected at the wearing course or surface of the structure. As a result; pavement surface condition was a commencement and indicator for the occurrence pavement failure that contribute their own impact for the incidence of road traffic accident. This review considers failures on pavement surface those contribute road traffic accident, particularly; pavement friction, roughness and rutting. In different research paper scholars consider factors causes road traffic accident differently. Sharma and Lozano (2000) stated that road traffic accidents were usually caused by three major error originators, namely: human, environment and vehicle (6). According to Komba (2006) environment factor causes road traffic accident encompasses natural and built environments (7). In spite of this;

environment, particularly; road pavement surface was one parameter incorporated as causes for road traffic accident. As a result; this paper tries to review the effect of pavement surface failure on road traffic accident.

### Effect of Pavement Surface Failure on Road Traffic Accident

Different researchers argue that traffic accident depends on the pavement type and pavement condition. There were many studies showing that pavement condition can significantly increase chance of accident on different road types in relation with other factors causes' road traffic accident. Particularly; pavement surface condition play vital role for the incident of traffic accident in relation with speed of the vehicle, geometric condition of the road, presence of wet, road pavement edge and etc. There were multiple variables of pavement surface condition those causes road traffic accident. However; the possible contributors to road traffic accident were pavement friction (skid resistance), roughness (ride quality) and rutting (8) (9).

Pavement friction was force developed when a tire prevented from rotating slides along the pavement surface (10). Whereas; pavement roughness was irregularities in the pavement surface that adversely affect the ride equality of a vehicle (11). Similarly; rutting also defined as a longitudinal depression of paved surface in the wheel path(s) (12). As a result; pavement friction, roughness and rutting was the concern of this review to examine effect of pavement surface failure on road traffic accident. The review indicated below emphasize on those depicted factor causes road traffic accident intensely.

Craus et al. (1991) conclude that effect of pavement surface condition on road traffic accidents in Nigeria has no significant unilateral correlation (13). Al-Masaeid (1997) inspected that pavement surface condition has significant effect on single and multiple vehicle accident rates on rural road, but has no statistical influence on the total accident rate (14). Also Lee et al. (2015), poor pavement surface condition increases the severity of single vehicle crash on high-speed roads. However, in the low-speed roads, severity of single-vehicle crashes decreases for poor pavement surface condition (15). According to Abbagana et al. (2012) in Nigeria normalized number of crashes in the year 2012 due to Pavement surface condition has visible relationship. Even though; the researcher argue with the findings of Craus et al.

(1991) and Al-Masaeid (1997) due to weaken by scatter as evidenced by the  $R^2$  value of 0.466 (16). In China, it was shown that two substantial factors which leading to fatal accidents were traffic flow condition and pavement surface condition (17). According to Toshihiro et al. (2018) the study held in Minnesota on pavement surface condition and road crash; poor road pavement surface quality was associated with more property damage and injury crashes (18). The interaction of road quality and curves indicating that good pavement surface quality on curves increased the fatal, injury and property-damage crash rate (18). Yingfeng Li et al. (2013) stated that when the pavement condition was poor severe crashes were more likely, but when the pavement surface condition was very poor severe crashes were less likely to occur than poor pavement surface conditions (19). According to Mannering (2011) the severity of traffic accident probabilities on Driver varies from one surface-condition group to the other (20). Degradation of the pavement surface has a significant impact on road safety and, in particular, asphalt polishing turns out to be very hazardous for powered two wheelers (21). More specifically some authors agree that the deterioration of road pavement has a significant impact on road safety (22) (23). According to Jaeyoung et al. (2015) poor pavement surface condition decreases the severity of single vehicle collisions on low-speed roads whereas it increases their severity on high-speed roads. On the other hand, the poor pavement condition increases the severity of multiple-vehicle crashes on all roads (24). A review by Andrey et al. (2003) found that almost all research has shown an increase in the frequency and severity of crashes during adverse surface conditions (25). Ahmad et al. (2018) signify that pavement skid resistances on roadway departure crashes cause sevier accident (26). Among operational factors on road traffic accidents the substantial was pavement surface condition due deterioration and defects of pavement surface (27). As a result; skid resistance, driving off tracks, improper maneuvering was happen on the surface of the pavement (27). Regarding pavement surface friction, higher macrotexture cases safer highways and reduces accident rate (28). Similarly, higher skid resistance value decreases accident risk on dry roads due to sufficient friction force develops between tire and road pavement surface (27). Noyce (2005) found that the decrease in skid resistance lead to an increase in the wet crash rate (29). Similarly, Hall (2009) reported that review of various studies show that low friction factor lead to an increased crash rate (30). As a result; pavement friction (Skid resistance) play thier own role to define the occurrences and rate of road traffic accident. But, it has not as such powerful impact for the occurrences of that traffic accident by itself other than in cooperation with other related factors causes road traffic accident.

Hashem (1997) Pavement surface condition expressed in terms of the international roughness index has significant effects on single and multiple vehicle accident rates, but it has no statistical influence on the total accident rate (31). In Iran the highest mortality rate account 3.45% was happen on oily pavement surfaces condition (32). According to Amir (2020) increasing Average Annual Daily Traffic (AADT) with higher IRI value causes higher accident frequency (33). Pavement surface quality decreases the risk for vehicle increases (34). According to S N Baskara et al. (2019) in Malaysia more than 70% of the accidents happened at a good condition of road which having high Mean Texture Depth (MTD), low Rutting Depth (RD) and minimum International Roughness Index (IRI) (35). The study held by

Anastasopoulos et al (2012), the increase in International Roughness Index (IRI) increases the accident rates by 95.72% (36). Al- Masaeid (1997) found that the road roughness will decrease single-vehicles accidents but increases the multiple-vehicle accidents rate. The single-vehicle accident rate decreases as the pavement roughness increases due to reduced speeds. The multi-vehicle accident rate increases due to lateral shifts and speed differentials between road users (14). Pavement Condition Index (PCI) related to distress in pavement surface has a direct influence on the smoothness (IRI) which was the surface irregularities that affect the ride quality of road users (37). Study by Park depict that the lower the IRI value, the flatter the profile (37). According to Chan et al. (2010) an increase in the Average Annual Daily Traffic (AADT) with a higher IRI value led to higher accident frequency (38). The study done by Miss Bernie (2014) on Effect of Road Roughness on Traffic Speed and Road Safety in South Queensland, Australia depicted that higher crash rates and increased pavement roughness has strong relationship (39). The analysis done by Mounica (2017) depict that there was a positive correlation between road roughness and rut depth in all cases irrespective of crash severity level. Roughness and rut depth values for crash and non-crash segments were close to each other, suggesting that roughness and rutting were not the only factors affecting number of crashes but possibly in combination with other factors such as traffic volume, human factors and etc. (40). As a result; pavement roughness play thier own role to define the occurrences and rate of road traffic accident. But, it has not as such powerful impact for the occurrences of that traffic accident by itself other than in collaboration with other allied factors causes road traffic accident.

According to Ihs (2004) citing Sjölander et al. (1997), ruts possibly seem to had a tendency to improve traffic safety while unevenness (roughness) has the opposite effect (41). He also investigated the relation between traffic safety and road surface condition for the Swedish National Road Administration's (SNRA) and stated that accident ratio increases with increasing unevenness (International Roughness Index, IRI) (41). As the depth of in rut increases accident rates also increases by 94.27% (36). Strat et al. (2004) quantifies that rut accidents increase as the rut depth gets greater and greater (42). Anastasopoulos et.al (2012) also revealed that lower rutting depth decrease accident rates (36). Another study revealed that severe rutting might distract the driver that resulted into collision or running off track (43). Chan et al. (2010) also mentioned that the occurrence of accidents increases significantly by the rutting and roughness during night and under rainy weather conditions (38). Both rutting and roughness on pavement surface condition increase the accident frequency with the increase of Average Annual Daily Traffic (AADT) (38). A study carried out in Turkey proved that rutting was the most viable road surface pavement defect that relates to traffic accidents (44). As a result; pavement rutting play thier own role to state the occurrences and rate of road traffic accident. But, it has not as such influential impact for the incidences of that traffic accident by itself other than in assistance with other related issues causes road traffic accident.

**In general;** as per the assessment pavement surface failure has no as such significant impact for occurrences of road traffic accident. Even though; pavement surface condition serve as a contributory factor for the occurrences of road traffic accident in relation with other factors like speed of vehicle, geometric condition of road, existence of wet substance on pavement, road pavement edge and etc. As a result; proper management and

periodic maintenance of pavement surface as per specification was mandatory and has significant impact on the reduction of road traffic accident. So, the concerning body and stakeholder must play a vital role in the management and maintenance of pavement surface condition in line with standard and specification that keenly reduce road traffic accident.

#### Acknowledgments

It gives me great pleasure to honor those who contributed their precious time in reviewing and commenting my work while conducting this review. First of all, I thank and glorify the Almighty GOD for the courage and strength I got to undertake this research. I would like to thank Mr. Meshesha Demie for his concern and cooperation in reviewing and providing constructive feedback on the report. At this occasion, I am very glad to thank all my family members specially Miss. Sifan Demie for her appreciation and consistent care towards all my efforts.

#### Statement of Declaration

I declare that the research entitled **“Effect of Pavement Surface Condition on Road Traffic Accident”** was my review work and it hasn't been presented for the award of any other similar titles by other researchers

In LC circuit (one with no resistor) charge flows back and forth between the capacitor plates through the inductance. The energy oscillates back and forth between the capacitor's electric field (E) and the inductor's magnetic field (B). The resonant frequency for such a circuit is un-damped resonance frequency. In RLC circuit (one with resistor), the resistor increases the decay of the oscillation and reduces the peak resonant frequency. Therefore, the peak resonance frequency depends on the value of the resistor and is described as the damped resonant frequency. The value of resistor causes the circuit oscillations to be critically damped, under damped and over damped. Despite of this, RLC circuits operate the same way as LC circuits, except that the oscillating currents decay with time to zero due to the resistance in the circuit.

#### REFERENCES

- Jorge de Brito, Ru V. Silva, Chao Qun Lye. Sustainable Construction Materials. s.l. : Woodhead Publishing Series in Civil and Structural Engineering, 2019. pp. 451-494.
- Jalal Asfar. Road Pavement | Pavement Types. s.l. : Engineering Intro, 2012.
- Lone Star Paving. <https://www.lonestarpavingtx.com>. <https://www.lonestarpavingtx.com/what-is-pavement-failure/>. [Online] April 28, 2017. [Cited: Febraury 29, 2020.]
- Incorporating pavement skid resistance and hydroplaning risk considerations in asphalt mix design. Chu L and Fwa T F. 2016, J. Trans. Eng. , p. 142.
- Pavement Defect and Failure. The Engineering Community. 2018.
- The global burden of injuries. Sharma and Lozano Krug. 2000.
- Risk Factors and Road Traffic Accidents in Tanzania: A Case Study of Kibaha District. Komba. 2006, p. 10.
- Assessing the Impacts of Pavement Surface Condition on the Performance of Signalized Intersections. . Hussein, R.A., Hassan and R., Evans N.A., Washington, DC, USA : s.n., 18-21 May 2015. The 9th International Conference on Managing Pavement Assets.
- Vinayakamurthy M. Effect of Pavement Condition on Accident Rate. . Arizona State University, Tempe, AZ, USA, 2017. : Masters' Thesis, 2017.
- Highway Research Board. Skid Resistance. National Cooperative Highway Research Program Synthesis of Highway Practice. Washington, D.C : National Academy of Sciences,, 1972. Vol. 14.
- Ksaibati, Khaled, and Shahriar Al Mahmood. Utilizing the Long-term Pavement Performance Database in Evaluating the Effectiveness of Pavement Smoothness. . Civil and Architectural Engineering,. s.l. : University of Wyoming, 2002. No.MPC Report No. 02-130. .
- U.S. Department of Transportation/Federal Highway Administration. Highway Performance Monitoring System (HPMS) Field Manual - Policy | Federal Highway Administration. USA : s.n., 2014.
- Effect of pavement and shoulder condition on highway accidents. Craus, J., Livneh, M., and Ishai, I. Washington, D.C., : Transportation Research Board, 1991, Transportation Research Record 1318, , pp. 51-57.
- Impact of pavement condition on rural road accidents. . Al-Masaeid, H. 4, 1997, Canadian Journal of Civil Engineering, Vol. 24, pp. 523-532.
- Effects of pavement surface conditions on traffic crash severity. Lee, Jaeyoung, BooHyun Nam and Mohamed Abdel-Aty. 10, 2015, Journal of Transportation Engineering , Vol. 141 .
- The Effect of Pavement Condition on Traffic Safety: A Case Study of Some Federal Roads in Bauchi State. Abbagana Mohammed, Tijjani Yero Ahmed, Samson Duna. 3, 2016, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Vol. 12, pp. 139-146.
- Towards Sustainable Transportation Systems. Yafeng, Y., Yin Hai, W., Lu, J., and Wei, W. s.l. : American Society of Civil Engineers. , 2011. 11th International Conference of Chinese Transportation Professionals. pp. 1925-1933.
- Toshihiro Yokoo, David Levinson, Mihai Marasteanu. Pavement condition and crashes. Minnesota : University of Sydney, 2018.
- Impact of pavement conditions on crash severity. . Yingfeng Li, Chunxiao Liu and Liang Ding. 2013, Accident Analysis & Prevention, , Vol. 59, pp. 399-406 .
- The effects of road-surface conditions, age, and gender on driver-injury severities . Mannering, Abigail Morgan and Fred L. 2011, 2011, Accident Analysis and Prevention, Vol. 43, pp. 1852-1863.
- Impact of Pavement Defects on Motorcycles' Road Safety. Francesco Bella, Alessandro Calvi and Fabrizio D'Amico. Department of Sciences of Civil Engineering, University Roma Tre Via Vito Volterra, 62 00146 Rome, Italy : s.n., 2012. SIIV - 5th International Congress - Sustainability of Road Infrastructures.
- Road safety and pavement management: new perspectives and advanced technologies. Benedetto A. and Angiò C. Tai'an, China. : s.n., 2002. Proceedings of International Symposium on Safety Science and Technology (ISSST).
- Incorporating road safety into pavement management. . Tighe S., Li N., Falls L. and Hass R., 2000, Transportation Research Record, Vol. 1699, pp. 1-10.
- Effects of Pavement Surface Conditions on Traffic Crash Severity. Jaeyoung Lee M.ASCE, BooHyun Nam A.M.ASCE and Mohamed Abdel-Aty M.ASCE. 10, 2015, J. Transp. Eng, Vol. 140, pp. 1-11.

25. Weather as a chronic hazard for road transportation in Canadian cities. Andrey, J., Mills, B., Leahy, M., Suggett, J., 2-3, 2003, *Natural Hazards* , Vol. 28, pp. 319-343.
26. Impact of Pavement Surface Condition on Roadway Departure Crash Risk in Iowa. Ahmad Alhasan, Inya Nlenanya, Omar Smadi and Cameron A. MacKenzie. 14, Iowa State University, Ames, IA 50011, USA : s.n., 2018, *Infrastructures*, Vol. 3, pp. 1-16.
27. Evaluation of Skid Resistance Characteristics And Measurement Methods. Andriejauskas. T, Vorobjovas. V and Mielonas. V. 2014. 9th International Conference of Environmental Engineering. *Enviro*. 2014.141.
28. Incorporation of Surface Texture, Skid Resistance and Noise into PMS. Alauddin & Susan. Ontario, Canada : s.n., 2008. 7th International Conference on Managing Pavement Assets. .
29. Noyce, David A. Incorporating Road Safety into Pavement Management:Maximizing Asphalt Pavement Surface Friction for Road Safety Improvements." Draft Literature Review and State Surveys". Madison, WI. : Midwest Regional University Transportation Center (UMTRI), 2005.
30. Hall, J. W. Guide for pavement friction. Washington,DC: NCHRP Project, 2009. pp.1-43.
31. Impact of pavement condition on rural road accident. Hashem R, Al-Masaeid. 1997, *Can. J. Civ. Eng.* , Vol. 24, pp. 523–531.
32. The impact of environmental factors on traffic accidents in Iran. Kamran B. Lankarani, Seyed Taghi Heydari, Mohammad Reza Aghabeigi, Ghasem Moafian, Amin Hoseinzadeh, Mehrdad Vossoughi. 2, 2014 , *J Inj Violence Res.* , Vol. 6, pp. 64-71.
33. Amir Bahador Parsa. Pavement Condition and Traffic Safety. Chicago : University of Illinois, 2020.
34. Simulation of road defects to incorporate safety measures in programming maintenance interventions. D'Amico F. Rome, Italy : s.n., 2007. *Proceedings of Road Safety and Simulation*.
35. Influence of pavement condition towards accident number on Malaysian highway. S N Baskara, H Yaacob, M R Hainin , S A Hassan, N Mashros, N Z M Yunus, N A Hassan, M N M Warid, M K Idham, C R Ismail, H M Nor, A Mohamad, MMA Aziz, R N Afiqah, M S A Ahmad and R P Jaya. Malaysia : IOP Publishing, 2019. *IOP Conf. Series: Earth and Environmental Science* 220 (2019) . pp. 1-9. 012008.
36. A Study Of Factors Affecting Highway Accident Rates Using The Random-Parameters Tobit Model. Anastasopoulos P. C., Mannering F. L., Shankar V. N. and Haddock J. E. 2012, *Accid. Anal. Prev.*, Vol. 45, pp. 628–33.
37. Applicability of the International Roughness Index as a Predictor of Asphalt Pavement Condition. Park, K., Thomas, N. E., Lee, K. W. 2007, *J. Transp. Eng.*, pp. 706–709.
38. Investigating Effects Of Asphalt Pavement Conditions On Traffic Accidents In Tennessee Based On The Pavement Management System (PMS). Chan, C. Y., Huang, B., Yan, X., and Richards, S. 3, 2010, *J. Adv. Transp.*, Vol. 44, pp. 150-161.
39. Miss Bernie-Anne King. The Effect of Road Roughness on Traffic Speed and Road Safety. South Queensland : University of Southern Queensland, 2014.
40. Mounica Vinayakamurthy. Effect of Pavement Condition on Accident Rate. Arizona : Arizona State University, 2017.
41. The Influence of Road Surface Condition on Traffic Safety and Ride Comfort., Ihs A. Brisbane, Queensland, Australia. : s.n., 2004. 6th International Conference on Managing Pavements.
42. Potential Safety Cost Effectiveness Of Treating Rutted Pavements. . Strat, M. R., Kim, J., Berg, W. D. 2004, *Transp Res Rec.*, Vol. 1629, pp. 208–213.
43. Incorporating Road Safety And Accidents Prediction Into Pavement Management. Li, N., Tighe, S. and Haas, R. 1998, *Transportation Research Record*, Vol. 519.
44. Modeling Traffic Accidents in Turkey Using Regression Analysis. Bilimlari, and Dergisi, Universitesi,. 2, 2012, *Igdir Univ. J. Inst. Sci. & Tech.*, Vol. 3, pp. 69–78.

**Citation:** Debela Deme (2020). A Review on Effect of Pavement Surface Failure on Road Traffic Accident. *J. of Advancement in Engineering and Technology*, V7I3.08. DOI: 10.5281/zenodo.3754298.

**Copyright:** © 2020: Debela Deme. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.